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Organic phosphorus in the soil constitutes a major portion of the total soil phosphorus. This organic phosphorus undoubtedly plays an important role in the nutrition of the plants. In order to better understand the factors affecting the availability of organic phosphorus to plants it is necessary to understand its composition. Previous workers have proposed that the organic phosphorus was composed of four different groups of compounds; namely, inositol phosphorus, nucleic acid, lipid phosphorus, and phosphorylated metabolic intermediates. The latter two have been shown to be present in very small quantities. It was believed, therefore, that the soil organic phosphorus was largely composed of inositol phosphate and nucleic acid. Good quantitative estimates have been made of the amount of inositol phosphorus occurring in soils, but the information on the occurrence of nucleic acid has been mainly of an indirect nature.

This study was instigated for the purpose of determining the quantity of nucleic acid in soil. A combination of chromatographic and spectrophotometric techniques was employed.

Several methods of soil extraction were tested and a method was developed, using 1N NaOH for 19 hours at 30°C. The alkaline extract thus obtained was acidified and the humic material precipitated. The nucleotides contained in the acidified filtrate were adsorbed onto activated alumina to separate them from excess salt. Removal of the nucleotides from alumina was accomplished with dilute NH₄OH. Concentration of the organic phosphorus solution and removal of the ammonia were effected by vacuum distillation.

The concentrated phosphorus solution was adjusted to a pH of 8 and adsorbed onto a column of Dowex A-1, a strong base anion exchanger. Elution of the adsorbed compound was effected by leaching the column with dilute solutions of HCl. The eluant was collected in several fractions by the use of an automatic fraction collector. Organic phosphorus determinations were made on the eluant fractions and the data obtained were plotted to give an ion-exchange graph.

Several columns containing soil extracts, combinations of soil extracts, and nucleic acid were prepared and eluted simultaneously so that their elution patterns could be better compared.

Spectrophotometric studies were made on the fractions of the eluted material which appeared to be similar to nucleic acid products. The ultraviolet absorption curves obtained from the soil extract eluants were then compared with those of nucleic acid components treated in the same way. Quantitative estimates were made of the amounts of nucleic acid in the soils studied. The data indicated that the Carrington soil did not contain more than 1 and the Webster not more than 6 ppm. of ribonucleic acid phosphorus. The above method is a specific test for nucleic acid components and offers a sound basis for estimating the maximum amounts in the soil.

Incubation studies were made to compare the dephosphorylation rates of deoxyribonucleic and ribonucleic acid in sand and soil cultures. The results indicated that both of these substances undergo rapid dephosphorylation in the soil.

Acid hydrolysates of soil organic matter were tested for the presence of purine bases. Soil extracts were compared on paper chromatograms with known materials. The developed chromatograms were scanned with ultraviolet light and no migration of purines from the soil could be detected.

All of the evidence obtained in this study indicates that only very small quantities of nucleic acid are present in soil. The large fraction of soil organic phosphorus has yet to be identified chemically.
The actions of genes controlling quantitative characters may be described by gene models. Complicated models may be devised which will describe the gene actions completely, but these models would undoubtedly be of no practical utility. Geneticists have devised simple models to describe the simple additive gene actions but have not been successful in devising a simple model which will describe interactions of genes as well as the additive action. The present work was undertaken to investigate possibilities of obtaining a model of the latter type. The result of the investigation was the adaptation and utilization of the factorial model for quantitative inheritance problems.

The factorial gene model, based on the factorial model used in the design of experiments, was developed. The comparisons in the population of all possible genotypes using this model allow that the heterozygotes have twice the weight of the homozygotes. As a result, the model for the genotypic value of an individual represented by \( a_{i_1}b_{j_1}c_{k_1} \ldots \), that is, an individual in which the \( a \) locus is in the \( i \)th phase, the \( b \) locus is in the \( j \)th phase and so on (\( i, j, \ldots = 0, 1 \) or \( 2 \) dominant alleles present at that locus), is

\[
\mu = A_i + B_j + A_iB_j + C_k + A_iC_k + B_jC_k + A_iB_jC_k + \ldots
\]

where:

(a) \( a_{i_1}b_{j_1}c_{k_1} \ldots \) = genotypic value for a character with any number of loci, e.g., 

\( a_1 = Aa, \ a_2 = AA \) and \( a_0b_1 = aaBb \),

(b) \( \mu = \) overall mean,

(c) \( A_0 = 1/4 (3a_0 - 2a_1 - a_2) \) evaluated over all the possible combinations for all other loci,

(d) \( A_1 = 1/4 (-a_0 + 2a_1 - a_2) \) evaluated over all the possible combinations for all other loci,

(e) \( A_2 = 1/4 (-a_0 - 2a_1 + 3a_2) \) evaluated over all the possible combinations for all other loci,

(f) Similarly for \( B_j (j = 0, 1 \) or \( 2 \)), \( C_k (k = 0, 1 \) or \( 2 \) and so on,

(g) \( A_iB_j = \) product of \( A_i \) and \( B_j \) (for all \( i \) and \( j \)) evaluated over all other loci,

(h) Similarly for \( A_iC_k, B_jC_k \) (for all \( i, j \) and \( k \)) and so on evaluated over all other loci,

(i) \( A_iB_jC_k = \) product of \( A_i, B_j \) and \( C_k \) (for all \( i, j \) and \( k \)), evaluated over all other loci, and

(j) Similarly all other combinations are found by products.

This model contains the following desirable features of a gene model:

(a) Additivity of the parameters,

(b) Parameters which have genetical interpretation,

(c) Applicability to a genotypic value for any number of loci,

(d) Symmetry with respect to the expressions for the homozygous loci and

(e) Flexibility of the model with respect to increasing assumptions.

The factorial gene model was applied to populations obtained by successively selfing from generations populations originating from one heterozygous individual. The total genotypic array in the \( m \) generation is

\[
\begin{align*}
1/2(1-q)aa + qAa & + 1/2(1-q)AA \\
1/2(1-q)bb + qBb & + 1/2(1-q)BB \\
\ldots & \\
1/2(1-q)pp + qPp & + 1/2(1-q)PP
\end{align*}
\]

and so on, where \( q \) is equal to \( 1/zm \). To obtain the mean genotypic value, we may substitute the genotypic value from the model for each genotype, use the restrictions of the form \( A_0 + 2A_1 + A_2 = 0 \) and find the \( p \)-factor interaction for the variable loci. Then, defining

\( K_1 = \) overall average effect plus the effects and interactions of fixed loci,

\( \beta_1 = \) loci effect of the variable loci plus the interaction of these effects with the fixed loci,

\( \beta_2 = \) the interaction of all possible pairs of variable loci plus the interaction of these interactions with the fixed loci, and so on,

we obtain the general formula for the mean genotypic value of the population produced by \( m \) generations of selfing as

\[
F_m = K_1 + \sum_{p=1}^{2m-1} \left( \frac{1}{-1} \right)^p \beta_p
\]
where $p$ is the contribution of the $p$-factor interaction.

The model was used on data given by Khambanonda (1). It was shown that epistasis may contribute considerably to inbreeding depression. Loci effects and epistatic parameters along with their standard errors were estimated from these data, and it was found in almost all cases that the epistatic contribution differed significantly, at the 5 per cent level, from zero.

The model was applied to populations which arise by crossing two inbred lines and subsequent crossing and selfing. For the two parent case a method of expressing the loci in groups were evolved. The loci fall into groups within which the loci have identical phase relationships to the parents. We may describe the parents as

<table>
<thead>
<tr>
<th>Loci group</th>
<th>Parent 1</th>
<th>Parent 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>$P_1$</td>
<td>R</td>
<td>D</td>
</tr>
<tr>
<td>$P_2$</td>
<td>R</td>
<td>D</td>
</tr>
</tbody>
</table>

where R and D are equivalent to phases 0 and 2, respectively, given earlier. For any cross arising from these two parents, loci group two specifies the genotype completely.

The genotypic array for the variable loci is

$\pi (pR+qH+rD) \pi (rR+qH+pD)$.

loci of loci of

group two group three

Inserting the factorial model and expanding, we obtain the total effect contribution as

$\sum (\text{effects}) + \sum (pA_0+qA_1+rA_2)$

loci of loci of

one and four group two

$+ \sum (rB_0+qB_1+pB_2)$.

loci of group three

Using the restrictions of the form $A_0 + 2A_1 + A_2 = 0$, we may acquire expressions for any genotypic value arising from the specified two parents in terms of $K_2$, the overall average effect plus the loci effects and interactions of fixed loci; $E$ and $F$, the loci effects of the variable loci plus the interaction of these effects with the fixed loci; and $G$, $L$ and $M$, the interactions of all possible pairs of variable loci plus the interaction of these interactions with the fixed loci.

The model was employed on data given by Stringfield (3). The results showed that epistatic contributions were an important part of the observed mean genotypic values. The flexibility of the model was shown by assuming no epistasis was present, dropping the interaction parameters and obtaining the usual estimates,

$A\left(1/4(P_1 + P_2 + 2F_1)\right)$

$A\left(1/2(P_1 + F_1)\right)$

$A\left(1/2(P_2 + F_1)\right)$.

It was shown that scaling tests described by Mather (2) were not necessarily tests of absence of epistasis. In fact, only if the interactions of three and more loci are zero are the scaling tests even tests of the absence of the interaction of all possible pairs of loci.

The model was applied to the case in which three inbred parents are crossed and the usual subsequent crosses are obtained. In this case there were eight loci groups, but only three of them were necessary to specify any of the genotypic values completely.

The same general procedure for obtaining the expression of the genotypic value for any genotype in the two parent case was used for the three parent case. From the same set of data used in the two parent case, estimates of the genetic parameters were obtained and it was shown again that epistasis was not negligible for the characters investigated in these data. Flexibility of the factorial model was demonstrated by assuming there was no epistasis for both the three and four parent cases and obtaining the usual estimates for the three way crosses and double crosses, respectively.

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LABORATORY ESTIMATION OF THE BIOLOGICAL VALUE OF SOYBEAN OIL MEAL AS RELATED TO METHOD OF PREPARATION

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The correlation of several laboratory tests with the nutritive value of soybean oil meal for chicks has been studied. As a necessary part of this evaluation, data were obtained on growth, feed consumption, feed efficiency and blood-clotting time of chicks fed diets containing different soybean oil meals.

The growth-inhibitor of raw soybean oil meal was progressively inactivated by autoclaving, with substantially complete inactivation when the meal had been autoclaved 20 minutes at 15 pounds steam pressure. This was indicated by maximum growth and optimum feed efficiency when chicks were fed diets containing soybean oil meal autoclaved 20 minutes. Either more or less heat produced a meal of sub-optimum nutritive value. The growth stimulation was not entirely due to a greater availability of the autoclaved soybean protein since chick growth was retarded when 10 or 15 per cent of underheated soybean oil meal was added to a diet containing adequate amounts of high-quality soybean oil meal. Heating soybean oil meals for periods longer than 20 minutes reduced the lysine content and the nutritive value of the meals.

Urease activity was a satisfactory measure of heating soybean oil meals up to the point of optimum heating, but was of no value in determining overheating. The titration of the ammonia released from added urea by the urease enzyme was a more precise measure of adequacy of heat treatment than was the measurement of pH change by the technique of Caskey and Knapp (1944).

REFERENCES


Three members of the rare earth metal series are known to be ferromagnetic at low temperatures. These are gadolinium, dysprosium, and erbium. The Curie point of gadolinium is 289 degrees Kelvin while that of erbium is \(56 \pm 2\) degrees Kelvin. Dysprosium shows a magnetic anomaly at about 180 degrees Kelvin and a ferromagnetic Curie point at 105 degrees Kelvin.

This study was undertaken because the onset of the ferromagnetic condition is often accompanied by anomalous behavior of the coefficient of thermal expansion.

The nature of the problem required a low temperature X-ray camera which could be used over a wide temperature range. Such a camera of the Debye-Scherrer type was designed and constructed. The X-ray sample was held at the desired exposure temperature by a gas stream which flowed by it. To reduce the heat leak, the camera interior was insulated except for a small free volume through which X-rays passed.

Several methods were employed to obtain the gas stream used for temperature control. Exposures above room temperature were obtained using a stream of helium which was electrically heated. For a few of the low temperature exposures, the X-ray sample was cooled with a stream of gas evaporated from a bath. Most of the low temperature exposures were obtained by another method in which the sample was cooled with a circulating stream of working gas. The working gas was cooled by use of a gas heat exchanger system as well as a coil submerged in the bath. The working gas returning from the camera and the gas evaporated from the bath were used to cool the working gas entering the cycle. Temperature control was obtained by mixing working gas at various temperatures and varying flow rates.

The X-ray samples were prepared by first annealing filings in a vacuum and then mixing sodium chloride with the filings before placing them in an X-ray capillary. The sodium chloride was used as an internal standard.

Exposures were obtained of gadolinium in a temperature range from 106 degrees Kelvin to 349 degrees Kelvin. For dysprosium the temperature range in which exposures were obtained was from 49 degrees Kelvin to 300 degrees Kelvin. The exposure temperature range of erbium was from 43 degrees Kelvin to 301 degrees Kelvin.

The structure of all three metals was found to be hexagonal close-packed for all exposures. The average values for the lattice constants at room temperature are summarized in the following table.

<table>
<thead>
<tr>
<th></th>
<th>(a_0)</th>
<th>(c_0)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gadolinium</td>
<td>3.635±.002(\AA)</td>
<td>5.775±.005(\AA)</td>
</tr>
<tr>
<td>Dysprosium</td>
<td>3.596±.002(\AA)</td>
<td>5.653±.004(\AA)</td>
</tr>
<tr>
<td>Erbium</td>
<td>3.562±.002(\AA)</td>
<td>5.602±.003(\AA)</td>
</tr>
</tbody>
</table>

Anomalous behavior of the same type was noted for all three metals. Below the Curie point the \(c_0\) parameter increased with decreasing temperature. In the cases of dysprosium and erbium the rates of decrease of the \(a_0\) parameter with temperature were somewhat larger below the Curie point.
The unusual behavior was considered to be due to the increase of the magnetization in the domains with decreasing temperature below the Curie point. Furthermore, the data were thought to suggest a close correlation between the directions of magnetization in the domain and the crystal directions. A qualitative discussion was included of the possible theoretical basis of the effect. It was assumed that the direction of easy magnetization in the domain was identical with the direction of the c₀ axis of the crystal. The observed result could then be regarded as magnetostriction due to the field within the domains.

THE PREPARATION OF THE SUPEROXIDES OF THE ALKALINE EARTH METALS

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This investigation was undertaken to determine if the alkaline earth metals formed a superoxide by the action of hydrogen peroxide on different alkaline earth metal salts, and to study the effect of the concentration of the hydrogen peroxide on the superoxide content of the products.

All references in the literature regarding the action of hydrogen peroxide on alkaline earth metal salts reported the formation of various hydrates of the alkaline earth metal peroxides. Most of these preparations were described as varying in color from white to light yellow. A few investigators postulated the existence of a small amount of a higher oxide in these preparations on the basis of the oxygen evolved upon decomposition.

The first part of the experimental work resolved itself into an investigation of the action of various concentrations of hydrogen peroxide on barium salts. The resultant products were analyzed and treated in various ways in an attempt to determine which method of treatment resulted in a high total oxygen content.

A method of preparing very pure barium peroxide octahydrate was established. When a saturated barium hydroxide solution, protected from carbonate formation, was allowed to pass directly into a chilled solution of the hydrogen peroxide, pure white crystals of barium peroxide octahydrate were formed. This compound, when heated in a 100°-110° C. oven for a period of twenty-four hours or when placed in a desiccator over anhydrous P₂O₅ for a period of several days, resulted in a pure form of the metal peroxide.

It was established that all concentrations of hydrogen peroxide, of 3% or higher, gave a product which was buff to light yellow in color when a saturated solution of barium hydroxide was allowed to pass into a chilled solution of the hydrogen peroxide. These preparations showed a high total oxygen content.

The second part of the experimental work, which constituted the major part of the investigation, was concerned with the treatment of salts of the three alkaline earth metals with various concentrations of hydrogen peroxide. These preparations were analyzed for per cent metal oxide, per cent total oxygen, and per cent superoxide oxygen.

An apparatus, modified from that described by Seyb and Kleinberg (J. Am. Chem. Soc., 73: 2308, 1915), was constructed. The method of determination of superoxide oxygen, in mixtures of superoxide and peroxide, described by these authors was followed. The basis of this determination depended upon the treatment of such mixtures with a glacial acetic acid-diethyl phthalate solution at 0° C. With this reagent only two-thirds of the total available oxygen from the superoxide was liberated, and none of the peroxide oxygen was decomposed. The total available oxygen of the mixture was determined by decomposition of the sample with a hydrochloric acid solution containing a high concentration of ferric chloride.

A comparison of the gasometric and titrimetric method of analysis for total oxygen content was made on an analyzed sample of potassium superoxide. This was done when it was seen that the determination of total oxygen content of some
barium peroxide preparations by the gasometric method always gave a larger value than when this determination was carried out by the titration of the acidified sample with standard permanganate solution. It was shown that only one-third of the total oxygen from superoxides was detected by the titrimetric method.

The analysis of a sample of barium peroxide, which had remained over an evacuated desiccator for nearly a year, was shown to contain a small percentage of barium superoxide. Several series of experiments were then carried out to determine the effect of the concentration of hydrogen peroxide on the superoxide oxygen content of the products formed when various alkaline earth metal salts were treated with hydrogen peroxide. Concentrations of hydrogen peroxide used ranged from 0.3% to 90%.

A saturated solution of each of the alkaline earth metal hydroxides was added to the hydrogen peroxide at 0°C. A portion of each of these preparations was analyzed immediately, while another portion was analyzed after ninety hours over P₂O₅. All of these preparations gave a relatively low superoxide content in the product. After ninety hours over P₂O₅, the products analyzed slightly higher in superoxide content.

The dry peroxide and the peroxide octahydrate of each of the alkaline earth metals were treated with various concentrations of hydrogen peroxide at room temperature for approximately one day followed by analysis of the product. It was found that treatment of the peroxide octahydrate with the same concentration of hydrogen peroxide, in almost all cases, gave a product containing a higher superoxide content than similar treatment of the anhydrous peroxide.

The treatment of strontium and barium compounds with the same concentration of hydrogen peroxide invariably gave a product with a considerably higher superoxide content than the treatment of the corresponding calcium compound.

Approximately thirteen percent of the product by weight was the highest concentration of metal superoxide obtained in any of the preparations made. This was the approximate metal superoxide content of the preparation obtained by the action of 30% H₂O₂ on barium peroxide octahydrate, 50% H₂O₂ on the corresponding strontium compound, and 90% H₂O₂ on calcium peroxide octahydrate.

**FACTORS RELATED TO PARTICIPATION IN FARMER COOPERATIVES**

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The American culture is noted for its many forms of formal voluntary associations. Sociologists have been actively engaged in studying this rather unique form of human togetherness in a framework that has been termed social participation research. The focus of this study is on participation in a single sub type of formal voluntary association, the farmer cooperative.

Most past research in farmer cooperatives has dealt with the two major areas of farmer opinions and attitudes toward cooperatives and of farmer knowledge of facts about cooperatives. Little detailed research has been done on what appeared to the author to be two important areas of cooperative research: (1) farmer participation in cooperative activity, and (2) farmer understanding of basic cooperative theory and principles.

The major purpose of this dissertation was to determine whether selected factors were related to different degrees of participation of people in farmer cooperatives. In addition, two minor objectives were: (1) to determine if generalizations from past general participation research would apply to a specific formal voluntary association, farmer cooperatives, and (2) to suggest and test hypotheses that might be useful for future research in the field of social participation.

In consultation with the Iowa State College Statistical Laboratory a sample of 22 Iowa communities was chosen and a total of 268 cooperative member and 278 non-member schedules were taken from farmers living in these communities in 1948.

A review of past research in social par-
participation did not reveal an acceptable device for the measurement of participation in farmer cooperatives. The unique nature of farmer cooperatives as economic associations was studied and eight major elements of cooperative participation were determined as follows: (1) use of plant or patronage, (2) decision making regarding the plant and its operations, (3) accepting financial responsibility, (4) sharing fixed and variable costs of operating the plant, (5) accepting responsibilities for risks and uncertainties, (6) sharing economic benefits from the plant, (7) participation to get facts and understanding, and (8) organizational maintenance duties. Using these elements as the framework a cooperative participation score composed of 12 items was constructed by the author and a panel of three judges.

An important part of past social participation research has been the comparison of those people who belong to some type of formal association with those who do not belong. Members and nonmembers of farmer cooperatives were first compared to determine if there were any significant differences between these two categories. Propositions were suggested that members and nonmembers would differ significantly when compared on the basis of the following factors: age, educational level, stage of family cycle, nationality background, number of years farmed, size of farm in acres, general social participation, participation in informal cooperative ventures, and socio-economic status. With the exception of the factor, educational level, the findings from the present study supported the propositions involving the above factors—members and nonmembers differed significantly when compared on the basis of these factors.

Propositions were suggested that members and nonmembers would not differ significantly when compared on the basis of the following factors: family composition, length of residence in the community, tenure status, and type of farming. With the exception of the factor, type of farming, the findings from the present study supported the propositions involving the factors listed directly above.

Propositions were suggested that cooperative participation scores of members would differ significantly when compared on the basis of the following factors: general social participation, membership in other farm organizations, socio-economic status, member understanding of basic cooperative principles, member definition of the cooperative as an agent or just another place to do business, member feeling of responsibility, member opinion regarding 100 per cent participation, member feeling of say or no say in running the cooperative, member "we feeling" or identity with the cooperative, number of neighbors who belong to the cooperative, receiving or not receiving current information about the cooperative, more information desired about local cooperative, more information desired about cooperatives in general, knowledge of facts about the local cooperative, knowledge of the existence of wholesale or "regional" cooperatives, greatest benefit from cooperatives, criticisms or no criticisms of cooperatives, specific cooperative named most important by member, community in which member resided, and size of community. In all cases the present findings supported the propositions that participation scores of members would differ significantly when compared on the basis of these factors.

Propositions were suggested that participation scores of members would differ significantly when compared on the basis of the following factors: educational level, participation in informal cooperative ventures, reasons for joining the cooperative, urgency of need at the time the member joined, stated responsibilities to cooperative, justification for not always patronizing the local cooperative, source of current information about cooperatives, type of criticisms named by members, type of cooperative, size of cooperative, and number of educational programs. However, the present findings did not support any of the suggested propositions involving the above factors.

Propositions were suggested that participation scores would not differ significantly when compared on the basis of the following factors: age, stage of family cycle, tenure status, number of years farmed, size of farm in acres, source of first information about cooperatives, number of cooperatives to which member belonged, number of years the member had belonged to the cooperative, type of educational program, and separate educational fund in cooperative. In all cases the propositions involving the factors listed above were supported by the findings of the present study.

A minor objective of this dissertation was to determine the degree to which research findings from other studies agreed with findings from the present study. Past research findings were cited in relation to 40 of the 58 hypotheses tested. In 11 of the 40 cases past research findings were not in agreement. The findings from the present study agreed with past research
findings in 17 of the 29 cases where there was agreement among the past findings. The present findings did not agree with past findings in ten cases and in two cases past research findings were not accepted for farmer cooperatives for logical reasons.

The findings from the present study have demonstrated that the framework of participation can be productive in cooperative research. As additional research is planned the following points should be considered: (1) the inter-disciplinary approach to the problem, (2) the improvement of the measurement of cooperative participation, (3) the improvement of the measurement of understanding of basic theory of cooperatives, (4) the incorporation of the concept of optimum rational participation in cooperatives into the research plan, (5) the choice of the population to be studied that will allow for (a) comparisons of cooperatives and communities and (b) the study of cooperative structure and process in individual cooperatives and their relation to participation, and (6) the further quantification of data to aid in statistical treatment.

A ROUND-OFF THEORY FOR SCALAR PRODUCTS

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Since the introduction of high speed calculating machines, the time and effort required to solve a linear system have become relatively small. However, other problems arise. For instance, for large systems where the number of operations required is no longer relatively small, a new need is felt for a round-off theory. This paper, starting with the basic symbols, definitions and inequalities of a theory developed by J. von Neumann and H. H. Goldstine (1), extends their theory and applies it to a method of inverting matrices which uses powers, and to a comparison of the exact solutions and pseudo-solutions of a linear equation, where the latter are solutions which pseudo-check as explained below. In addition, maximum permissible absolute values of the coefficients of a matrix are determined, using strict and probabilistic considerations, in order that relevant higher powers of the matrix be digital.

The Bingham Method is selected to determine the inverse of a matrix. This method requires that the first n-1 powers and the diagonal elements of the nth power of the matrix be computed. One of the disadvantages of this method is that it requires the storage of approximately $n^3$ bits of information. This shortcoming is overcome however by the introduction of a new recursion relation, which results in the need for only about $3/n$ as much memory storage as that required by the usual Bingham Method.

If a matrix A is pseudo-multiplied times itself a finite number of times, it is often desirable to start with and obtain a matrix whose coefficients are less than one in absolute value. This can be done by dividing each coefficient by an appropriate scale factor. Using strict considerations to compute the scale factor then, of course, one can guarantee that relevant higher powers have coefficients numerically less than one, or if desired, that all powers, after some selected one, round-off to zero. But if one makes the assumption that the coefficients are uniformly and independently distributed, and uses the theory of the Edgeworth series, then a partial sum of the Edgeworth series may be used to ascertain a scale factor, although the accuracy of the result must be measured by the remainder term for which measurement there exists as yet no practical method. If one uses three terms of the series and the order of the matrix is one hundred, then the calculated probability is 0.95 that the square of a matrix will have coefficients which are less than one in absolute value, if its coefficients are numerically less than 0.4. This 0.4 should be compared to the value 0.1 which is the value obtained when strict considerations are used.

A comparison of exact solutions and pseudo-solutions of a linear equation is based on the following definitions:
a) Any point \( (X_j) \) for which one has exactly
\[
n \sum_{j=1}^{n} a_j X_j = b
\]
is naturally called an exact solution.

b) Any point \( [X^P(j,k_j)] \) is called a pseudo-solution if
\[
n \sum_{j=1}^{n} a_j X^P(j,k_j) = b
\]
where the symbol \( x \) indicates that ordinary precision multiplication is to be used. Here \( k_1, \ldots, k_n \) is an associated \( n \)-tuple defined below. c) If the coordinates of the point \( [X^P(j,k_j)] \) also satisfy the condition
\[
a_j X^P(j,k_j) = a_j X^P(j,k_j) \quad j = 1, 2, \ldots, n,
\]
then \( X^P(j,k_j) \) is denoted by \( X^{PC}(j,k_j) \).

**THEOREM 1.** The points \( [X^{PC}(j,k_j)] \) exist and are pseudo-solutions which lie on the hyperplane of exact solutions. These points are located at the centers of \( n \)-dimensional rectangular parallelepipeds, called \( n \)-topes, which contain all the pseudo-solutions.

The point \( [X^{PC}(j,0)] \) is defined as the point \( [X^{PC}(j,k_j)] \) closest to the exact solution under consideration and is the center of the principal \( n \)-tope.

The general coordinate of any point on the hyperplane can be written
\[
X_j = X^{PC}(j,0) + k_j \beta^{-\delta} |a_j| + m_j \beta^{-\delta/2} |a_j|
\]
where the \( k_j \) integers and the \( m_j \) are any real numbers which satisfy the conditions:
\[
n \sum_{j=1}^{n} k_j a_j / |a_j| = 0,
\]
\[
n \sum_{j=1}^{n} m_j a_j / |a_j| = 0.
\]

**THEOREM 2.** An exact solution of a linear equation is a pseudo-solution if and only if
\[
\sum_{j=1}^{n} \text{positive} \frac{a_j m_j}{|a_j|} = \sum_{j=1}^{n} \text{negative} \frac{a_j m_j}{|a_j|}
\]
where the \( m_j \) are the same as in equation (1) and the symbol \( [x] \) means the closest even integer to \( x \), except when \( x \) is equal to an \( m_j \) which is an odd integer, in which case the closest even integer is selected, if possible, so as to satisfy equation (2).

There is no loss of generality if the hyperplane \( (n+1) \) dimensions
\[
n \sum_{i=1}^{n+1} x_i = x_{n+1}
\]
is used in order to determine the distribution of the number of congruent subregions in a suitably defined generating region, the classification of such subregions according to whether they contain pseudo-solutions or not and the determination of the ratio of the volume of the subregions which contain pseudo-solutions to the total volume of the generating region.

**THEOREM 3.** Let \( n \) be odd in equation (3). Of the \( 2^n \) volumes in the \( g \)th position of the unit \( n \)-topes which make up the generating region, \( (n+1) \) contain pseudo-solutions. If the volume in the \( g \)th position of the unit \( (n-1) \)-tope is designated \( V_{g,n} \), then the ratio of the volume of the subregion containing pseudo-solutions to the total volume of the generating region is
\[
\frac{(n+1) V_{1,n+1} + \ldots + (n+1) V_{n,n+1}}{2^n \left[ V_1,n+1 + V_{2,n+1} + \ldots + V_{n,n+1} \right]}
\]
By use of the fact that
\[
V_{i,n+i} = V_{n+1-i,n+i}, \quad (i=1, 2, \ldots, n+1 \text{ if } n \text{ is odd}, n+1/2 \text{ if } n \text{ is even})
\]
the above ratio is shown to approach zero as the dimension becomes infinite.

**REFERENCE**

An allocation of the thirteen nitrogen atoms of vitamin B_{12}a was made by acid hydrolysis of the vitamin, Craig countercurrent distribution of the hydrolysate, and analyses of the various fractions for different types of nitrogen. It was found that five atoms of nitrogen were present in the hydrolysate as ammonia, two atoms as 5, 6-dimethylbenzimidazole, four atoms as the red acid fragment, and two atoms as 1-amino-2-propanol (or alternatively, one atom as 1-amino-2-propanol and one atom as a small unknown nitrogen compound). Of the five molecules of ammonia found, it was learned that three of these are readily formed during hydrolysis, but the remaining two are produced quite slowly. No carbon dioxide is produced during the acid hydrolysis of B_{12a}, some carbon dioxide, less than one mole, is produced in the hydrolysis of B_{12}, probably from the partial hydrolysis of the cyanide group.

The red fragment produced on acid hydrolysis of B_{12a} is a mixture of cobalt-free and cobalt-containing materials. All attempts to purify the red acid fragment from either B_{12} or B_{12a} failed. Among the methods tried were countercurrent distribution, chromatography and ion-exchange. No single specie could be obtained in crystalline form, either as the free acid or as a metal salt. The information reported on the properties of the red acid fragment was thus obtained on a mixture of closely related materials.

The infrared spectra of the red acid fragment and vitamin B_{12} were obtained. The differences in the spectra are in conformity with the hypothesis that acid amide groups are hydrolyzed during the acid treatment. The infrared spectrum of the red fragment suggests also that a cyclic structure, anhydride or lactone, is present. The infrared spectrum of the sodium salt of the red fragment is that expected of an ionized carboxylic acid. Treatment of the red acid fragment with acetic anhydride gives a product having the infrared spectrum typical of an acid anhydride.

The spectrum of the cyanide derivative of the red acid fragment is similar to that of the cyanide derivative of vitamin B_{12}.

Bromination of the red acid fragment results in a product with a markedly different spectrum (ultraviolet and visible) from that of the red fragment itself. The solubility properties of the product are also markedly different. Attempts at quantitative bromination of the red fragment gave uncertain values.

The fact that vitamin B_{12} contains primary amide groups suggested a number of reactions which could conceivably be carried out that would possibly result in information as to the actual structure of the molecule, either per se, or by forming a compound which would be capable of crystallization, characterization and identification following hydrolysis.

A reaction of B_{12} with alkaline hypochlorite was carried out. No ammonia was evolved during the reaction, thus precluding a substituted area structure. No pure reaction product could be isolated from the reaction mixture, although the formation of an amorphous picrate indicated that amine formation had occurred.

Both mercuric oxide and mercuric acetate were found to react with B_{12}, presumably through the amide groups. The two products were not the same, however. Mercury to cobalt ratios determined on the mercuric acetate reaction product gave values approaching three.

The reaction of vitamin B_{12} with acetic anhydride at reflux temperature yielded a purple product, somewhat soluble in ethylene chloride. The infrared spectrum of this material showed two absorption bands, 5.6 μ and 5.7 μ. These could be interpreted as resulting from either anhydride or cyclic imide structures. The ultraviolet and visible spectrum of the product did not resemble that of vitamin B_{12}.

During attempts to study the consumption of bromine by vitamins B_{12} and B_{12a}, it was found that B_{12a} was markedly active in the catalysis of the oxidation of iodide to iodine by air. B_{12} was also active, but only at much higher concentrations.

The catalysis of the air oxidation of iodide to iodine was studied in detail; the rates of the reaction were measured at various concentrations of B_{12a}, iodide and sulfuric acid. It was possible to apply...
classical enzyme theory to the system, in that dissociation constants of the complex (with either iodide or acid as "substrate") could be determined, and a plot of reciprocal velocity versus reciprocal "substrate" (iodide or acid) resulted in a straight line.

DETERMINATION OF MOISTURE IN SEEDS

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Moisture content is the dominant factor in the establishment of grain grades and accurate methods for its estimation are essential. There is evidence, unfortunately, that the available moisture tests are not uniformly reliable under all conditions. We have attempted, therefore, to study moisture content of two locally important seeds from the basic standpoints of seed physiology and moisture bonding as these affect estimates of total moisture content.

The total water content of whole seeds of maize and soybeans was determined by drying to constant weight in an air oven at 100° C., a vacuum oven at 70° C., or in a vacuum desiccator at 25° C. Similar moisture percentages were indicated by drying at 100° C. for 12 days or in the vacuum oven for 23 days. Ninety-five per cent of the total moisture loss was obtained in the first two days at 100° C., and the first six days at 70° C. Seeds in the vacuum desiccator were still losing weight slowly after 60 days, and still contained about 3 per cent moisture on a dry weight basis. This moisture is considered to be a minimum estimate of bound water in the seeds. Drying in a desiccator did not affect viability of the seeds.

When constant weight at 100° C. was taken as a measure of true moisture content, the Brown-Duvel moisture test gave reasonably concordant results, while the Tag-Heppenstall conduction method was consistently low, indicating standardization on a less rigorous drying procedure. Any of the three methods could have been expected to give a satisfactory estimate of moisture content with proper manipulation. When, however, the moistened seeds were frozen at -23° C. before testing, the Tag-Heppenstall readings were about 1 per cent high on all seeds whose permeability had been increased by freezing injury.

Drying tests were carried out on corn in a 100° C. air oven for 24 hours. At temperatures of 100°, 110°, 120° and 130° C., moisture loss curves formed a set of hyperbolas which tended to become parallel. Such curves indicate that the specific free energy of moisture at the surface of the seeds decreased with decreasing moisture content. Specific free energy at the surface may be considered to be affected by adsorption bonds, which reduce the vapor pressure of water, and by permeability factors which control the rate of movement of moisture to the surface.

Moisture loss at varying times was a linear function of temperature. Ruptures of corn seeds with 45 per cent of moisture heated to 130° C. increased permeability, thus causing a deviation in this relationship.

The moisture content of seeds varies with the relative humidity of the environment under both laboratory and commercial conditions. Experiments on weight changes in corn and soybean seeds stored at varying relative humidities gave an opportunity to study the forces acting in the distribution of moisture between atmosphere and seeds. Rate of water loss or adsorption was greater in soybeans than corn, as measured by the diffusion coefficient, and water was held more loosely by soybeans than corn, as determined from free energy calculations.
THE HISTOLOGY OF THE BUD GRAFT UNION IN ROSES

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The growing importance of stock-scion compatibility in roses has called attention to the possible relationship between the histology of the bud union and relative compatibility. This investigation was undertaken to determine the course of histological events in the healing of the bud graft of rose, and thereby, provide basic information for further studies in relation to incompatibility.

Six lots, each consisting of 25 seedlings of Rosa multiflora, were budded with R. multiflora, Welch strain, on each of three successive mornings beginning on July 15. One random sample was taken daily from each lot of budded plants for 14 days beginning the day of budding. The samples were killed in a Nawaschin-type formula and processed for sectioning in paraffin.

In order to compare bud grafts made in root tissue with those made in stem tissue, rooted cuttings of R. odorata, 22449, were budded with R. odorata, 22449, scions on October 10, 11, and 12, 1952. The same procedures of budding, processing, and sectioning described for the bud grafts made in seedling understocks were followed. Samples were taken at 48-hour intervals.

In the processes of making the incision in the stock and the removal of the scion from the bud stick, the cambium and young cambial derivatives were found to be destroyed in the areas involved.

Within two days following budding, a plate of dead, dry, necrotic tissue forms over the injured surfaces of the stock, scion, and bark flaps. The necrotic plate is ruptured by callus strands derived from proliferated terminal cells of broken rays. The callus strands derived from tissues of the stock and scion coalesce by the fifth day. The callus is produced by cambial derivatives which are regarded to be immature secondary xylem and phloem. These secondary cells on the injured surfaces of the stock and scion between the rays undergo repeated tangential division and form arcs of stratified callus which do not rupture the necrotic plate behind which they develop.

Between the third and fifth day after budding, spongy callus cells adjacent to uninjured stock cambium undergo repeated tangential and radial division and form a short arc of bridging cambium, which connects the intact stock cambium with cambiform tissue that had differentiated simultaneously from cells of the stratified callus. This cambiform tissue elongates in the direction of the scion by radial division at the edges. By the tenth day an uninterrupted cambiform layer connects the intact stock cambium on either side of the scion by bridging cambium and extends across the face of the stock.

Between the tenth and fourteenth days, arcs of cambiform tissue differentiate in scion tissue, elongate by radial division at the edges, and join with arcs of cambiform tissue derived from stock callus. Simultaneously with the development of cambiform arcs, the cambium of the bud elongates by radial division at the edges, usually following the inner surface of the scion. The bud cambium unites with cambiform tissue extending out of stock callus through the zone of merged callus, and, thereby, forms an uninterrupted ring of cambium through the stock and scion. Union of cambial elements of stock and scion occurs between the tenth and fourteenth day.

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M.S. Ibid., 1949.
GENERALIZATIONS OF CONTINUITY

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A generalization of continuity is developed. This generalization includes several known generalizations as special cases.

Let $X$ be a Hausdorff space in which each neighborhood is inexhaustible (a set of Baire's second category), and let $[N]$ denote the system of neighborhoods in $X$. Let $Y$ be a regular separable Hausdorff space metrized by $\rho$, and let $[M]$ denote the system of neighborhoods in $Y$. Denote the complement with respect to $X$ of a set $S$ by $S^c$, and denote the closure of $S$ by $\overline{S}$.

In the following definitions and theorems, $\lambda$ is a set property defined for subsets of $X$, $S$ is a set in $X$, $f$ is a function on $X$ into $Y$, and $\xi$ is a point in $X$.

DEFINITION 1. a. The point $\xi$ is said to be a point of $\lambda f$-approach by $S$ if, for every $N(\xi)$ and for every $M(f(\xi))$, $N(\xi) \subseteq M(f(\xi))$ has property $\lambda$.

b. The point is said to be a point of $\lambda f$-approach (concentrated $\lambda f$-approach) by $S$, if, for every $M(f(\xi))$, there exists an $N(\xi)$ such that, for every $N$ contained in $N(\xi)$, $[N \subseteq M(f(\xi))]$ has property $\lambda$.

c. The point $\xi$ is said to be a point of $\lambda f$-approach (weak $\lambda f$-approach) by $S$ if, for every $N(\xi)$ and for every positive number $\epsilon$, there exists a point $\eta$ such that $N(\xi) \subseteq M(f(\xi), NSE \ni f(\eta) + \epsilon \subset \eta)$ has property $\lambda$.

DEFINITION 2. a. The function $f$ is said to be neighborly (1) at $\xi$ if $\lambda$ is the property that a set contains a neighborhood and if $\xi$ is a point of $\lambda f$-approach by $X$. If $f$ is neighborly at each point of $S$, $f$ is said to be neighborly on $S$.

b. The function $f$ is said to be cliquish (2) at $\xi$ if $\lambda$ is the property that a set contains a neighborhood and if $\xi$ is a point of $\lambda f$-approach by $X$. If $f$ is cliquish at each point of $S$, $f$ is said to be cliquish on $S$.

DEFINITION 3. a. The property $\lambda$ is an ascending set property if, for every set $S$ which has property $\lambda$ and for every set $A$ in $X$, the set $(S + A)$ has property $\lambda$.

b. The property is locally characterizing if, for every set $S$ which has property $\lambda$ and for every $N$ such that $NS$ has property $\lambda$, there exists an $N_1$ contained in $N$ such that $N_1S$ has property $\lambda$ and $N_1(S^c)$ does not have property $\lambda$.

If $\lambda$ is the property that a set contains a neighborhood of $\xi$, and if $\xi$ is a point of $\lambda f$-approach by $X$, then $f$ is continuous at $\xi$. Particular generalizations of continuity are obtained if $\lambda$ is one of the following properties: residual on a neighborhood, inexhaustible, contains a dense-in-itself subset, has positive outer measure, nondenumerable, infinite, contains a neighborhood.

The following theorems are typical results of the thesis.

THEOREM 1. The set of points of $w_\lambda f$-approach by $S$ is closed.

A particular consequence of this theorem is the result that if a function is cliquish on a dense set in its domain of definition, then it is cliquish at every point of its domain of definition.

In the following theorems, $\lambda$ is assumed to be an ascending set property.

THEOREM 2. The set of points of $\lambda f$-approach by $S$ which are not points of $\lambda f$-approach by $S$ is inexhaustible.

In case $\lambda$ is the property that a set is inexhaustible, theorem 2 reduces to a result of Blumberg (3).

THEOREM 3. If the sequence of functions $[f_n(x)]$ converges uniformly to $f(x)$ on $X$, and if there exists a point $\xi$ such that for each $n$, $\xi$ is a point of $\lambda f_n$-approach by $S$, then $\xi$ is a point of $\lambda F$-approach by $S$.

In particular, Theorem 3 yields the known results that the uniform limit of a sequence of continuous (neighborly) functions is continuous (neighborly).

THEOREM 4. If $X$ is a metric space, if $f$ is bounded at $\xi$, and if $\xi$ is a point of $\lambda f$-approach by $S$, then $f$ may be redefined at $\xi$ in such a manner that, for the resulting function $f_1$, $\xi$ is a point of $\lambda f_1$-approach by $S$.

In the remaining theorems, $\lambda$ is assumed to be both ascending and locally characterizing.

THEOREM 5. If each element of $S$ is a point of $\lambda f$-approach by $S$, and if $\xi$ is a point of $\lambda f$-approach by $S$, then, for every $M(f(\xi))$ and for every $N(\xi)$, there exists an $N$ contained in $N(\xi)$ such that, for every $x$ in $N$, $f(x) \in M(f(\xi))$.

THEOREM 6. If $R^k$ is inexhaustible, if the sequence of functions $[f_n(x)]$ converges to $F(x)$ on $X$, and if, for every $n$, each $x$
in \( R \) is a point of \( \lambda f_n \)-approach by \( R \), then 
\( F(x) \) is continuous over \( R \) with respect to 
\( R \), except on an exhaustible set.

In particular, Theorem 6 yields 
the known results that the limit of a sequence 
of continuous (neighborly) functions is 
continuous except on an exhaustible set.

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INTERRELATIONS OF MILK PRODUCTION AND BREEDING EFFICIENCY 
IN DAIRY COWS

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Three criteria of breeding efficiency 
were studied to find their relationship with 
each other and with production, and to 
learn their repeatability and heritability. 
These three criteria were days to first 
estrus, days to conception and services to 
conception. It was also possible to study 
how these three criteria were affected by 
some other variables such as age, season 
of year, differences between herds, etc.

The data were 1646 lactation periods of 
763 cows in either the Holstein herd at 
Iowa State College or the Iowa State Board 
of Control herd at Cherokee from January 
of 1940 to August of 1951.

Differences between the herds were found 
in days to first estrus and in days to conception, 
but not in services to conception. In days to first estrus the modal class was 
31-50 days in both herds with means of 55 
and 71 days and standard deviations of 30 
and 50 days in herds 1 and 2 respectively. 
For number of days to conception the 
means were 28 and 42 with standard devia-
tions of 28 and 76. The mean number of 
services to conception was 1.8 in herd 1 
and 1.7 in herd 2. The corresponding 
standard deviations were .4 and .3.

In both herds the age distributions were 
highly skewed in the direction of the younger 
animals. Most heifers in the Iowa 
State College herd calved for the first 
time as two year olds, but many heifers 
in the Cherokee herd did not freshen until 
three years old. Age differences accounted 
for less than two per cent of the variance in 
these criteria of breeding efficiency. Parities coincided closely with age, of course.

Yearly changes accounted for less than 
four per cent of the variance in all three 
criteria in both herds, except that in herd 2 approximately 15 per cent of the variance in days to first estrus seemed due to yearly effects. This seemed due, in part at 
least, to changes in labor and manage-

When the records were grouped according to each cow's previous production, lit-
tle relationship was observed. When the 
same variables were grouped by current 
production, differences were found in days 
to conception and in services to conception. Much of this was probably automatic in that delaying conception lessens the effect of recurrent pregnancy in hampering the cow's opportunity to make a good re-
cord.

Using 444 records in herd 1, 487 in herd 2, correlations were computed be-
tween the three variables and between them and preceding production. These 
correlations were small and statistically insignificant except that the correlation between days to conception and services to conception was +.84. That this corre-
lation is so high is largely automatic, be-
cause the two variables are to a consider-
able extent measures of the same thing.

The corresponding correlations between 
the three variables and current production 
were calculated on 759 records from herd
ABSTRACTS OF DOCTORAL THESES, 1952-53

1. and 780 records from herd 2. Again the correlation between days to conception and services to conception was high, r = +.81. Current production was correlated, +.151 and +.153, with days to conception and with services to conception, both correlations being statistically significant at the one per cent level. Presumably much of this reflects the effects of early or late recurrence of pregnancy on production late in the lactation.

Multiple regression preceding production on the three variables showed little relationship. R² was .005 for herd 1 and .017 for herd 2. Multiple regression of current production on the same variables revealed essentially the same picture except that the partial regression of 5.147.7, in herd 2, indicated that for each additional service required for conception an extra 510 pounds of milk could be expected in that lactation. R² was .027 in herd 1 and .036 in herd 2.

Repeatabilities were estimated from 764 records on 321 cows in herd 1 and from 782 records on 294 cows in herd 2. Repeatability of days to first estrus was .15 in herd 1, and .27 in herd 2. The average repeatabilities of days to conception and services to conception were .05 and .06, respectively. Repeatability of these three variables is probably positive but very low.

Heritabilities were estimated by doubling the intra-sire regression of daughters on dams. 243 daughter-dam pairs were available in herd 1, and 191 in herd 2. Four of the six very small values obtained were negative, a result theoretically impossible except for sampling errors. Since the sampling errors could be large in this amount of data, the only reasonable conclusion is that the heritability of the three measures of breeding efficiency is not far from zero.

If heritability and repeatability of the three variables really are as low as the estimates obtained from this investigation, selection for breeding efficiency in these herds cannot be very effective. Giving attention to breeding performance will decrease the progress that could otherwise be made in selecting more strongly for other traits of economic importance for which repeatability and heritability estimates are considerably higher.

UNIDENTIFIED CHICK GROWTH FACTORS IN UNSATURATED FATS

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Sources of unidentified growth factors for chicks have been studied using semipurified diets.

Crude or refined corn oil, wheat germ oil, soybean oil, and cottonseed oil were sources of unidentified growth factors which increased chick weight at four weeks from 10 to 30 per cent. Factors in fat were not required for livability of chicks or for the prevention of dermatitis. The requirement of the chick for the growth factors in these vegetable oils was satisfied by the addition of from one to two per cent of any one of these oils to the basal diet. The four vegetable oils contained similar quantities of the unidentified factors. The saponifiable fraction of cottonseed oil possessed the major portion of its growth factors, but the nonsaponifiable fraction was also growth promoting. Commercially hydrogenated soybean oil, in the form of oleomargarine, was devoid of much of the growth factor activity possessed by soybean oil.

Growth responses to the 60 per cent lineoleic acid concentrate were inconsistent. This may have been due to its decided tendency to become rancid. One and a half per cent of this concentrate in the diet was superior to lower levels for increasing growth. Lower levels of the concentrate were adequate when they were fed in combination with low levels of wheat germ oil.

An oleic acid concentrate prepared from beef tallow was consistently slightly superior as a source of growth factors to individual supplements of vegetable oils or the linoleic acid concentrate. The optimum level of feeding the oleic acid concentrate was one per cent. The addition of a vegetable oil to a diet containing one per cent of the oleic acid concentrate did


2. a. B.S., State College of Washington, Pullman, Wash., 1950. b. Graduate Assistant, Agricultural Experiment Station.
not stimulate growth.

Growth response from feeding pure methyl oleate, methyl linoleate and methyl linolenate was inconsistent and rather small. Stearic acid was not growth-promoting for the chick at either the one or two per cent level.

The unidentified factors in fats and fatty acid concentrates were distinct from the growth factors shown by other workers to be present in fat-free Liver L and Biopar C. The factors in Liver L and Biopar C increased growth only slightly.

Pork liver residue, which contains 18.8 per cent arachidonic acid of its total fatty acids, was a fair source of growth factors which were shown to be ether-soluble.

Yellow corn increased growth and feed efficiency, but this study did not establish whether this was entirely attributable to factors in the ether-soluble portion of the corn.

Butter and oleomargarine were approximately equal as fat supplements for chicks, but were inferior to more unsaturated fats.

Carcass protein was increased and carcass fat was reduced by the addition of unidentified growth factors to the "fat-free" diet. No hormonal activity, as measured by weight of testes, could be demonstrated for the various sources of unidentified growth factors.

ADAPTATION OF THE FARM FIRM IN WESTERN KANSAS TO CONDITIONS OF UNCERTAINTY

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The objective of this thesis was to examine methods of adaptation by the farm firm to the conditions of uncertainty that exist in Western Kansas. Methods that have been developed in economic logic were tested empirically. Primary data were available from the Colby and Garden City Kansas Agricultural Experiment Stations.

The precautions that have been developed in the literature of economics which may be taken by the firm under conditions of uncertainty are diversification, liquidity, and flexibility. These methods were examined from a theoretical as well as from an empirical standpoint. In addition, the effect of the proximity of the household to the firm and the variability of the management function were treated.

A deductive examination determined that the effect of diversification on variability will depend upon the relative variability of the added and the existing enterprises and the degree of association among the enterprises. Yields and prices are the relevant variables that determine the effect of the addition of enterprises.

Flexibility is a precaution which may take the following forms: output, product, and contract. All forms were examined from a deductive standpoint and were thought to have application to the problem of decision making under conditions of uncertainty.

Liquidity, which permits assets to be converted into cash easily, is a precaution available to the firm. It is a safety device which permits unfavorable production conditions to be met. The logic of flexibility and liquidity are similar; the distinction is that the former applies to production while the latter relates to exchange.

Yields from the Garden City Station indicated that the variability of wheat or milo alone could be reduced by some combination of the two. Kafir forage had lower variability than did any of the grain crops. This suggested the possibility of a livestock enterprise.

Price relationships were studied prior to the calculation of gross income from the various enterprises. The degree of association was quite high among various prices indicating that the possibilities of diversification in the reduction of variability would not be great.

When price and yield data were combined for the Garden City Station, it was found that either the addition of milo or the addition of a cattle enterprise to the production of wheat would reduce variability.

The variability of the physical production of wheat was not reduced by the addition of any other grain crop at the Col-
by Station. Sorghum forage production was a more stable crop than wheat. This fact suggested that a forage consuming livestock enterprise might stabilize returns from wheat alone. Although variability was not decreased, it was found that a wheat-milo combination decreased the number of years that there were complete crop failures.

An analysis of gross income data of various enterprise combinations indicated that milo and, or, cattle when added to wheat would decrease variability. It was concluded that while the reduction in variability was not large, the reduction may occur in strategic years since the number of years in which there were complete failures was reduced by a combination of enterprises.

The possibilities of area diversification were examined. Data for the Colby and Garden City Experiment Stations were combined. The reduction in variability was not large but was of the same general magnitude as the reduction due to product diversification.

Soil moisture tests at seeding time at the Colby Station were used as a basis for making decisions for seeding or following for a hypothetical flexible organization. The net returns from this organization were compared with the returns from a continuous wheat organization and an alternate crop and fallow organization. It was found that the continuous wheat organization was inferior to the other organizations both in terms of variability of income and also in terms of net income. The flexible system was superior to the alternate crop and fallow system in terms of net income but was inferior in terms of variability of income.

PHOTOSYNTHESIS IN THE POTATO, SOLANUM TUBEROSUM L.

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The air-stream method was used to measure the rate of CO₂ absorption by potato leaves during three seasons under field conditions. Four absorption units were attached to leaf chambers with enclosed leaves; two units were used as checks. The effects of temperature, light, CO₂ supply, and leaf hydration on the rate of photosynthesis were of primary concern.

Large variations in the rate of CO₂ absorption by potato leaves were observed, both with paired leaves on the same plant and on different plants. Due to this paired variation, large populations of observations were required to determine the significance of observed relationships.

Changes in temperature did not influence significantly the rate of CO₂ absorption between 21° and 42° C. It appears likely that the Q₁₀ for photosynthesis of potato leaves under field conditions is near 1.0; thus the dark or enzymatic reactions (Q₁₀ > 1.0 or more) must not be limiting. Since light saturation of the photosynthetic process was reached at approximately 3000 f.c. the light intensity (Q₁₀ of photochemical reactions 1.0), a diffusion process, probably gaseous or liquid diffusion of CO₂ to the sites of photosynthesis (Q₁₀ 1.0 to 1.4), must be limiting under field conditions.

Twice normal CO₂ (0.06% by volume) and five times normal CO₂ (9.15%) in the air-streams resulted in linear increases in CO₂ absorption by potato leaves. Doubling the apparent assimilation required an increase of the CO₂ concentration by a factor of 2.2 to 2.6. Close correlation between light intensity and CO₂ absorption was found below 3000 f.c. with normal CO₂ in the air-stream, below 4200 f.c. with twice normal CO₂, and below 5200 f.c. with five times normal CO₂. These facts indicate that at high light intensities the quantity of CO₂ diffusing into the cells of a potato leaf limits their rate of photosynthesis.

The family of lines formed when rate of CO₂ absorption was plotted against light intensity (below saturation) increased in slope as the CO₂ concentration of the air-stream was increased. Therefore, photosynthesis may be limited by both CO₂ diffusion into leaf cells and light below saturation intensities.

Badly wilted potato leaves usually ab-
sorbed 1/10 to 1/2 as much CO₂ as turgid leaves. Turgidity of permanently wilted leaves was regained within 1 to 3 hours after watering, while their rate of CO₂ absorption returned to normal much more slowly. Physico-chemical changes in the protoplasm may be responsible for this delayed recovery. A gradual decline in the general level of CO₂ absorption was observed as the season progressed and the plants increased in age.

On bright days the rate of CO₂ absorption of potato leaves increased rapidly as light intensity increased in the early morning hours, reaching a maximum for most days between 7:00 and 9:00 a.m. This peak was followed by a gradual decline during midday and a rapid drop to zero as light diminished in the late afternoon. Such a diurnal curve is typical of many species of plants.

The mean rate of CO₂ absorption by leaves of four different potato varieties did not differ significantly. Variations between paired leaves with the air-stream method are too large to allow measuring small varietal differences, if they exist.

The CO₂ content of the air around potato plants, as determined by the check towers during the day, averaged about 0.48 mg. per liter; considerably less than the generally quoted mean of 0.59 mg. per liter. Equilibrium between photosynthesis and respiration is generally assumed to be reached at about 0.20 mg. per liter for land plants, depending on the temperature and other factors. Thus only some 0.28 mg. of CO₂ per liter of air was more or less readily available for photosynthesis by potato leaves in western Nebraska.

NON-SPORULATING OBLIGATELY ANAEROBIC BACTERIA IN DAIRY PRODUCTS
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Non-sporeulating anaerobic bacteria have not been reported in the literature as being associated with dairy products. This study was made to determine the relative number, types and importance of non-sporeulating anaerobes which might be found in dairy products. The products examined were raw milk, raw cream, Cheddar cheese and rumen liquid. When raw milk and cream were used as the source material, the samples were enriched by placing at room temperature until they coagulated, after which deep-agar shake tubes and deep-agar plates with an overlay were made of the proper dilutions. The medium that proved to be most successful for anaerobic isolation was a trypticase-soy-glucose agar containing 10 per cent V-8 Juice, 0.05 per cent cysteine hydrochloride and 0.05 per cent Tween 80. The medium was adjusted to pH 6.3-6.5, using phosphate buffer. The shake tubes or plates made of the diluted samples were incubated at 35-37° C. under anaerobic conditions for 7-10 days. Anaerobic conditions were established by removal of residual oxygen with a palladinized asbestos catalyst, 90 per cent hydrogen and 10 per cent carbon dioxide being present in the incubation chamber. The colonies which were small or were winged-shaped were picked into tubes of solid medium. Those cultures showing growth in the bottom of the tube and not in the aerobic zone 8-10 mm. from the surface of the agar were selected as being anaerobes. The use of a semi-solid medium containing 0.13 per cent agar was very successful in carrying anaerobic cultures in the shake tubes. In this study a total of 4,202 colonies were picked from 18 milk samples, 33 cream samples, 13 cheese samples, and three rumen-liquid samples. From the total colonies picked, only 239 (approximately 6 per cent) proved to be non-sporeulating anaerobes.

One paramount problem encountered in the isolation of anaerobes was the relatively large number of facultative types usually found in dairy products. Several methods were tested to either selectively prevent the growth of the facultative types or to find some distinctive characteristic of the obligate anaerobes that would be
The 239 anaerobes isolated were divided into four groups on the basis of morphology, biochemical tests and fermentation ability. Group I consisted of 115 isolates from milk, cream, cheese, and rumen liquid. These cultures were gram-positive, nonmotile, short rods 0.5-0.7 x 0.7-1.3 µ, which formed lens or winged sub-surface colonies and circular, translucent, convex and smooth surface colonies. Group I cultures reduced litmus milk and coagulated milk with a pH of 5.7. The cultures grew well at 21, 30 and 35-37° C., while only a few also grew at 45 and 10° C. Generally they did not survive 60° C. for 10 minutes. Group I cultures were catalase-positive, reduced nitrates, produced indole, were proteolytic, produced propionic and acetic acids and utilized lactates. They fermented fructose, galactose, glucose, mannose, mannitol, and sorbitol. Some cultures were lipolytic and a few were hemolytic on bovine blood. All cultures tested were hemolytic on human and rabbit blood. Group I cultures grew well in Collins' and Delwiche's media when modified by addition of tryptophane and reticulogen, respectively. The cultures produced bitter and rancid flavors in milk. Group I cultures resemble Bacteroides pseudoramosus (Eggerth) ATCC No. 8489. Because the genus Bacteroides has been reserved for gram-negative organisms, it was proposed that cultures of Group I be considered closely related to Rambacterium pseudoramosum (Prévot). The proposed name for this species is Rambacterium lactum, spec. nov.

Group II consisted of 88 isolates from milk and cream. The cells of Group II cultures were gram-positive, nonmotile rods 0.4-0.6 x 0.8-1.6 µ, which formed lens shape sub-surface colonies and punctiform, translucent, convex and smooth surface colonies. These cultures reduced litmus milk and coagulated milk with a pH of approximately 4.0 and a titratable acidity of 1.7-1.9 per cent. The cultures grew well at 10, 21, 30 and 35-37° C., but not at 45 and 5° C. Generally they survived 60° C. for 10 minutes, while only a few cultures survived for 20 and 30 minutes. Group II cultures were catalase-negative, produced acetic and inactive lactic acid and fermented arabinose, cellobiose, fructose, galactose, glucose, lactose, maltose, mannose, raffinose, sucrose, and salicin. A few cultures also fermented inulin, xylose, mannitol, and sorbitol. Group II cultures grew well in Collins' and Delwiche's media when modified by addition of tryptophane and reticulogen, respectively. When inoculated into milk, the cultures produced a clean acid flavor. In many instances, Group II cultures resemble members of the genus Lactobacillus and more specifically L. bifidus types I and II described by Retger. Because of several uncommon characteristics, cultures of Group II were considered different from these types, and it was proposed that they be placed in the genus as Lactobacillus anaerobius, spec. nov.

Group III consisted of three isolates from one sample of cream. These cultures were gram-positive, nonmotile, short rods 0.5-0.7 x 0.7-1.3 µ, which formed lens shape sub-surface colonies and circular, translucent, convex and smooth surface colonies. Group III cultures did not reduce litmus milk or coagulate milk, but after 7 days the pH was 5.7. The cultures grew well at 10, 21, 30 and 35-37° C., but not at 45 or 5° C. They survived 60° C. for 30 minutes. Group III cultures were catalase-positive, reduced nitrates, produced propionic and acetic acid, utilized lactates and fermented arabinose, fructose, galactose, glucose, maltose, mannose, mannitol, sorbitol and salicin. Group III cultures grew well in Collins' and Delwiche's media without supplementation. Because of the resemblance of Group III cultures to Group I cultures, it was proposed that they be placed in the genus Rambacterium (Prévot). The proposed name for this species is Rambacterium lactum, spec. nov.

Group IV consisted of one isolate from a milk sample. The cells of this culture were 0.4-0.6 x 0.7-1.0 µ, which formed lens shape sub-surface colonies and punctiform, translucent, convex and smooth surface colonies. This culture did not reduce litmus milk or coagulate milk and the titratable acidity after incubation for 7 days was 0.27 per cent. The culture grew well at 21, 30, 35-37 and 45° C., but not at 5 or 10° C. It did not survive 60° C. for 10 minutes. This culture was catalase-negative, reduced nitrates, produced hydrogen sulfide and acetic acid, utilized lactates, but did not ferment any of the carbohydrate compounds tested in the study. Group IV culture grew well in Collins' and Delwiche's media without supplementation. When inoculated into milk, the typical hydrogen sulfide odor and flavor was produced. In many respects, the Group IV culture resembles...
The adsorption of the normal aliphatic alcohols and the normal fatty acids containing two to seven carbon atoms from their aqueous solutions on three different non-porous carbon adsorbents has been investigated. The purpose of this investigation was to establish experimentally the effects of variation of the solute activity, the chain length of the sorbate molecules, the type of functional group contained in the molecule, and the nature of the carbon surface upon the amount of solute adsorbed from solution, and in this manner to contribute toward the possible development of a satisfactory general theory of solution adsorption. Non-porous adsorbents were used to eliminate capillary condensation effects which arise with charcoals and other porous materials, and which obscure the effects of any adsorption forces actually existent at the solution-solid interface. In this investigation, absolute solute activity extended in every case from zero to at least 0.88. The amount of solute adsorbed was determined by interferometric measurements of the change in solution concentration upon exposure to the solid adsorbent samples.

Adsorption from the aqueous phases of those of the alcohols and acids which are not totally miscible with water invariably showed a rapid rise in the amount of adsorption as the solution concentration approached the saturation value. This rise reflects the dependency of the adsorption upon the work required to remove the sorbate from solution, and the adsorption values reached in these measurements demonstrate that the adsorption necessarily must be multimolecular.

For a given adsorbent the surface excesses of the immiscible acids depended only on the absolute activity of the acid in the solution over the entire activity range. The miscible acids followed the same surface-excess versus activity curve for ranges which were more extensive the higher the position in the homologous series. A similar generalization applies approximately to the alcohols; deviations were significantly greater with the alcohols than with the acids, and appear to be systematic. In both homologous series, the individual isotherms varied only five to ten per cent for all the different members of the series in the activity range 0.0054 to 0.10. Traube's rule has been shown to be a necessary consequence of this behavior.

For the miscible systems, the adsorbents Graphon and DAG-1 showed positive adsorption of the organic component over the entire concentration range; the adsorbent Spheron-6 gave S-shaped isotherms, with negative adsorption of the organic component at high concentrations. Correspondingly, measurements of the adsorption of water from the organic phases of the immiscible alcohols and acids showed no preferential adsorption of water at any concentration by Graphon nor DAG-1, while Spheron-6 did show a definite adsorption of water in all cases. The water adsorption isotherms on Spheron-6 were of the Langmuir type. Apparently a portion of the surface of Spheron-6 consists of sites, perhaps particular types of oxygen complexes, which possess specific affinity for water molecules. These sites are removed in the process of graphitization of the Spheron-6 carbon black.

While the varying specific surface characteristics of the three carbon adsorbents markedly affect the adsorption of water from binary solutions of low water concentration, these characteristics have little effect on the adsorption of organic solutes from dilute aqueous solution. The effects appear to be significant but
are small compared with the absolute activity factor.

A mean isotherm for the immiscible alcohols on a given adsorbent was identical with the corresponding isotherm for the acids. This lack of dependence on functional group suggests that any specific interaction which may exist between organic adsorbate and carbon surface involves primarily the alkyl group rather than the functional group, and again emphasizes the relative importance of absolute solute activity as the most important factor in determining adsorption from solution.

Attempts to compute thickness of adsorbed layers from solution adsorption data alone have proved unsuccessful. For such computations, independent related data giving information such as actual potential functions or vapor phase adsorption would be required.

Solubilities of water in the alcohols and acids with which water is not miscible in all proportions have been determined at 25° C., as have also the solubilities of these alcohols and acids in water. Some of these are new measurements; the others have been independently determined, and their values compared with values published in the literature.

The adsorption of alcohols and acids from aqueous solution on non-porous carbons has been found to be a rapid process. Equilibrium was established in less than two minutes. There was no indication of a further rise in adsorption after this time.

Twenty-two tables of experimental data and twelve graphs are given in support of the above observations and conclusions.

BIOLOGY AND CONTROL OF THE WOOLLY APPLE APHID IN IOWA NURSERIES,

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The woolly apple aphid Eriosoma lani-gerum (Hausmann) has been a major pest of nursery grown apple trees for many years. This is especially true in the vicinity of Shenandoah, Iowa, where the largest and most concentrated nursery industries in the United States are located. At the request of the industry and with their active support, the studies were begun in the fall of 1949 and continued through 1952.

The studies were divided into two parts. The first part consisted of a re-examination of the life history of the insect; the second part was devoted to methods of control.

From observations it was found that the life history of the woolly apple aphid in Iowa followed, in general, that outlined for other areas of the eastern United States. The earliest dates of observation of the stem mother form on American elm were April 10, 1950; April 20, 1951; and April 7, 1952. The average number of progeny deposited by 16 stem mothers under labor-
five; however, two aphids moulted six times each.

It was demonstrated that seedling apples could be infested by budding them with aphid-infested buds.

The first fall migrants were observed October 10, 1949; September 27, 1951; and September 23, 1953. Fall migrants developing under field conditions contained sex forms in the ratio of 1:1, while migrants developing under greenhouse conditions contained a relatively large number of female embryos. In some instances all the sexuals of a migrant were females. The average number of sexuals obtained by dissecting 20 migrants collected in the field was 8.9.

Two experiments demonstrated that only a small percentage of seedling apple trees became infested with root form aphids during the first growing season in the nursery row. In one experiment 2.69 per cent of the trees were root infested the first year and 51.86 per cent were infested at the end of the second growing season. In the second experiment not a single tree was infested at the end of the first growing season.

Tri-6 WE-10 (10 per cent gamma isomer) at levels of 1 and 2 pounds gamma isomer per acre and chlordane at levels of 15 and 30 pounds per acre, applied as sprays, were ineffective in controlling the root form aphids on heavily infested two-year budded apple trees. The chemicals were also ineffective when an additional spray was applied during the third growing season.

Treatments using gamma isomer of benzene hexachloride at levels of 0.25, 0.5, and 1 pound, when applied in 200 gallons of finished spray per acre, were ineffective in controlling the root form aphids on one-year budded apple trees.

A treatment using one application of Isotox (20 per cent lindane) spray applied at the rate of 1.56 pounds of lindane per acre to one-year budded apple trees was as effective as a treatment using the same level of lindane but making two applications, one during the first and one during the second growing season. The percentage infestations at digging time was 13.59 and 11.96 respectively. When one application of lindane was made during the second growing season, only, the percentage infested trees was 42.48 and that for the untreated check 56.72 per cent.

Sprays of 2 per cent chlordane, 0.012 per cent endrin, 0.026 per cent gamma isomer of benzene hexachloride, applied in 200 gallons of spray to infested scion trees, did not significantly affect the establishment of buds from these trees when budded to apple seedlings.

Sprays of 0.12 per cent endrin, 0.029 per cent isodrin, 2 per cent chlordane, and 0.026 per cent gamma isomer of benzene hexachloride, when applied at the rate of 200 gallons of finished spray per acre to budded seedling apple trees, one day following the budding operation, did not significantly affect the establishment of buds. Although the incidence of aphid infested trees was very low in the experimental plot, all treatments were significantly better than the control. Following an additional application during the first growing season the percentage of infested trees in the treatments was: chlordane 14.70, Gammol 17.38, isodrin 20.40, endrin 41.19 and untreated control 51.86.

Sprays of 0.1 per cent isodrin: 2 per cent chlordane; Gammol (2 pounds gamma isomer in 100 gallons of spray); and Black Leaf "40" 1:200 with soap gave complete control of aphids when applied to heavily infested three-year apple trees following the digging operation. The results were based on examination of the trees when removed from storage the following spring.
Dwarf apple trees are commonly produced by propagating standard varieties with short trunk sections of a dwarfing stock. The dwarfing stem section causes less growth, earlier fruiting, and more highly colored fruit than is found in standard trees. The physiological action of the dwarfing interstem was studied.

A length x diameter square factor for measurement of top growth was compared with the seasonal dry weight increase of greenhouse trees. A correlation coefficient, \( r = 0.94 \), was obtained which showed that the L x D² factor could be used as an estimate of dry weight increase. Growth measurements of own-stem, dwarf interstem, bridged dwarf interstem, and Golden Delicious interstem trees showed that dwarf interstem trees produced less top growth and fewer lateral branches than did the other three treatments. Root growth of dwarf trees was reduced significantly below the root growth of own-stem. The root reduction was about equal to the reduction in leaf area of dwarf trees.

Habits of growth of field grown dwarf, bridged, and own-stem trees were compared. The narrow crotch angles and spreading tops of the dwarf and bridged trees were distinctly different from the wide crotch angles and upright tip growth of own-stem trees. An antiauxin mechanism is suggested.

Graft unions of Clark Dwarf with Golden Delicious showed no evidences of incompatibility conditions. Radial checking of dry Clark Dwarf interstems and profuse bark development on the Clark Dwarf interstems indicate that this stock is similar in anatomical structure to the dwarfing stocks used widely in Europe.

A series of studies was run to evaluate translocation activity of the interstem. Nitrogen translocation was studied by determining nitrogen accumulation in leaves following application of fertilizer to a low-nitrogen soil. Own-stem trees accumulated nitrogen somewhat more rapidly than did the dwarfs. Golden Delicious interstem trees accumulated nitrogen more rapidly than dwarf trees after the graft unions were well developed. Bridged interstem trees tended to occupy an intermediate position between dwarf and own-stem trees.

Analysis of bark strips following application of radioactive carbon dioxide to a leaf of a dwarf tree showed no evidence of sugar accumulation at the graft union or in the interstem. The erratic results obtained with one tree suggest some of the complexities involved in using this method of studying translocation in the apple. Chromatographic analysis showed the photosynthetic involved in translocation to be glucose.

Loss of water from dwarf, bridged, and own-stem trees measured over various periods showed that water loss per unit of leaf area was approximately equal for trees on the three stem treatments. Transport of water did not appear to be effected by the graft unions or by the interstems.

Leaves from field grown trees of own-stem, dwarf, and bridged stem treatments were used for reducing sugar, reserve polysaccharide, and total nitrogen determinations. Dwarf trees were highest, own-stem trees lowest, and bridged trees were intermediate in reducing sugar content. Reducing sugar content declined from June 27 to August 28 in all treatments. Reserve polysaccharides and total nitrogen content were not significantly different for the three treatments. A linear increase occurred from June 27 to August 28 in both materials.

The dwarf interstem effects observed in this study were: (1) reduced growth, (2) possible interference with nitrogen translocation, (3) growth habit differences, and (4) high reducing sugar above dwarf interstems. Effects (2) and (4) suggest that the dwarf interstem interferes with the translocation of organic materials through the trunk. Effect (3) suggests hormone actions. The reduced growth could have been due to either or both of these. Reduced growth, spreading growth habit, and higher sugars in the tops would tend to favor early fruiting, and dwarf trees commonly fruit the third year in the orchard. Once initiated, fruiting itself has a dwarfing effect which would accentuate the continuing action of the interstem.
APPLICATION OF EXPECTATION MODELS TO LIVESTOCK PRODUCTS

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The purposes of this study were (1) to formulate possible expectation models which could be utilized in forecasting prices and yields and (2) to test the efficiency of these models in terms of the magnitude of the errors which would result from their use.

Twelve different expectation models were tested for efficiency in predicting future values of price or yield series. The average model projected a constant value, namely the average of the series as the predicted value. In a variant of the average, the cumulative model, the predicted value was a moving average whose length increased with an increase in the length of the series. In the random and current year models, the predicted value was based on a single observation; in the random model, the predicted value was chosen at random from the past values of the series; in the current year model, the predicted value was last year's value of the variable. The five year moving average and the five year weighted moving average models introduced some stability into the predicted values by using the indicated averages; in addition, the weighted moving average model emphasized the importance of the current period. The trend and reverse trend models utilized the concept of trend which is based on the difference between consecutive observations. The trend from average and the reverse trend from average models utilized both average values and trends in the formulation of the predicted value. Each of these models utilized some characteristics of a particular series, namely, the average of several observations, the short-term linear trend, or the relationship between consecutive observations in making predictions. The random model was unique because, in addition, it utilized various random influences in the environment as a basis of prediction. Two other models, namely, the outlook and the parallel price models, did not utilize any characteristics of the series whose values were being forecast; the outlook model used the forecasts of government agencies and the parallel model utilized the prices of similar periods in the past as the basis of price prediction.

All the expectation models were tested for efficiency on empirical series, and all but the cumulative, outlook and parallel models were tested on hypothetical series. The hypothetical series were three in number; the first, a generalized autocorrelated series; the second, a series with autocorrelation of positive unity, and the third, a random series. The empirical price series consisted of steer, hog, lamb, egg, and butterfat prices, each extending over the period from 1917 to 1950, inclusive. The empirical yield series consisted of eggs laid per hen, milk produced per cow, and pigs weaned per litter on twenty different farms; each series on each farm extended for a period of twenty consecutive years or more.

The generalized autocorrelated series was useful in developing a set of formulas which would be applicable to any autocorrelated series; the random series and the series with autocorrelations of positive unity are two particular cases of this generalized series. The application of the expectation models to a random series resulted in several conclusions; the most important of these was the usefulness of the moving average model in forecasting. The series with autocorrelations of positive unity was less fruitful in its results; it was possible, however, to indicate the efficiency of the current year model.

The application of the models to the empirical data indicated the magnitude of the errors which resulted from a series with parameters intermediate in value between that of a random series and that of a series with autocorrelations of positive unity. In addition, it was possible to obtain the percentage of extreme errors and the range of the errors. This allowed a more complete evaluation of the efficiency of the various models as indexes of uncertainty. The most efficient models in prices were the outlook, current year, parallel and the five year weighted moving average models. In yields, the current year model was the most efficient for the egg and milk series, while the average and moving average models were most efficient in the

1 a. Chairman of Committee, Earl O. Heady, Dept. of Economics and Sociology.
1 c. B.S.A., University of Saskatchewan, Canada, 1944.
pig series. The efficiency of the current year model in prices, and in the egg and milk series in yields was partly offset by the existence of extreme errors.

On the basis of the theoretical and empirical evaluation of the models, two policy recommendations appear possible. First, given a series with an imperfect degree of positive autocorrelation, farmers could be advised to use the current year model; it is one of the highest in efficiency and also one of the simplest to adopt. In price series the efficiency of the current year model may be further increased by supplementing it with outlook information. Since the outlook forecasts were particularly accurate in forecasting large price changes, farmers could be advised to formulate expectations on the basis of the current year model, but to shift to the outlook model whenever severe price changes were indicated. Utilizing the outlook information would be particularly useful in reducing the number of extreme errors in the current year model. Second, for yield series which tend to approximate randomness, the five year moving average model may be recommended for use by farmers. Its efficiency is only one-fifth less than that of the average model, and it is more practical for farmers to adopt than the average model, as the average value of a series is not usually known. Five years is selected as the length of the moving average, as an interval of this length is a convenient memory period for the farmer. The use of a longer moving average would allow a small increase in the efficiency of the model; its use is not recommended as the increased efficiency may be more than offset by the memory error introduced as the farmer attempted to recall the more distant yields or prices.

APPROXIMATION OF SERVOMECHANISM TRANSIENT RESPONSE

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Although servomechanism design requirements usually specify the output time response to some standard form of time input signal, the design process is commonly performed on a frequency response basis. The existing wealth of knowledge and experience in steady-state alternating current circuit theory and in feedback amplifier performance justify this design procedure. Under these conditions the need to transform from the frequency to the time domain and vice versa is very great.

Exact mathematical methods of performing these transformations for linear systems under very general conditions exist but unfortunately do not lead to closed form results except in very special cases.

The purpose of this study was to investigate a certain approximation of the inverse Laplace transform from the frequency to the time domain based on the behavior of the imaginary component of the closed-loop system transfer function. This imaginary component was assumed to be zero for all angular frequencies above an empirically determined cutoff point, \( \omega_0 \). Further assumptions were made that the imaginary component decreased linearly in the range where its absolute value was less than one tenth, that eighteen point graphical integration would give sufficiently accurate Fourier coefficients in an expansion of the imaginary component as a sine series, and that the contributions to the time response of terms higher than the fourth would be negligible.

The cutoff frequency, \( \omega_0 \), was selected on the basis of the results obtained for four systems having varied open-loop transfer functions. These systems were restricted by the necessity of analytically performing the exact transformation as a basis of comparison. Excellent results were obtained in the systems investigated when \( \omega_0 \) was taken equal to 1.3 times the frequency at which the imaginary component was equal to minus 0.1 and decreasing. The figure of 1.3 represents a lower limit set so that the part of the imaginary component excluded from consideration did not introduce more than five per cent error.
into the results. The upper limit for five per cent error is dependent on the validity of the latter three assumptions and varies widely in the systems studied.

The method results in the following expression for the system response, $h(t)$, to a unit impulse input.

$$h(t) = 2\omega_0 \sin \omega_0 t \sum_{n=1}^{4} \frac{a_n}{n^2 \omega_0^2}$$

(1)

where

$$a_n = \frac{2}{\pi} \int_{0}^{\omega_0} I(\omega) \sin \frac{\pi}{\omega_0} \omega d\omega$$

(2)

$I(\omega)$ being the imaginary component of the closed-loop transfer function. $h(t)$ is easily calculated from this expression since the term $\sin \omega_0 t$ occurs outside the summation sign.

Procedures are included for deriving the imaginary component of the closed-loop transfer function as a function of frequency when the open-loop transfer is available either analytically or as a plot in polar (Nyquist) or log modulus vs angle coordinates.

The proposed method was found to be valid for times less than $\frac{4\pi}{\omega_0}$ when four terms of the series were retained, and the labor of computation was materially less than that required by other methods giving results of comparative accuracy. However, this method should be checked on more complicated systems using an analog computer, or equivalent means, to determine the correct results for comparison.

MANAGEMENT ASPECTS OF AND EDUCATIONAL CRITERIA FOR SCHOOL LUNCH PROGRAMS IN IOWA

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Part I. Management Aspects of School Lunch Programs in Iowa.

The purpose of this part of the study was to investigate problems in the management and operation of lunch programs in Iowa schools. This research was a part of the Iowa State College Agricultural Experiment Station Research Project 1021, the Nutritional Status of Iowa School Children: the School Lunch as a Contributing Factor.

During the school year of 1948-49 data were collected in 25 schools drawn at random and representing junior and senior high, elementary and schools with 12 grades in one unit. Of the pupils enrolled in these schools, 36 per cent ate the school lunch.

Analyses of covariance indicated that, other than variation attributed to the number of lunches served, there were real differences among the three groups of schools in the labor time scheduled for personnel, the kitchen area, and the labor, other and total cost of operating the lunch programs; there was no real differences in the food costs. Other than variation due to seating capacity, there were differences in the dining table area but not in the dining room area. There was wide variation among schools within each group in the food cost and the dining area.

The average rates of production were 7.9 lunches per man-hour of labor, 7.5 minutes of labor time per lunch served and 7.2 lunches served per minute per serving line. An average of one third of the labor time was used for food preparation, one third for cleaning and one fifth for serving. The greatest percentage of time was used for cleaning in the high and elementary schools and for preparation in the schools with 12 grades. The average kitchen area was 2.3 square feet per lunch served; in 21 schools the space exceeded the minimum standard. In 16 schools the dining space was inadequate. The average length of the basic food route was 57.6 feet. Most of the schools in larger cities had more institution equipment than those in smaller towns. None of the kitchens in the latter schools was adequately equipped.

The rates of production and the division
of labor time seemed to have been affected by the number of lunches served, space and layout of facilities, amount, type and condition of equipment, organization of work, training and experience of personnel, cleaning duties required and the number and type of food items prepared and served.

Food prices, wage levels, monetary value of donated commodities and the amount of other expenses paid from lunch funds influenced the expenditure distribution of income; an average of 56.8 per cent was used for food and 31.8 per cent for labor. The average total cash received per revenue lunch served during the school year of 1948-49 was 27.3 cents and the range was from 24.8 for the schools with 12 grades to 32.5 cents for the high schools. The average per meal total cost was 26.5 cents for the total group and 31.6 for the high schools. The average per meal food costs were 17.1, 12.8 and 15.1 cents for the high, elementary and schools with 12 grades, respectively, and averaged 15.1; the labor costs were 9.5, 8.3 and 7.8 cents and averaged 8.4.

The total weight of the food returned averaged 5.9 pounds per 100 students served. Of the food served, 5.08 per cent was returned, in the high schools 2.41, elementary 6.34, and schools with 12 grades 5.49 per cent. Salads, vegetables, desserts, main dish items, breads and sandwiches, milk, fruits and fruit juices were returned in order of decreasing amounts.

An average of one third of the recommended nutritional allowances for a child ten to 12 years old was supplied by the lunches prepared in 24 schools except for calories and iron. When the adequacy of the lunches in the high schools was determined on the basis of the dietary allowances for boys from 13 to 15 years, only protein, thiamine, riboflavin and ascorbic acid were adequate. The menu items in the more nutritionally adequate lunches were relatively more expensive and usually required more preparation time than those in the lunches which were less adequate.

On the basis of the findings it was recommended that: training for school lunch personnel emphasize menu planning in relation to organization of work, cost and nutritional adequacy; school personnel request assistance in planning and equipping lunchrooms; that more comprehensive studies be made regarding the factors influencing participation, labor time and cost and the acceptability of food, adequacy of dining room space and facilities, school lunch expenditures and monetary and nutritive value of donated commodities.

Part II. Educational Criteria for School Lunch Programs.

The purpose of this part of the study was to develop a set of criteria which can be used to determine to what extent a school lunch program is an integral part of the total school program. After developing a concept of the basic characteristics of such a program, the following criteria were proposed: there are sound policies for the administration of the school lunch program; the school administrator assumes responsibility for the administration of the program; teachers assume and share responsibilities for promoting the educational effectiveness of the program; pupils participate in educational activities related to the program; the professionally trained manager and the school lunch personnel contribute to the educational effectiveness of the program; community members participate in the program.

Using educational practices which had been classified according to the six proposed criteria, a schedule was developed for obtaining data believed to be necessary for determining to what extent the proposed criteria are fulfilled in a given school. The schedule was tested in ten schools to determine whether the questions would elicit the information believed to be necessary, whether the schedule was applicable to various types of schools and whether the proposed criteria provided a practical basis for this kind of evaluation.

After revisions were made in some questions and the form for recording the data, the schedule was applicable to the ten schools regardless of size of enrollment, number of pupils served, kind of management of the lunch program and type of school.

The schedule was recommended for use by federal or state agencies, state supervisors, school personnel or members of a community to determine the extent to which a school or group of schools is fulfilling the criteria, to secure some knowledge of the attitudes of schools and communities regarding the educational potentials of lunch programs, to determine needs for assistance in planning methods whereby the criteria can be more completely fulfilled and to suggest possibilities which exist for making the lunch program more educational.
CONDUCTANCES, TRANSFERENCE NUMBERS, AND ACTIVITY COEFFICIENTS
OF SOME RARE EARTH CHLORIDES IN AQUEOUS SOLUTION,

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The conductances, transference numbers, and activity coefficients of aqueous solutions of some rare earth chlorides at the equivalence pH were measured at concentrations up to 0.1 normal. The measurements were made on the chlorides of neodymium, dysprosium, holmium, erbium, thulium, and ytterbium. In addition to these measurements, a new mathematical treatment of the electrophoretic part of the Onsager Theory of conductance was carried out. This resulted in better agreement between the theoretical and experimental values of the transference numbers and conductances.

The rare earth chloride solutions were brought to the equivalence pH value before measurement of the properties was undertaken. This equivalence pH value was determined by titration of an aliquot of the stock solution with acid. The titration was followed with a pH meter. It was found that the clear "solutions", at pH values of 6 to 6.5, which had been previously made by dissolving anhydrous rare earth chlorides in water in a closed system, actually contained small amounts of colloidal oxide or basic salt. This was negligible for the light members of the rare earth series, but exceeded by a small amount the normal experimental errors for the heavier members of the series. The small error of this deviation was demonstrated by repeating the measurements which had been made previously on neodymium chloride, erbium chloride, and ytterbium chloride.

The conductances were measured, using a Jones bridge and its accessories, for solutions ranging from 0.0003 normal to 0.1 normal in concentration. Since these measurements were made at the equivalence pH values, which were below the neutral point, a correction for conduction of current by the hydrogen ion was necessary for low concentrations. The equivalent conductances obeyed the simple Onsager Equation up to about 0.008 normal and agreed with the new mathematical treatment of Onsager's Theory up to about 0.002 normal.

The transference numbers were determined by the moving boundary method for solutions from 0.01 normal to 0.1 normal in concentration. The simple Onsager Equation predicted much lower transference numbers than were measured. When the mathematical extension of the theory of Onsager was developed, however, the theory agreed with the experimental values much more closely.

The conductances and transference numbers both exhibit similar changes with atomic number. The experimental values of both the transference numbers and the equivalent conductances at any concentration remain nearly unchanged for the first five or six rare earth chlorides. A relatively large change in these properties then takes place between samarium chloride and holmium chloride, and again the values remain nearly unchanged for holmium, erbium, thulium and ytterbium chlorides. This probably is due to changes in the hydration number of the rare earth ion, but has not been fully explained as yet. It would be of interest to study further the structure of the hydrated chlorides in this connection.

The activity coefficients were determined by a measurement of the E.M.F. of cells with transference in the concentration range, 0.002 normal to 0.1 normal. The experimentally obtained activity coefficients were found to agree with the predictions of the Debye-Hückel Theory throughout this range with a precision of about ± 0.2 per cent. The values of )), the distance of closest approach of the ions, indicate that the rare earth ion has one layer of water molecules which adheres rather firmly to the central ion. The )), values obtained from the experiments do not increase or decrease in a regular fashion throughout the series, but are larger for the high atomic number rare earth chlorides than for the lower members of the series.

A new mathematical treatment of the electrophoretic part of Onsager's Theory of conductance is described, which employs graphical methods to evaluate integrals which were only approximately evaluated by Onsager. The approximate methods, while satisfactory for 1-1 electrolytes, are unable to explain the transference number behavior of unsymmetrical...
electrolytes. The extension of the mathematics resulted in much better agreement of experiment with theory for the transference numbers of unsymmetrical electrolytes. This treatment of the theory was applied to the conductances and transference numbers of neodymium chloride, erbium chloride, and calcium chloride. The calculated conductances agreed with the experimental values up to about 0.008 normal, compared with agreement to about 0.0008 normal in the case of the simple theory. The calculated transference numbers agreed well enough with the experimental values to explain the large discrepancy which had existed between theory and experiment for the transference numbers of unsymmetrical electrolytes. In addition, the possibility of determining the mean distance of closest approach of the ions, \( \delta \), from conductance measurements was recognized. This would make it possible to calculate activity coefficients from conductance measurements, using the equation of Debye and Huckel, which includes the parameter \( \delta \). These calculated activity coefficients should certainly be better than those obtained from the simple limiting law, since the theoretical basis for the inclusion of \( \delta \) in the theories of both activity coefficients and conductances demands a single value for \( \delta \).

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**APPROXIMATE SOLUTION OF BOUNDARY VALUE PROBLEMS**

I. BY MINIMIZATION OF THE LEAST SQUARE ERROR

II. BY USE OF FINITE DIFFERENCES

WALTER G. DYER

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The first part of this study deals with the method of least square error in obtaining an approximate solution of a boundary value problem involving Laplace's differential equation in two dimensions. The terms of the proposed solution \( \hat{u}(x,y) = \sum c_i f_i(x,y) \) where \( i = 1, 2, \ldots, n \), are chosen as solutions of the governing equation \( L(\phi) = 0 \). In particular they are selected from exact solutions of related boundary value problems whose boundary values partly agree with those of the required problem. The constants in \( \hat{u}(x,y) \) are determined by minimizing the integral of the square of the error along the entire boundary. The usual necessary conditions for a minimum of this error integral lead to a non-homogeneous finite linear system for the unknowns \( c_i \).

After it is shown that the method is capable of producing the exact solution in certain examples, it is applied to an example with mixed boundary conditions at the edges of a square region. In another example a rectilinear region involving a reentrant corner has edge conditions assigned along its six bounding lines. There is no known analytical solution for these problems. The least square method yields results which are in good agreement with the numerical results obtained by an iteration procedure employing finite differences methods. Although an effort was made to determine whether a selection of functions from exact solutions of related boundary problems would yield more favorable results than those produced by a general choice of functions satisfying \( L(\phi) = 0 \), no conclusions were made. It is believed that the type of mixed boundary conditions in the problems to which the least square method was applied is responsible for this. The main task involved in using this method lies in the choice of terms to be set into the approximate expression. There seems to be no rule that can be followed to help in choosing these terms. In general it is suggested that they might be chosen from among any standard functions which satisfy the given differential equation, which also conform to the symmetry of the problem and which are a part of known analytical solutions of similar problems.

In the second part, a finite difference method of solving Poisson's differential equation in two dimensions is developed. The method recognizes the importance of Green's theorem for the solution of boundary value problems. Let the field over which the function \( \phi(x,y) \) is to be determined be covered by a network of squares of side \( h \). When the finite difference statement equivalent to the integral state-
ment of the theorem is formed, the approximate value of the required function at any point of the network may be computed in terms of the known values at the network points on the boundary. The statement for Green's theorem involves an auxiliary function \( \psi(x,y) \). The method requires that \( \psi(x,y) \) be harmonic at interior points of the network and that \( \psi_x \) and \( \psi_y \) be zero along the right hand and upper boundaries, respectively. The main task involved here is the formation of \( \Psi \)-grids. The method for forming the appropriate harmonic \( \Psi \)-grids is outlined in this study. When they are applied to the difference statement for Green's theorem, they give rise to a non-homogeneous finite linear system of not more than \( 2n-2 \) equations in the \( 2n-2 \) unknown \( \Psi \)-values. These \( \Psi \)-values lie on the first inner contour of points just inside the \( 2n \) points of the upper boundary. The remaining \( \Psi \)-values may be computed by using the harmonic relationship, i.e. any interior point is the mean of its four neighboring points. Or if other approximate \( \Psi \)-grids are formed as indicated in the paper, they give rise to equations which express each of the remaining \( \Psi \)-values in terms of the boundary values and the \( \Psi \)-values already determined.

The method is applied to the solution of a boundary value problem involving a square cross-section where the boundary values are zero along the lower side, functions of \( x \) and \( y \) along the upper and lateral sides, respectively. In another example the torsion problem for an angle section is solved. This method yields results which are in excellent agreement with the numerical results obtained from the same iteration procedure employed before.

The method is less time consuming than most other procedures of finite differences and may be carried out by means of the ordinary desk calculation. The exposition shows how this method may be extended to modified square fields, rectangular fields and to cylindrical regions where the axis is an axis of symmetry. The method may be extended to biharmonic difference equations. The procedure for such a solution including the method of forming the appropriate \( \Psi \)-grids is outlined in the paper.

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**FORM FUNCTIONS OF NON-LOCALIZABLE INTERACTIONS**

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Certain well-known difficulties are encountered in current theories describing elementary particles by quantized wave fields. Notably, divergent integrals result from computations of physically-observable quantities which are known to be finite. As a consequence, a number of techniques have been suggested recently for removing these infinities.

An analysis is made of one such proposal, that of a non-local interaction between the fields. It is assumed that the interaction energy density is a function of field operators at three points, instead of just one, a form function being used to weight more heavily contributions from nearby points. The additional freedom provided by the introduction of the somewhat-arbitrary form function is sufficient to permit making previously-divergent integrals converge.

It is shown that, for the most general form function, an energy-momentum tensor and a charge-current four-vector in the usual sense will not satisfy a differential continuity equation; energy, momentum, charge, and current are conserved only over the collision as a whole. As a result, a Hamiltonian in the familiar form does not exist, and it is necessary to find the S-matrix for the process directly from the equations of motion. A method of doing this is presented. Rules analogous to those of Feynman and Dyson are developed, so that the matrix element for a given process may be written down directly.

The theory is made relativistically-covariant, invariant under charge conjugation, and invariant under changes in gauge of an external electromagnetic field, by placing various restrictions upon the form function. These restrictions limit the form function to be a function of only
three variables. It is shown that the non-local interaction gives results similar to those which would be obtained from a theory providing for the propagation of virtual particles from one point of the interaction to the other, with the form function merely giving the distribution in masses of these virtual particles.

The transverse self-energy of the electron and the lifetime of a neutral spin zero meson against two-photon decay are computed, using a Gaussian form function. If the interaction between electron and electromagnetic field is assumed to occur over a region whose diameter is of the order of magnitude of an electron Compton wavelength, then the electromagnetic mass is only about $10^{-3}$ the ordinary mass of the electron.

Taking the range of the meson-nucleon interaction to be no greater than the nucleon Compton wavelength, a meson lifetime of about $2 \times 10^{-18}$/g$^2$ sec. is obtained with scalar coupling between the fields, and a lifetime of about $2 \times 10^{-14}$/g$^2$ sec. for pseudoscalar coupling. In these $g$ is the unknown meson-nucleon coupling constant, which may be presumed to be about 0.5. The lifetime under scalar coupling is about $10^3$ smaller than that obtained by the use of regulators, but the pseudoscalar result is approximately the same as that given by the previous calculations.

The appendices define and explain the various Green's functions used, the concept of charge conjugation, the method of evaluation of matrix elements, and the Gupta-Bleuler method of quantization of the radiation field. The actual calculations involved in computing the meson decay probability are also included.

The general outline of the theory, the reduction in the number of variables in the form function, and the technique of assuring invariance under gauge transformations of the external electromagnetic field have been given by other workers, although the treatment here is slightly different in some respects. The use of the requirement of invariance under charge conjugation to limit the form function, and the application of the theory to quantum electrodynamics are new, although the techniques used are the same as those which have been applied to fields in local interaction. The formulation of rules for writing the S-matrix elements directly, and also the interpretation given to the interactions are original with this work.

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**DECARBOXYLASE ACTIVITY OF PSEUDOMONAS SPECIES FOUND IN DAIRY PRODUCTS**

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Many of the species of *Pseudomonas* which may be found in dairy products are decidedly proteolytic and some are able to produce a markedly alkaline reaction in such substrata as sterile milk. Little information is available about the enzyme systems active in protein degradation by these organisms. The studies reported here were undertaken to determine the extent of amino acid decarboxylase activity among certain *Pseudomonas* species and to establish the conditions under which these enzymes are produced and are active against their specific substrata.

The ten species tested for decarboxylase activity were *P. fragi*, *P. fluorescens*, *P. putrefaciens*, *P. aeruginosa*, *P. gravis*, *P. mucilaginosum*, *P. cytogenes*, *P. syxanthia*, *P. ichthyosoma* and *P. viscosa*. The medium usually used for culturing the organisms consisted of 1 per cent casamino acids, 1 per cent glucose and 0.068 per cent potassium phosphate (monobasic). Fifty ml. portions of this medium were dispersed into 32 oz. bottles, sterilized at 250° F. for 15 minutes, cooled to room temperatures, inoculated with a cell suspension and incubated for 24 hours. The pH of the medium at the time of inoculation ranged from 5.36 to 5.65. The incubation temperature was 18° C. for all species, except that *P. aeruginosa* was incubated at 37° C.

The cells were harvested by centrifuging the 24 hour culture medium at 4200 rpm for 15-18 minutes. The supernatant fluid was decanted off and the remaining cells washed twice by resuspending in physiological saline. The final suspen-
sion was made by diluting the cells with enough saline to give a cell population of 5,000,000,000 per ml., as determined by optical density.

The decarboxylase activity was measured by the amount of carbon dioxide given off when the cell suspensions were allowed to react with an amino acid substrate in the Warburg constant-volume respirometer. The amino acids used for testing were arginine, glutamic acid, histidine, lysine, ornithine and tyrosine. The flask contents during the manometric measurements were 2.0 ml. of phosphate buffer (pH 6.0), 0.5 ml. of cell suspension and 0.5 ml. amino acid substrate previously adjusted to various pH levels. All measurements for decarboxylase activity were made at 30±0.2° C., using atmospheric air as the gas phase. Manometric readings were made at 5 minute intervals for at least 1 hour and the data reported as microliters of carbon dioxide liberated per hour.

When the decarboxylase activity was measured on cells grown in various media, no activity occurred unless the specific amino acid was present in the growth medium. Based on this fact, it is believed that the decarboxylases are adaptive enzymes produced only when the specific substratum is present in the free form. However, many species lack the potential to produce certain of the decarboxylases, even under the most favorable conditions.

Of the buffers studied, the Clark and Lubs phosphate buffer appeared to be most satisfactory, whether in the growth medium or in the Warburg reaction flasks. This buffer apparently did not exert as strong a buffering effect, thus allowing the pH to drop to lower levels during growth of the cultures, a condition which is more conducive to higher decarboxylase activity.

Under the conditions of the manometric determinations, the largest decarboxylase activity occurred within the pH range of 3.25 and 4.25 for the six amino acids studied. As the reaction levels approached the extremes of pH 2.5 and 5.6, the amount of enzyme activity decreased. In no case were there measurable amounts of carbon dioxide liberated when the reaction level exceeded pH 6.0.

An incubation temperature of 18° C. was found to give the highest decarboxylase activity for all species studied, except that P. aeruginosa gave the best response when cultured at 37° C. These optimum temperatures were found by comparing results from 15, 18, 21 and 24° C. and 25, 30, 37 and 45° C., respectively. Using the optimum growth temperatures for decarboxylase activity, time trials showed that 24-hour incubation yielded cultures of greater enzyme activity then did 18, 30, 36 or 42 hours. Based on the cell population for the different time periods studied, the maximum growth was obtained between 24 and 30 hours of incubation. Since the time for active cell growth and maximum decarboxylase activity are about equal, it appears that greatest enzyme activity is attained late in the logarithmic growth phase. Apparently the decarboxylases are not produced in appreciable quantities in the early growth cycle and there is considerable loss in activity after reaching the stationary growth phase.

The distribution of the decarboxylases with these ten species of Pseudomonas is extremely variable. P. fluorescens, P. putrefaciens, P. cyanoenogenes, and P. synxantha each produced only one decarboxylase; P. ichthyosmia produced two decarboxylases; P. graveolens produced three decarboxylases; P. fragil and P. mucido lens each produced four decarboxylases and P. aeruginosa and P. viscosa each produced five of the six decarboxylases for which tests were made. The level of enzyme activity against any one amino acid was quite variable among the different cultures. When a culture attacked more than one amino acid, the level of activity was not the same against each of the different compounds.

Several reports have suggested that pyridoxine is required as the coenzyme for the decarboxylase enzymes. In some cases, the addition of pyridoxine to the casamino acids-glucose-phosphate medium brought about a very small increase in production of some decarboxylases. In all cases where enhancement occurred, the increase in enzyme activity was less than one-fold.

The number of cultures employed is not such as to permit conclusions as to whether qualitative differences in possession of amino acid decarboxylases might be of value in the taxonomy of the genus Pseudomonas. However, conditions necessary for maximum decarboxylase production and activity for specific substrata are shown for the ten Pseudomonas species found in dairy products. These decarboxylases would be active in dairy products only when acid-producing organisms had dropped the pH to levels somewhat below that normally encountered in fresh milk.
YIELD AND PRICE EXPECTATIONS FOR PRIMARY AGRICULTURAL PRODUCTION

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Since farm production takes time, in certain cases up to several years, the role of expectations in economic planning is highly important. The objective of this study was to test the predictional accuracy of various price and yield expectation models which can be used by farmers at the present time.

Fourteen mechanical price and yield expectation models were tested for efficiency in prediction. Models were selected which were based on specific and general experience of the farmer. These models are: (1) random price and yield, (2) current price and yield, (3) five-year moving average price and yield, (4) ten-year moving average price and yield, (5) weighted moving average price, (6) average price and yield, (7) trend price, (8) trend from average yield, (9) reverse trend price, (10) reverse trend from average yield, (11) outlook price, (12) parallel price, (13) future market price, and (14) preseasonal rainfall.

For evaluating the efficiency of each price or yield model in prediction, three measures of errors are used. Those measures are the average error as a percentage of the mean, the frequency distribution and the coefficient of the total range. They were selected because of their meaningfulness to farmers in formulating production plans and because of the amount of information they provide about error or uncertainty.

Most models had a smaller magnitude of errors when used to predict the prices of tobacco and hay than when used to predict the prices of other crops. The smaller error in predicting tobacco prices is partly caused by its price series covering a period (1933-1951) when support prices prevailed and had a stabilizing effect. The smaller error for hay is due in part to the fact that its series has the smallest coefficient of variation. The various models are inconsistent in the magnitude of their errors for the rest of the crops (i.e., larger errors for one model and smaller for another). The ranking of the price series on the basis of a model's mean error is somewhat in agreement with its ranking on the basis of the extreme error and the range of errors. However, that ranking on the basis of the three measures of error is not always in agreement because a model which has approximately the same mean errors in predicting different price series may vary in the shape of the frequency distribution of its errors.

A comparison of the errors which would be obtained if the eleven price models were mechanically and consistently used by farmers was made. For all prices considered as a group, each model is evaluated on the basis of its average efficiency where the average rank of each model is an indicator of its average efficiency. The comparison of the price models on the basis of their ranking according to three measures of errors showed that the weighted moving average, outlook, future market, current and parallel models composed the first group (best) in predictional efficiency for all prices considered as a group. The five-year moving average, reverse trend, ten-year moving average, average and random models formed the second group which was less efficient in prediction than the first group. However, within each group the order of the models is altered. The model which has relatively lower (or greater) mean error usually has lower (or greater) range and extreme errors.

The weighted moving average price model has the least mean error, range of errors and percentage of the extreme errors for all prices considered as a group. The outlook price model ranks second least in magnitude of the mean error and fourth least in magnitude of the extreme error and the range of errors. The important feature of this model is the greater ability of the persons who prepare the outlook to accurately forecast major rather than minor economic changes. The future market price model which was only applied to corn and wheat ranked third least in magnitude of the mean error and second least in magnitude of extreme and range of the errors. Since there are no future prices in most years in the months before planting for grain delivery after the new harvest, this model in contrast to the other ten price models would not help farmers in their
production plans. However, the future market model is useful in other respects. The current and parallel models have larger errors than the previous models.

When predicting yields, smaller errors for all models occur with potatoes, oats, corn, and cotton, because the coefficients of variation for the yield series of these crops are smaller than for other crops. Kafir, wheat, hay, and tobacco caused larger errors because their coefficients of variation are larger. The ranking of the yield series on the basis of the three measures of error introduced in prediction is more consistent than in the case of prices because of the larger difference in variability between the yield series.

A comparison of the eight yield models was also made. For various yield series, each model is more inconsistent in its ranking than the corresponding price models because yield series do not move in the same direction as prices. The yield series are for various crops from different experiment station farms located in various states. The weather conditions and the other factors which affect agricultural production vary according to location and kind of crop. On the other hand, agricultural prices are affected by the same secular forces.

For each crop yield series, the ranking of a model according to the range of the errors is not always in agreement with its ranking on the basis of the mean error expressed as a percentage of the mean and the percentage of the extreme error. For all crop yield series considered as a group, the ranking of a model on the basis of the mean error is in approximate agreement with its ranking on the basis of the range of the errors while it differs somewhat but not much with its ranking on the basis of the extreme error. However, the ranking of the models on the basis of the three measures of error led to the conclusion that the average, pre-seasonal rainfall, five-year moving average, reverse trend, and ten-year moving average models form the most efficient group. The current, random, and trend models have less predictive accuracy for all crops considered as a group. However, within each group of models the order is somewhat altered. The average model gives approximately the same efficiency in prediction as the pre-seasonal rainfall model while it does not require the complicated calculations of the latter.

On the assumption that the yield and price populations will continue to repeat themselves in the future, farmers may adopt the models to which the least uncertainty is attached in planning their crop production. It is suggested that further research should be conducted in forecasting prices or yields using advanced statistical techniques. It remains to be seen whether the differences in the prediction accuracy between the simple mechanical expectation models (used in this study) and the econometric analysis approach justifies using the latter method with its higher costs.

THE FERROMAGNETIC PROPERTIES OF THE RARE EARTH METALS,

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The magnetic properties of gadolinium, dysprosium, and erbium metals have been studied in their ferromagnetic ranges.

The absolute saturation magnetization of gadolinium was found to have a linear $T^{3/2}$ temperature dependence between 20-250° K. The saturation magnetization at absolute zero, determined by extrapolation was found to be $253.6 + 0.9 \text{ cgs units}$ confirming the previous work of Trombe. This absolute saturation moment corresponds to about $7/12$ Bohr magnetons per atom. The data fell considerably below the theoretical curve predicted by the Debye-Weiss theory of ferromagnetism for the $^{85}_{7/2}$ state. The Curie point determined from spontaneous magnetization data was found to be $17.7 \pm 0.3° C$. This temperature is some two degrees higher than the Curie point determined by a ballistic method using a small applied field of about 23 oersteds, and observing the temperature at which ferromagnetism disappears.
The magnetic moment of dysprosium was measured in applied fields of 4000-18000 oersteds, over the temperature range of 20.4° K to 205° K. The susceptibility of dysprosium was shown to be field dependent below about 175° K. Below 90° K, dysprosium appeared to have true ferromagnetic properties, confirming the previous work of Trombe. An absolute saturation magnetic moment of at least 8 Bohr magnetons per atom was indicated by the data obtained in the temperature range of 31.25° K to 80° K. The magnitude of the measured values of the magnetic moment of dysprosium indicated that the orbital angular momentum of the 4f electrons contribute to the ferromagnetism.

The magnetic moment of erbium was measured for applied fields of 4000-18000 oersteds over the temperature range of 20.4° K to 71° K. The susceptibility of erbium was shown to be field dependent at about 55° K. The metal exhibits true ferromagnetic properties at 20.4° K. A saturation moment at 20.4° K of at least 286 cgs units, corresponding to 8.6 Bohr magnetons per atom is indicated by the data. The magnitude of the measured values of the magnetic moment of erbium shows that the orbital angular momentum of the 4f electron contributes to the ferromagnetism.

THEORY OF ADSORPTION FROM SOLUTION AND MIXED GASES

WALTER V. FACKLER, JR.

A quasithermodynamic theory of adsorption from solution and mixed gases is presented. The theory is developed from a consideration of conditions for equilibrium between matter in a fixed volume of space in the neighborhood of the adsorbent surface and matter in bulk solution (or gas phase). Where thermodynamic standard states are chosen as pure liquid component at the points of interest (either in a specified neighborhood of the adsorbent surface or in bulk phase) two assumptions are critical in the theoretical development. They are first, that the difference in standard state chemical potentials between component in bulk and component at a point near the surface is given by the Polanyi adsorption potential of the component at the point near the surface as inferred from the pure component gas adsorption isotherm, and second, that the activity of a component is the same function of concentration at a point near the surface as it is in bulk. Possible limitations of these assumptions are discussed.

The theory developed permits the prediction of isotherms for adsorption of water, ethanol, propanol-1, butanol-1, and cyclohexane on the furnace carbon black Spheron-6 were determined at 25° C. as were also those for the adsorption of water, and propanol-1 on the deflocculated artificial graphite DAG-1. These isotherms are used together with the adsorption theory to predict adsorption isotherms in the solution-adsorbent systems water-propanol-1-Spheron-6, water-butanol-Spheron-6, ethanol-cyclohexane-Spheron-6, and water-propanol-1-DAG-1. Calculated isotherms are compared with experimental isotherms observed by R. P. Craig and R. D. Hansen in this laboratory. With the exception of the system water-butanol-1-Spheron-6, agreement between theory and experiment is at least qualitatively satisfactory, and the theory accounts for puzzling phenomena such as adsorption inversion in a satisfactory manner.

Agreement between theory and experiment is made nearly quantitative in the water-alcohol-Spheron-6 systems by adding to the alcohol Polanyi potential an energy of interaction with an oriented water dipole layer at the adsorbent surface. Arguments justifying this procedure are presented.

Data of Arnold for the system oxygen-nitrogen-anatase are re-interpreted in an effort to test the application of the adsorption theory to mixed gases. Total adsorption predictions agree quantitatively with experiment; the unmodified theory is found from the gas phase. Isotherms for the adsorption of water, ethanol, propanol-1, butanol-1, and cyclohexane from the gas phase. Isotherms for the adsorption of water, ethanol, propanol-1, butanol-1, and cyclohexane from solution and mixed gases is presented. The theory is developed from a consideration of conditions for equilibrium between matter in a fixed volume of space in the neighborhood of the adsorbent surface and matter in bulk solution (or gas phase). Where thermodynamic standard states are chosen as pure liquid component at the points of interest (either in a specified neighborhood of the adsorbent surface or in bulk phase) two assumptions are critical in the theoretical development. They are first, that the difference in standard state chemical potentials between component in bulk and component at a point near the surface is given by the Polanyi adsorption potential of the component at the point near the surface as inferred from the pure component gas adsorption isotherm, and second, that the activity of a component is the same function of concentration at a point near the surface as it is in bulk. Possible limitations of these assumptions are discussed.

The theory developed permits the prediction of isotherms for adsorption from solutions and gas mixtures, given isotherms for adsorption of pure components

1 a. Chairman of Committee, Robert S. Hansen, Dept. of Chemistry.
   b. Graduate Assistant, Institute of Atomic Research.
to underestimate the adsorption of nitrogen and to overestimate the adsorption of oxygen. This discrepancy is ascribed to superposition of adsorption at solid-liquid and liquid-gas interfaces; no satisfactory method for correcting for this effect appears to exist at present.

RETURNS TO SCALE IN POTATO FARMING

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The economic theory which is applicable to the production process on the farm firm emphasized two interrelated problems. The first is concerned with the optimum combination of factors to obtain a given output. The second is concerned with the optimum adjustment in factor inputs to variations in outputs. The latter problem is one of evaluating returns to scale.

The primary objective of this study was to estimate the returns to scale in potato production in Connecticut. In achieving this objective, the secondary objectives of collecting, analyzing, and utilizing input-output data to determine the optimum combination of resources were accomplished.

In the past, economic studies of the relationship between size of enterprise and efficiency of production have confounded the influence of size with the influence of other variables. Farmers have not known influence of size upon their farm businesses. The methods used in this study permitted control of variables which are often confounded with size of business. Through the use of budgets for hypothetical resource combinations, only those variables which were directly related to size were allowed to vary.

In the development of farm budgets, it was necessary to select at least one fixed factor with which to specify the size of each hypothetical farm unit. The quantity of the regular labor force available during the production period was selected as this fixed factor. Five levels of the fixed resource were selected for study. All other resources were permitted to vary. Alternative resource organization and production techniques were tested on each unit to determine the optimum cost position, when all phases of the production activity were carried on as efficiently as possible under given technology and price relationships.

Once the physical inputs and production techniques were determined for each farm unit, an approximation of the short-run average unit cost curves was derived. Next, the long-run cost curve, which indicated the economies associated with size of enterprise, was constructed.

The scale curve developed in this study covered an annual production range from approximately 6,000 to 75,000 bushels of potatoes. Under the level of management efficiency visualized for this study, less than a full man-equivalent in regular labor was needed in the range under 22,000 bushels. A full man-equivalent or more was required in the range above 22,000 bushels.

The cost per bushel of potatoes declined 20 percent as annual production increased from 6,000 to 40,000 bushels. Beyond this size, the reductions in unit cost were small. With the production relationships and institutional conditions assumed for this study, costs per bushel fell only 2 percent in the range from 40,000 to 75,000 bushels. Thus, size of enterprise was an important factor in reducing unit costs up to 40,000 bushels annually. Beyond this size, unit costs were influenced only to a minor extent by increases in size of enterprise.

The level of unit costs was defined only for the assumed conditions. Input-output data were obtained from physical scientists and from an analysis of actual production methods on farms. The prices used were those for the 1949 production period. The level and shape of the scale curve would change with changes in these assumptions. However, there is leeway for some variation in the assumed conditions without nullifying the following conclusions:

1. Operators of one-man farm units achieved a unit cost level approximately equal to the level on farms of larger size when a similar level of management efficiency was achieved. Operators of farms...
on which the labor resource was less than a full man-equivalent did not achieve a unit cost level similar to the level on larger farms, unless the labor and management returns to the operator or returns to other owned resources were substantially below such returns to operators of larger farms.

(2) Small, or non-existent, economies of scale in the upper size range indicated that opportunities for lower unit costs from specialization of labor and management and from a lower investment-output ratio did not occur in potato production as it was organized in New England under existing technology. Furthermore, the production facilities necessary to potato production were sufficiently variable in size and related price schedule so that costs were not lowered substantially by a more complete utilization of indivisible production elements.

Secondary objectives of this study were to develop production data which would be useful to the individual operator. The study indicates that unit costs could be lowered substantially by improved resource organization and production practices on potato farms--large or small. This report demonstrated the resource organization and management practices that contributed to greater efficiency in potato production, and it established a goal in the level of production costs under ideal conditions. Some potato growers could attain such efficiency; most of them could move in that direction.

In accomplishing the primary and secondary objectives, the technique used in this study evolves as a useful tool in the establishment and in the integration of basic relationships. The method serves the farm operator and the farm management technician in the following ways:

(1) It indicates the unit cost reduction opportunities that are attributable directly to a change in the size of the enterprise. Other sources of variation in costs which arise largely because of differences in the quality of resources and management are largely eliminated between farms of various size by using resources of identical quality and by employing production organizations and practices which result in a similar level of management efficiency.

(2) Determination of unit costs necessitates the collection and appraisal of input-output data in potato production. This step serves to integrate the available information and to uncover the gaps in the physical data. One can then appraise how well the existing data help to answer the economic problem of allocating scarce resources between alternative uses in a maximizing process.

(3) The technique indicates the combination of resources and practices that will lead to maximum efficiency at various sizes of enterprise under specified conditions. Such knowledge is useful to farmers. It sets up a goal of efficiency with which operators can compare their present situations, and it indicates possible practices in organization and management that may lead to improved efficiency.

(4) The method provides the farm management analyst with a much needed experimental device. The models can be used to test the influence of a particular variable when many other variables are held constant. In this way, the farm management worker is able to fulfill a major responsibility to farmers by anticipating management problems and by arriving at possible solutions. No longer must he wait until many farmers have made a decision and have committed productive resources for future periods. The basic aim of science is prediction and control. Creation of the farm units needed in estimating economies of scale provides a tool for realizing this goal in farm management.
Let $K = X \otimes Y = (y_{ij} X)$ denote the Kronecker product of two square real matrices $X$ and $Y$ of orders $s \geq 1$ and $r \geq 1$, respectively. Let $W$ be the set of all square real matrices of order $n = rs$, $P$ the set of all $K$'s of order $n$, and $P(s, r)$ the subset of $P$ obtained when $s$ and $r$ are fixed. Let $W$, $P$, and $P(s, r)$ be represented in $n^2$-dimensional Euclidean space by the point sets $E_W$, $E_P$, and $E_{P(s, r)}$, respectively.

**Theorem:** $E_P$ is an arcwise connected set and the intersection of $E_{P(s, r)}$ with any hypersphere centered at the origin is an arcwise connected set. Furthermore, the intersection of $E_{P(s, r)}$ with any closed hyperspherical neighborhood of the origin is a closed and connected set.

For $A$ in $W$ and $K$ in $P$, let $F = \text{tr}(A-K)(A-K)'$ and let $R$ be a positive constant.

**Theorem:** For any fixed $A$ in $W$, the absolute minimum of $F$, $\min F$, and a closest $K$ can be obtained by applying the methods of the calculus. Furthermore, for the set of $A$'s for which $\|A\|^2 = \text{tr}AA' = R^2$, 
$$\max (\min F) \leq (1 - 1/r^2)R^2.$$If $r = s$, then the equality sign holds.

The simultaneous algebraic equations to be solved for $\min F$ and the closest $K$ for a given $A$ are derived for the case $n = 2s$. Explicit formulas are obtained for the cases (1) $A$ is symmetric, and (2) $A$ = diagonal $(A_1, A_2)$ where $A_i$ is $s$ by $s$.

The given matrix $A$ may also be interpreted as determining $p(\leq r^2)$ points in a $q(\leq s^2)$-dimensional space. The problem of determining $\min F$ and the closest $K$ is equivalent to the problem of finding a ray through the origin such that the sum of the squares of the distances from the $p$ points to the ray is a minimum.

**Theorem:** If $q \leq p$, the matrix $A$ can be written as the sum of the $q$ or less distinct Kronecker products by successive determination of $K_1, K_2, \ldots, K_q$, where $K_i$ is closest to $A - K_1 - K_2 - \ldots - K_{i-1}$; if $p < q$ a trivial decomposition into $p$ summands exists.

Using the above interpretation, let $H$ be the positive definite symmetric matrix which represents the ellipsoid of inertia, centered at the origin, and generated by the $p$ points of unit mass (assumed non-collinear with the origin) determined by $A$. Let $c_1$ be a characteristic root of $H$.

**Theorem:** If $p \geq q$, then only those $H$'s whose characteristic roots satisfy the conditions
$$\sum_{i=1}^{q} c_i (q-2) c_j \geq 0 \quad j = 1, 2, \ldots q \quad i \neq j$$will represent ellipsoids of inertia. If $p < q$, then the equality sign must hold for at least $q-p$ of the above conditions. Furthermore,
$$(q-1) \|A\|^2 \geq \|H\| \geq (q-1) \|A\|^2 / q^{1/2}.$$Finally, for any set of $p$ particles, whose polar moment of inertia is $R^2$, the smallest characteristic root of $H$ is less than or equal to $(p-1)R^2/p$. 

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1. a. Chairman of Committee, B. Vinogradov, Dept. of Mathematics.
2. a. B.S. University of Minnesota, Minneapolis, Minn., 1946.
2. b. M.S. University of Iowa, Iowa City, Iowa, 1948.
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Crown rust of oats caused by the fungus *Puccinia coronata avenae* Eriks. and E. Hemm. has caused severe reduction in yields in some seasons. Recent changes in the prevalence of important physiologic races of this organism clearly emphasize the dynamic nature of breeding for crown rust resistance in oats. The presence of two sets of genetic factors, those carried by the organism and by the host plant, stress the importance of a combined attack on disease resistance by the plant breeder and plant pathologist. The production of new races and biotypes within races through hybridization and mutation makes the task of maintaining effective resistance to prevalent races a difficult one.

Fundamental studies on the inheritance of resistance to crown rust in oats have been somewhat limited. Published information generally has resulted from studies involving a limited number of races and only a few resistant parents. Host-parasite relationships involving crown rust represent a delicate balance between genotypes of both the host and pathogen. It might be expected, therefore, that opportunity for complex gene interaction would occur, with different genes or a combination of different genes determining resistance to various forms of crown rust.

The mode of inheritance of reaction to races 57 and 109 of crown rust was studied in several oat crosses. Conclusions drawn on the basis of the reaction of segregating progenies are summarized below.

1. The resistance of Clinton to race 109 was conditioned by a single dominant gene (AA). Clinton exhibited only recessive alleles to factors for resistance when tested to race 57.
2. The resistance and susceptibility of Ukraine to races 57 and 109, respectively, was governed by the same gene (MM).
3. Two dominant linked genes determined the resistance of Santa Fe to both races. The genes (M1M1U1U1) were linked in the coupling phase with 28.8±0.8 per cent recombination. One of the duplicate linked genes (M1M1) was allelic to the genes (MM) in Ukraine while the Ukraine gene (MM) was dominant to (M1M1).
4. Trispernia appeared to possess two factors (M2M2V1V1) which gave resistance to both races. One of the genes was allelic to the Victoria gene (VV).
5. The resistance of Landhafer to both races was observed to be due to a single partially dominant factor. This factor (LL) was epistatic to the Ukraine gene for susceptibility when tested to race 109.
6. A single partially dominant gene (KK) conditioned the resistance of Klein 69b to both races. However, the Ukraine gene inhibited the resistant reaction of Klein 69b when tested to race 109.
7. The resistance of Victoria to both races was governed by a single dominant factor (VV), which appeared to be epistatic to one of the two linked genes in Santa Fe, and dominant to the gene (V1V1) in Trispernia. Inheritance of reaction to *H. victoriae* was shown to be monogenic with susceptibility dominant and completely linked with the Victoria type of crown rust resistance.
8. Several varieties and selections commonly used as resistant parents in breeding for crown rust resistance appear to represent mixtures of genotypes. Different selections from these parents may possess from one to three factors for resistance.
9. Results of this study were combined with results of previous investigations in an effort to catalogue some of the genes determining resistance to crown rust.
The compositions and structures of the phases obtainable at room temperature in the binary systems of thorium with the transition metals of the first period have been determined by X-ray diffraction methods and are summarized in Table 1. The compositions of these intermetallic compounds bear little relation to the customary valences of the metals. Attempts to correlate these compounds with one another and with intermetallic compounds in general have been based essentially upon a consideration of the relative values of metallic radii and upon the ratio of valence electrons to atomic nuclei.

A study of the Laves phases, common to many compounds with the formula AB₂ and a radius ratio of approximately 1.25, suggests that it is the A-B distance which determines the size of the polyhedra comprising the unit cell. Inspection of the lattices and coordination polyhedra of the compounds, Th₄Mn₁₂, Th₂Fe₁₇, Th₂Co₁₇, Th₂Ni₁₇, and ThNi₅, shows that they are related to one another though the compounds belong to different crystal classes. It appears that the compounds, Th₃Mn₁₂, Th₄Mn₁₂, and ThMn₁₂, are related to the Hume-Rothery phases, ψ and ε phases, with electron to atom ratios of 1.5, 1.615 and 1.75 on the basis of Hume-Rothery's valences or with the ratios of 4.94, 4.82 and 4.69 on the basis of Pauling's valences. However, only Pauling's ratios give a consistent value for the valence of manganese. It also appears probable that the compounds in the thorium-iron, thorium-cobalt and thorium-nickel systems are Hume-Rothery type compounds.

Table 1. Compounds of Thorium with Transition Metals of the First Period

<table>
<thead>
<tr>
<th>Compound</th>
<th>Group Lattice</th>
<th>Lattice Constants (Å)</th>
<th>Space Group</th>
</tr>
</thead>
<tbody>
<tr>
<td>Th₇Fe₃</td>
<td>C₄ᵥ</td>
<td>9.85, 6.15</td>
<td>Th₇Fe₃</td>
</tr>
<tr>
<td>Th₇Co₃</td>
<td>C₄ᵥ</td>
<td>9.83, 6.17</td>
<td>Th₇Ni₃</td>
</tr>
<tr>
<td>ThCo₁₇</td>
<td>D₄h</td>
<td>3.74, 10.88, 4.16</td>
<td>ThCo₁₇</td>
</tr>
<tr>
<td>ThMn₁₂</td>
<td>D₄h</td>
<td>5.48, 8.95</td>
<td>ThMn₁₂</td>
</tr>
<tr>
<td>Th₂Fe₁₇</td>
<td>D₄h</td>
<td>5.22, 24.96</td>
<td>Th₂Fe₁₇</td>
</tr>
<tr>
<td>Th₂Co₁₇</td>
<td>D₄h</td>
<td>5.03, 24.54</td>
<td>Th₂Co₁₇</td>
</tr>
<tr>
<td>Th₂Ni₁₇</td>
<td>D₄h</td>
<td>4.97, 4.01</td>
<td>Th₂Ni₁₇</td>
</tr>
<tr>
<td>ThNi₅</td>
<td>D₄h</td>
<td>3.95, 4.97</td>
<td>ThNi₅</td>
</tr>
<tr>
<td>Th₄Mn₁₂</td>
<td>D₄h</td>
<td>9.68, 8.56</td>
<td>Th₄Mn₁₂</td>
</tr>
</tbody>
</table>

a Structure C14 type (Strukturbericht designation).
b Structure: 24(e) Th with x=0.203; 4(b) Mn; 24(d) Mn; 32(f) Mn with x=0.378; 32(f) Mn with x=0.178 (all point groups as listed in "Internationale Tabellen zur Bestimmung von Kristalldurchmesser", Erster Band, Gebrüder Borntraeger, Berlin, 1935).
The specific problem in this study was to examine the cytogenetic aspects of maize monoploids and monoploid derivatives. For the study of diploid derivatives of monoploids, 186 different progenies consisting of 1,289 mature plants from crosses involving one or more monoploids, homozygous diploids, and standard inbreds were grown at Iowa State College experimental plots. Microsporocytes were examined by means of fresh aceto-carmine smears. Each plant was also examined for visible mutations and pollen sterility.

The hybrids of 58 progenies of tester x homozygous diploids, a total of 555 mature plants, showed seven plants with pollen sterility in two progenies, but no structural aberrations were noted. The hybrids of 12 progenies of tester x inbreds, a total of 130 plants, showed three plants with pollen sterility in one progeny, each plant having a structural aberration.

No observable mutations appeared in either group of hybrids. The study indicates quite strongly that the homozygous diploids have no more structural heterozygosity, no more pollen sterility, or no higher mutation rate than the inbreds, hence in these respects would be just as satisfactory in a breeding program. Miscellaneous crosses involving monoploids as male and female parents together with normal diploids showed very little pollen sterility or cytological irregularity.

Five monoploids appeared in the 1,171 plants reaching maturity in stocks arising from monoploids as one or both parents, an incidence of 1:234.2. Monoploid meiosis was studied in fifty plants and the following noted: chiasmataformation, bivalents, homologous vs. non-homologous pairing, pachytene doubling, apparent secondary association, irregular spores, foldbacks, bridges, and fragments. Probably most viable monoploid pollen arises from diploid sectors, but some viable eggs may arise from monoploid tissue. If so, and if true crossing over does occur, then the homozygous diploids may not be completely homozygous.
ABSTRACTS OF DOCTORAL THESSES, 1952-53

NATURE AND INHERITANCE OF MALE-Sterility
IN THE ONION VARIETY, SCOTT COUNTY GLOBE,

RICHARD L. FOSKETT

Departments of Horticulture and of Botany and Plant Pathology

From a cross made in 1941 at Beltsville, Maryland, Dr. H. S. Jones of the U.S. Department of Agriculture observed male-sterile onion plants, although none were expected. Neither parent had any record of male-sterility in its parentage. The female parent was a male-fertile Scott County Globe plant and the pollen parent was from an F{subscript 4} generation of a cross between plants of the varieties Australian Brown and White Persian. Of the 11 plants grown, five male-fertile plants and six male-sterile plants appeared in the progeny. The male-sterile plants were crossed with various fertile plants and the normal plants from the same progeny were selfed. The seed lots from these crosses and selfed plants were used as the original material upon which this investigation was based.

This investigation was undertaken because of the utilization of male-sterility in producing hybrid onions. The type of male-sterility used is expressed only when an S type of cytoplasm (maternally inherited) and a simple recessive gene $ms$ are both present. The S cytoplasm was found in a plant of the variety Italian Red and has been introduced into the commercially used inbred lines, none of which have been found to otherwise contain the type of cytoplasm necessary for expression of male-sterility. The $ms$ gene, however, has been found in almost all varieties.

In this investigation a study was made of the inheritance of this male-sterility by observing segregation in the progenies received from Beltsville, Maryland, and by making two types of test crosses. The test crosses made were 1) between male-sterile plants and plants containing normal cytoplasm with the $ms$ gene in the homozygous condition and 2) between normal plants with the Scott County Globe male-sterile cytoplasm and male-ster-

1. Chairman of Committee, E. S. Haber, Dept. of Horticulture, and Sherret S. Chase, Dept. of Botany and Plant Pathology.
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In the northwestern part of Iowa there is an area covering about six to seven counties that is almost continuously covered with loess which rests directly on the calcareous Iowan or Tazewell drift. The loess thins from about 140 inches to 40 inches in an easterly direction. The annual precipitation increases from about 25 to 29 inches in a southeasterly direction. Six profiles, belonging to the Galva and Moody series and representing well drained loess derived soils formed on 3 to 4 percent slopes, were studied in the field and laboratory. The profiles were selected along two traverses which represent soil development under increased annual precipitation or under increased annual precipitation and decreased loess thickness. Greater profile development was associated with increased annual precipitation and decreased loess thickness.

In the field, greater profile development was associated with slightly darker and thicker A1 horizons, greater structural development in the B horizon and a sharper color contrast between the B and C horizon.

Physical changes associated with increased profile development include greater amount of clay in the solum, increased aeration and total porosity and increased permeability and water storage. A characteristic feature of the soils was the occurrence of the maximum percent of inorganic colloids in the A1 horizon. This was taken to mean that conditions for weathering and clay formation were most favorable in that zone and that clay movement has not been extensive.

Chemical changes associated with increased profile development were decreased pH, decreased base saturation, increased amount of exchangeable calcium and hydrogen, increased calcium to magnesium ratio, and increased organic carbon and total nitrogen. The maximum amount of exchangeable hydrogen occurred in the surface layer, of calcium in the subsurface layer, and of magnesium in the first to third layer below the subsurface layer. All sola showed diffusion pattern with depth for pH, base saturation, organic carbon, total nitrogen, and carbon to nitrogen ratio. Exchangeable potassium and release of nonexchangeable potassium to Dowex-50 were not clearly related to increased profile development. Ammonium fixation in nonexchangeable form under moist conditions occurs in the Galva and Moody soils to an extent of about 5 to 8 percent of the cation exchange capacity. A comparison of ammonium fixation in the Moody with that in the highly weathered Putnam of Missouri indicates that there is relatively more illite and less montmorillonite in the Moody soil.

The classical separation of the Chernozems and Brunizems was based primarily on the presence of a lime accumulation layer in the former and its absence in the latter. It has been pointed out more recently that soils with or without a lime accumulation layer occur in what was formerly considered to be areas of Pedocal and Pedalfer soils. On the basis of present concept, the Galva and Moody profiles investigated belong to the Brunizem great soil group even though the two Moody profiles studied had a lime accumulation layer at 31 inches.
ESTIMATION BY SIMULTANEOUS EQUATION
OF RESOURCE PRODUCTIVITIES FROM TIME SERIES
AND CROSS SECTIONAL FARM OBSERVATIONS

BURTON LEROY FRENCH
Department of Economics and Sociology

The main objective of this study was to estimate resource productivities of a group of central Iowa farms by two methods:

1. simultaneous equations,
2. single equation-least squares.

A dynamic economic model was specified to describe the behavior of farm operators in their production operations. It was designed to explain the annual fluctuations in the quantities of crops and livestock produced by these individual farmers, and the quantities of the factors of production employed in the transformation processes. The model was simplified by assuming that two independent systems existed: (1) cropping system and (2) livestock system. Each system included five equations; the production function and four decision functions.

The equations presented expressed the relationship among the variables specified. These variables were described in detail and classified as jointly dependent, the formation of which is to be explained, and predetermined, those variables that influence the jointly dependent variables but are not influenced thereby.

Estimation of the parameters in the production functions by the use of simultaneous equations utilizes all of the variables in the system whether they enter the equation to be estimated or not. The single equation-least squares method of estimation utilizes the information provided by the variables that enter the equation to be estimated.

Data used to represent the cross section, inter-farm, variables was obtained from Farm Management Association record summary sheets for a sample of 18 central Iowa farms. Restrictions placed upon the sample were that the farms maintained the same size and the same operator for the ten year period under study. Thus each farm for a particular year was considered as an independent observation, with a "sample" size of 180. Time series data was constructed from the Iowa Crop Reporting Service records.

The parameters of the production functions, algebraic functions linear in the logarithms, were then estimated by the single equation-least squares method of estimation and the limited information method. There appeared to be no degree of comparability between the parameters obtained by the two methods. The least squares method seemed to provide the more acceptable estimates.

The marginal productivities and average productivities were computed for both systems at the average value of the observed data. Analysis of the productivities obtained by both methods of estimation exhibited a great variation between the estimates of the productivities within each system, between the two systems, and between the two methods of estimation. The greater variation was found in the estimates made by the limited information method.

No definite conclusion as to the superiority of either system was attempted from the empirical results. Possible points of criticism that might improve the estimation are improvements of the dynamic model to be constructed, with the main criticism being on the assumption of independence between the two systems, and refinement in the data used to construct the variables. Before any conclusive reports may be made, other algebraic forms of the production functions should be used, e.g., an equation that is linear in the observed variables, or mixed logarithmic and linear forms.

Employing other models may improve the estimations of the parameters. Before estimations may be made from data drawn from a sample of farms and inferences drawn for a population of farms, more positive conclusions must be presented as to the statistical method to use the model to employ. The present results might mean a complete misuse of research funds in terms of the value received by the group for whom the estimates are made.

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2 a. B.S.A., University of Nebraska, Lincoln, Nebr., 1948.
   c. Graduate Assistant, Department of Economics and Sociology.
   d. Research Fellow, Agricultural Experiment Station.
ABSTRACTS OF DOCTORAL THESES, 1952-53

EFFECT OF INSECTICIDES ON CUCURBIT INSECTS AND PLANTS

WILLIAM DON FRONK
Department of Zoology and Entomology

Experiments were conducted for four years to determine the effect of several insecticides applied as sprays and dusts to the insects associated with cucurbits and to determine the effects on the plants themselves. The dusts were applied by means of a rotary hand duster and the sprays by a knapsack sprayer. In all, 17 dusts and 21 sprays were tested. Experiments on muskmelons were made at Muscatine Island Field Station, Fruitland, Iowa, and the other experiments at Ames, Iowa. The insects of primary concern were the striped cucumber beetle, Acalymma vittata (Fab.); spotted cucumber beetle, Diabrotica undecimpunctata howardi Barb.; squash vine borer, Melittia cucurbitae (Harr.); squash bug, Anasa tristis (DeG.); and melon aphid, Aphis gossypii Glov.

During the period covered by this study, the infestation of cucumber beetles was light on Muscatine Island. Bacterial wilt of cucurbits, which is transmitted by cucumber beetles, was greatly reduced in muskmelon plots by heptachlor, EM 25-3 and purified DDT. Plots of muskmelons treated with purified DDT, methoxychlor, aldrin, lindane and heptachlor usually produced high yields although the differences were not of statistical significance. The insecticides did not have any effect on the maturity date of the muskmelon fruit. Dieldrin, aldrin, chlordane, BHC and EPN reduced the amount of injury by the larvae of the cucumber beetle to the rind of the muskmelon fruit. The effect on plant growth was determined by measuring the diameter of randomly selected plants from each plot. Penfluor, toxaphene, and BHC were so phytotoxic that their use for insect control was ruled out.

A number of the insecticides stimulated growth of the plants. Rotenone and purified DDT mixed in varying proportions showed the amount of vine growth to be proportional to the amount of DDT used; however, there were no statistical differences in yield. With all combinations tested, there was a significant increase in yield between plants treated every three days and those treated every seven days. Plants treated for six weeks yielded no more than those treated for three weeks. Many more plants in plots of the variety V-1 were killed by cucurbit wilt than were killed in plots of five other varieties examined.

On three varieties of squash, actual counts were made of the striped cucumber beetle population following treatment with insecticides. All the materials tested proved effective in reducing the beetle numbers; however, when the number of seedling plants injured by beetle feeding were counted, EM 25-3, purified DDT and methoxychlor were found to have given the best control.

The squash bug population was determined by placing strips of tarred felt beside the base of the squash plants. The bugs collected under these strips in the evening and were counted early the next morning. Metacide and EM 25-3, both of which contained parathion, proved the most effective in reducing the squash bug infestation.

Melon aphids were controlled with metacide, lindane, heptachlor, and EM 25-3. Purified DDT and methoxychlor caused an increase in the melon aphid infestation.

Lindane and dieldrin showed good squash vine borer control while the results with heptachlor, purified DDT, and methoxychlor, were erratic. None of the materials tested showed any ovicidal action on squash vine borer eggs. C1110, a proposed synergist for DDT, failed to show this action when used for control of squash vine borer in summer squash, but the borer population was low and the synergistic action may have become apparent under a heavier infestation.

No off-flavors were detected in squash fruit treated with lindane or heptachlor.

The greatest yield came from squash plants treated with heptachlor, dieldrin and lindane. Yield results with purified DDT were erratic. All of the chemicals tested caused an increase in vine length. The treated plants increased in length more rapidly than the untreated plants early in the growing season, but later the control plants grew just as rapidly as the treated plants. Among the possible factors which may have led to an increase in growth were (1) control of insects and (2) a plant hor-
mone-like effect of the insecticide. The amount of precipitation greatly influenced vine growth and tended to mask the effects of the insecticides. There was varietal difference in reaction to the effect of insecticides on growth rate of the plants. Methoxychlor caused a decreased rate of growth in Golden Delicious squash and an increase in Buttercup variety. The insecticides had little or no effect on the number of nodes or on the position of the first female flower or position of the first fruit on the squash runner.

Single runners were so trained in the plots that initiation and development of flower buds could be followed. The plants in the methoxychlor-treated plots of Golden Delicious squash produced significantly fewer female flowers than did the untreated plants. The rate of feminization along the runner was also less in these treated plots.

The insect population of squash flowers was determined several times during the season. Five species of diptera, five species of coleoptera, and 15 species of hymenoptera were collected during this time. The number of wild and domestic bees was inversely proportional to the number of spotted and striped cucumber beetles present. The bees seemed to avoid entering flowers inhabited by beetles.

An approximate rate of photosynthesis was determined by measuring the gain in weight per unit area of squash leaf during 12 hours of daylight. The reaction of the squash varieties to the insecticides varied greatly. The photosynthesis rate in methoxychlor-treated Golden Delicious squash declined steadily in relation to the rate in the other insecticide treated plants. In Buttercup variety, however, methoxychlor-treated plants always had a higher photosynthesis rate than the other treated plants.

Summer squash grown in plots receiving various amounts of commercial fertilizer showed no relationship between fertility level and damage by the striped and spotted cucumber beetle or in the egg laying preference of the female squash vine borer. The establishment of the vine borer larvae in the vines, however, was directly proportional to the amount of fertilizer applied to the plot.

Two unusual plant injuries of unknown etiology are noted and figured. Fourteen dusts were applied to watermelon grown at the Muscatine Island Field Station for a study of striped cucumber beetle control but a heavy infestation of Fusarium wilt prevented obtaining satisfactory data.

The area of new growth that a plant makes after an insecticide has been applied is left unprotected from insect attack. To get an estimate of this area, measurements of runner elongation and of increase in leaf area were made on one untreated variety each of squash, pumpkin, muskmelon, watermelon, and cucumber. Squash and pumpkin had the highest rate of growth and thus the greatest unprotected area, while cucumber and muskmelon had the least amount of growth and least unprotected area.

SEX DEVELOPMENT IN DROSOPHILA MELANOGASTER AS INFLUENCED BY A GENE IN THE THIRD CHROMOSOME

SUI-TONG GHAN FUNG
Department of Genetics

In 1942, a dominant sex-limited gene (Hr) causing hermaphroditism was isolated in our laboratory. This gene is in the third chromosome of Drosophila melanogaster. It produces no effect on the viability and fertility of the males, but diploid females carrying it develop into hermaphrodites which are sterile. The fact that it causes complete sterility in females, coupled with the fact that there is no crossing over in the males, makes it impossible to obtain the exact location of the gene within the third chromosome.

The effect of this gene is first visible in the second instar larvae, indicating that the time at which the gene acts is very early in larval development. Adult hermaphroditic flies resemble diploid females in body size and form. The anal valves are often displaced and possess both dor-
soventral and lateral clefts. Below the anal valves are a pair of abnormal claspsers, which are supported by irregular plates. Between the anus and the sternite, a large irregularly-shaped, heavily pigmented and sclerotized protuberance is generally found. This knob represents the rudimentary vulva or the posterior part of the female genitalia and often carries spermathecae. All hermaphrodites have sex combs on the basal tarsal segment of each foreleg. The comb consists of seven or eight teeth instead of the usual ten found in normal males. The presence of modified sex combs indicates that the first tarsal segments of the forelegs of the hermaphrodites are composed of some male tissue, which can evoke the sex comb forming capacity. Morphologically, the internal genitalia exhibit great variability, yet in no case is a complete sex reversal found. Each specimen represents a distinct degree of mixture of male and female parts, either rudimentary or well developed. In cases where genital ducts of both sexes are present, vasa efferentia as well as part of the ovarian tissue are yellow pigmented. This suggests that the hermaphroditic gonads have the potentiality of developing the yellow pigment of the testicular epithelium as well as retaining the unpigmented condition of the ovary.

Transplantations of normal male and female ring glands into the hermaphrodites accelerate the growth and differentiation of the gonads and accessory organs to a considerable extent. The result indicates that a nonautonomous development occurs. The ring gland of normal genetic constitution must release some substance necessary for growth and differentiation which is lacking in the hermaphroditic individuals.

Morphological, physiological, and genetic studies suggest that the normal allele of the hermaphrodite factor is a sex-differentiating gene guiding normal development of the reproductive tract. The hermaphrodite gene (Hr) has significant sex effects. It retards the growth process of the gonad, distorts the hypothetical embryonic field of the imaginal leg and genital discs, lacks the potency to regulate the activating agencies of both sexes, and, finally, reduces the growth and differentiation hormone produced by the ring gland. In sum, the effects seem to extend to all organs concerned with sexual development.

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ELECTRICAL RESISTIVITY AND HALL EFFECT IN SODIUM TUNGSTEN BRONZE

WILFORD ROBERT GARDNER

Department of Physics

The electrical resistivity and Hall coefficient have been measured for single crystals of sodium tungsten bronze (NaₓWO₃) as a function of temperature, and as a function of sodium concentration, for values of x between 0.58 and 0.90.

Single crystals of the bronze were prepared by heating sodium tungstate, tungstic oxide, and powdered tungsten, in the proper proportions, at 1000° C. for several hours, and then cooling the melt slowly. The sodium concentration of the resulting crystals was governed by the proportion of sodium tungstate in the initial mixture. Sodium analysis of the crystals was accomplished by an X-ray determination of the lattice constant. The x value was then determined from the known relationship between the sodium concentration and the lattice parameter. The X-ray analyses revealed appreciable amounts of free, metallic tungsten in many of the crystals. The crystals used in the experiments were about 3 mm. long and about 1.5 mm. in cross-sectional area.
Using a potential method, measurements were made of the resistivity of sodium tungsten bronze in the temperature range 10° K. to 300° K. The low temperatures were obtained in a Collins Helium Cryostat. The room temperature resistivity exhibited a minimum value of $(3.20 \pm 0.14) \times 10^{-5}$ ohm-cm. at $x = 0.75$, in agreement with previous reports. The room temperature resistivity was $(12.5 \pm 0.23) \times 10^{-5}$ ohm-cm. at $x = 0.584$ and $(5.89 \pm 0.20) \times 10^{-5}$ ohm-cm. at $x = 0.863$.

The resistivity was linear with temperature in the range 125° K. to 300° K. The temperature coefficient of resistivity was also a minimum at $x = 0.75$. The value of the temperature coefficient of resistivity at that sodium concentration was $(9.45 \pm 0.45) \times 10^{-5}$ ohm-cm./°C. The resistivity was very nearly constant below 30° K. The residual resistivity was obtained by extrapolation of the resistivity to absolute zero. A minimum in the residual resistivity was found at $x = 0.75$ where the value of the residual resistivity was $(1.25 \pm 0.10) \times 10^{-5}$ ohm-cm. The residual resistivity for all concentrations measured was from about one-third to one-half the room temperature resistivity.

The Hall coefficient was measured using an alternating primary current method. The variation of the Hall coefficient was less than 2 per cent with temperature in the range 78° K. to 370° K. The Hall coefficient was inversely proportional to the sodium concentration in the range of concentrations studied. At $x = 0.584$ the Hall coefficient was $-(6.10 \pm 0.15) \times 10^{-4}$ cm.$^2$/coulomb and at $x = 0.857$ was $-(4.07 \pm 0.03) \times 10^{-4}$ cm.$^2$/coulomb. Within the experimental error the values for the Hall coefficient corresponded to one free electron for each sodium atom in the lattice.

The minimum in the resistivity as a function of sodium concentration is due to an anomalous maximum in the electron mobility at $x = 0.75$. The reasons for this anomaly are not clearly understood.

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DIFFERENTIAL EQUATIONS IN THE DISTRIBUTION OF SCHWARTZ,

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This thesis is an investigation in the recently developed distribution theory of Schwartz (1). The notation used follows that used by Schwartz (1). Greek letters ($\varphi, \alpha, \theta$) are used for testing functions, S and T denote distributions. The value of $T$ for $\varphi$ is $T. \varphi$.

The equation

$$L(T) = P_0(x)T(n) + P_1(x)T(n-1) + \cdots + P_n(x)T = S,$$

where $S$ is given and each $P_i(x)$ is inde- finitely differentiable, is a linear differential equation in distributions of one variable. If $S = 0$, the equation is homogeneous.

Theorem 1. $L(T). \varphi = T.L(\varphi)$, where $L$ is the linear differential operator adjoint to $L$.

Theorem 2. The operator $L$ maps the space of testing functions $D$ onto the linear subspace $D_\alpha$, whose elements are $\alpha = \varphi$.

The operator $L$ is a continuous linear operator on the space of distributions. The notation used follows that used by Schwartz (1). Greek letters ($\varphi, \alpha, \theta$) are used for testing functions, $S$ and $T$ denote distributions. The value of $T$ for $\varphi$ is $T. \varphi$.

Theorem 3. The totality of solutions of $L(T) = 0$ forms a linear subspace $D_\alpha$ of the space of distributions. $D_\alpha$ is the annihilator of $D$.

Theorem 4. If (a) the mapping $L(\varphi)$ has a continuous inverse $L^{-1}$, (b) the distributions $T_1, T_2, \ldots, T_n$ are a basis for the subspace of solutions of $L(T) = 0$, and (c) $T_1, \varphi = T_2, \varphi = \cdots = T_n, \varphi = 0$ implies that $\varphi$ is an element of $D_\alpha$, then the differential equation $L(T) = S$ admits a unique general solution having the form

$$n \quad T. \varphi = \sum_{i=1}^{n} c_i T_i. \varphi + S. L^{-1} (\varphi - \sum_{i=1}^{n} c_i \varphi_i),$$

where $c_i = T_i. \varphi$, and the $\varphi_i$'s are a set of linearly independent testing functions satisfying $T_i. \varphi_j = \delta_{ij}$.

Theorem 4 is proved with the aid of a well-known algebraic theorem (2). Examples are given in the thesis of cases where hypothesis (a) in Theorem 4 is not satisfied.

Using Theorem 4, solutions are obtained for the equations

(a) $T(n) = S$
(b) $T' + f(x)T = S$
(c) $\alpha T - \lambda T = S(\lambda$ real)
A typical solution is that for (c). The equation \( xT' - \lambda T = S \) has the solution
\[
T = C_1 T_1 + C_2 T_2 \phi + S \theta,
\]
where \( C_i \) is an arbitrary constant. For values of \( \lambda < -1 \) and not integral

\[
T_1 = \mathcal{F}_p \int_{-\infty}^{\infty} |x|^\lambda \phi (x) dx,
\]
\[
T_2 = \mathcal{F}_p \int_{-\infty}^{\infty} |x|^\lambda \psi (x) dx,
\]
and
\[
\theta (x) = -\alpha (x) + \ldots + (-1)^{p-1} x^{(p-1)} \alpha (x) + \ldots
\]
\[
\frac{\lambda + 1}{(\lambda + 1) \ldots (\lambda + p)}
\]
\[
\int_{-\infty}^{\infty} [\Gamma (\lambda + 1)] (\text{sign} x) x^p dt.
\]

Here \( \lambda = \ell + p \), where \( p \) is an integer, and \( 0 < \ell < 1 \). \( \mathcal{F}_p \) refers to the finite part of an integral (1). The testing function \( \alpha \) is given by
\[
\alpha (x) = \varphi (x) - c_1 \varphi_1 (x) - c_2 \varphi_2 (x),
\]
where
\[
T_1 \phi j = \delta_{ij} \text{ and } c_1 = T_1 \phi .
\]
for values of \( \lambda > -1 \),

\[
T_1 \phi = \int_{-\infty}^{\infty} |x|^\lambda \varphi (x) dx,
\]
\[
T_2 \phi = \int_{-\infty}^{\infty} |x|^\lambda \psi (x) dx, \text{ and}
\]
\[
\theta (x) = -x^{-1} |x|^{-\lambda} \int_{-\infty}^{\infty} |t|^\lambda \alpha (t) dt,
\]
\( \alpha \) being defined as above. For negative integral values of \( \lambda (\lambda = k) \)

\[
T_1 \phi = \delta (k - 1), \phi,
\]
\[
T_2 \phi = \mathcal{F}_p \int_{-\infty}^{\infty} x^{-k} \phi (x) dx, \text{ and}
\]
\[
\theta (x) = \frac{\alpha (x) + x \alpha (x)}{(k-1)(k-2)} + \ldots \frac{x^k \alpha (x)}{k!}
\]
\[
\frac{1}{(k-1)!} \int_{-\infty}^{\infty} \ln |x| \alpha (x) dx + \ldots x^k \int_{-\infty}^{\infty} \ln |t| \alpha (x) \alpha (t) dt.
\]

In the definition of \( T_1 \phi \) above, \( \delta \phi = \phi (0) \)
is the Dirac distribution.

A solution of the "equation of composition"

\[ L(\delta) * T = \delta, \]

where \( L \) is a linear differential operator with constant coefficients, is an elementary solution of the more general equation

\[ L(\phi) * T = S. \]

Theorem 5 (Schwartz). If the distribution \( E \) satisfies

\[ L(\delta) * E = \delta, \]

then the distribution \( E * B \) satisfies

\[ L(\delta) * (E * B) = B, \]

where \( B \) is a given distribution.

It is shown in the thesis that to the fundamental solution

\[ V(x, t) = \left\{ \begin{array}{ll}
(4\pi kt)^{-1/2} \exp(-x^2/4kt), & t > 0 \\
0, & t \leq 0
\end{array} \right. \]

on the theory of heat conduction corresponds a distribution which is the elementary solution of the heat equation

\[ \frac{\partial U}{\partial x^2} - \frac{\partial U}{\partial t} = -k \left. \frac{\partial U}{\partial x} \right|_{x=t} = S, \]

where \( U \) is the temperature distribution and \( S \) is an arbitrary distributional heat source.

Some solutions of this equation are derived from the elementary solution by means of the result of Theorem 5, and are found to agree with those in classical literature (3).

Finally, an example is given of the solution of a boundary value problem involving the heat equation in one dimension by a separation of variables method.

REFERENCES


ABSTRACTS OF DOCTORAL THESES, 1952-53

SUBJECTIVE EVALUATION OF OBJECTIVE QUALITY MEASUREMENTS OF CANNED SWEET CORN

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At present, objective tests of sweet corn maturity and quality are used to determine the chemical or physical changes occurring as maturity increases or they determine specific characteristics of a given sample. This use of objective tests and the corresponding subjective evaluation does not take into consideration the limits of the smallest increment of quality change which can be detected by the average consumer.

The objectives of this investigation were:
(1) to determine the smallest increment of several variable quality factors of sweet corn, measured objectively, which can be detected subjectively by a panel of competent judges, and
(2) to determine the relative importance of the presently accepted objective quality measurements on subjective evaluation.

Twenty-eight sample lots of canned sweet corn were prepared from plantings of the sweet corn variety Iochie. Objective measurements of field and canned moisture content, pericarp content, alcohol-insoluble solids content, and kernel volume were made to determine the quality composition of each lot.

Lot comparisons were submitted to a panel of qualified judges, whose acuity was assumed equal to or greater than average consumers, for subjective evaluation. The panel attempted to distinguish between various combinations of two lots by use of the triangle taste test.

The influence of quality factors other than the one under investigation influenced the decisions of the judges to such an extent that differences between lots could not be distinguished by a single quality factor, such as succulence.

Objective quality factors were so highly correlated that one factor could not be varied independent of other factors sufficiently to obtain all desired combinations for a study of the influence of objective quality factors on subjective evaluation.

An equation representing the effects of the four objective quality measurements on the subjective decisions of the judges was formulated by the use of the multiple regression technique. Paired sweet corn lots were submitted to the panel of judges for detecting difference on any desired palatability basis. The multiple regression equation computed was:

\[ Y = 7.64 + 0.647X_{cm} + 6.038X_p + 0.027X_a + 6.22X_v \]

The symbol designations are:
- \( Y \) = estimated number of correct solutions.
- \( X_{cm} \) = difference in per cent moisture between two lots being tested.
- \( X_p \) = difference in per cent pericarp between two lots being tested.
- \( X_a \) = difference in per cent alcohol-insoluble solids between two lots being tested.
- \( X_v \) = difference in volume of 20 kernels, expressed in milliliters, between two lots being tested.

The degree of linear association between the dependent and the independent variables was statistically significant at the ninety-nine per cent probability level, since the coefficient of multiple regression, \( R \), and the \( F \) value in an appropriate analysis of variance were significant at that level. The portion of the sum of squares of the dependent variable accounted for by the independent variables was approximately 23 per cent. While four factors accounted for 23 per cent of the variation in number of correct judgements rendered by the panel, they were the commonly accepted quality measurements and it is very likely that a large number of additional factors were involved in influencing the subjective decisions of the judges.

An improvement upon the amount of variation accounted for was attempted since the subjective effects could be nonlinear. This attempt included the addition of factors to a multiple regression equation which equalled the square of each individual term and the addition of factors for the two factor cross products of the objective measurements. No appreciable improvement was made with this approach.

The relative effects of the objective measurements were determined by computation of the standard partial regression coefficients between the objective measurements and the correct judgements of the panel. The proportionate effect was:
- canned moisture 45 per cent, pericarp 31 per cent, kernel volume 22 per cent, and alcohol-insoluble solids 2 per cent. It
was concluded that moisture was the best criterion for the judging of quality in sweet corn among the objective measurements of pericarp, kernel volume and alcohol-insoluble solids.

The computed regression equation was employed for determination of the increments of various quality factors of sweet corn, measured objectively, which could be detected subjectively. Several statements can be made relative to the computed equation: (1) the dependent variable, $Y$, must equal at least nine if 15 tests are conducted; (2) the first term on the right side of the equation should equal five if all of the quality factors had been studied, since five correct solutions would occur by chance; (3) the difference between the first term, a constant, mentioned and the dependent variable, $Y$, having a value of nine in this example, equals the quantity required to be accounted for by the independent variables, $X_i$, in the equation, and (4) a change in any $X_i$, with all other $X_i$s held constant, necessary to make the dependent variable, $Y$, equal to nine is the difference increment in the objective quality measurements which can be detected subjectively by the judges who were on the panel used to obtain the regression equation empirically.

The computed difference necessary to ensure detection, at the 95 per cent probability level, between canned sweet corn lots for each variable measured objectively and with all others held constant was: 2.10 per cent for canned moisture, 0.23 per cent for pericarp, 50.37 per cent for alcohol-insoluble solids, and 2.19 ml. per 20 kernels for kernel volume. The minimum difference in objective quality measurements which could be detected by the experienced panel of judges in this investigation was: 0.52 per cent for moisture, 0.06 per cent for pericarp, 0.95 per cent for alcohol-insoluble solids, and 0.68 ml. per 20 kernels for kernel volumes.

Verification of the regression equation for prediction of establishing difference between sweet corn lots was checked on 19 separate triangle tests. All the actual values of correct judgements fell within the 95 per cent confidence limits of the predicted results.

The ability for detecting differences between lots of sweet corn did not vary among the judges. It was also found that three triangle tests at one sitting was not fatiguing.

EFFICIENCY OF MARKETING EGGS IN DES MOINES;

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Consumer preferences for eggs and their reflection to sellers were investigated in this study as a means to estimating the efficiency with which eggs were marketed in Des Moines. An efficient egg market is defined as one in which consumers, under a given income distribution, obtain the greatest amount of satisfaction possible in the consumption of eggs so that no other method of marketing a given quantity of eggs will provide greater satisfaction. If preferences for eggs are not reflected to sellers, consumer satisfaction can be maximized only by chance since sellers are unaware of desired qualities. It is assumed that sellers can respond to preferences, and that the only reason they do not is because of imperfect knowledge of consumer preferences.

Consumer preferences for different factors were examined. Interior quality preferences were related to establish grades by obtaining observations from respondents on four United States standards of quality for individual eggs, AA, A, B, and C. Colored photographs of these grades were pasted on circular disks and randomly numbered. Top view photographs and top-view-with-profile photographs of these grades were used on two different charts. The two charts gave similar results: There was no significant agreement on AA being preferred over A and vice versa, but AA (or A) was preferred over B and B was preferred over C. The profile chart appeared to aid respondents in their selection.

More general observations were obtained on other preference factors. Res-
pondents were asked about shell cleanliness, shell color preferences and yolk color preferences. Shell cleanliness did not appear to be a problem to respondents although samples of store eggs did indicate a high number of dirty shells when graded according to United States Department of Agriculture standards. About 50 per cent preferred a particular shell color; a slightly larger number preferred white than preferred brown shells. Darker yolk colors were preferred to lighter yolk colors.

Although it would have been informative to learn whether or not respondents would pay for their preferences, it was concluded that survey data would not permit such estimates since the supply of varying qualities and different preference factors confounds any estimates of the relation of quality and price. To take the supply factor into account, it was concluded that experimental designs in stores, in which price differentials among qualities are the stimuli, would provide estimates of the monetary value consumers place on preferences. Suggested experimental designs were presented for studying preferences of one factor or several factors simultaneously.

The remainder of the analysis was involved with estimating marketing efficiency and the extent that the utility function of consumers was maximized. The following observations led to the conclusion that the efficiency of marketing eggs was not at a maximum:

1. Higher quality and prices which averaged ten cents lower at the farm appeared to be primary reasons that 34 per cent of the respondents purchased eggs from producers.

2. Eggs were not purchased at the nearest sources by respondents because of distrust of retailers, too high prices, and poor quality.

3. Of respondents buying eggs from retail stores and primary producers, a much higher per cent of store purchases were unsatisfactory.

4. Uncertainty of purchases was repeatedly referred to by respondents.

In view of the condition of quality uncertainty in Des Moines, it was concluded that marketing efficiency could be increased, if not maximized, by introducing a grading law in which the contents of a carton of eggs were defined clearly to buyers. Theoretical reasoning also led to the belief that such a grading law would minimize quality discounting and strengthen, if not increase, the demand for eggs.

ESTIMATION OF THE GENETIC INFLUENCE ON GROWTH AND ORGAN WEIGHT CHANGES IN MICE FOLLOWING TOTAL BODY X-IRRADIATION

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In order to estimate quantitatively the influence of the genetic constitution on radiation response, six genetically differentiated inbred strains of mice, maintained at the Genetics Laboratory, Iowa State College, have been exposed to total body x-irradiation. The dosages were 0, 20, 200, 400, and 800 roentgens. The age of exposure was 40-43 days for all mice. Equivalent numbers of each sex and strain were placed at each exposure level, permitting complete orthogonality of comparison.

Body weights were determined at the ages of 40, 41, 42, 45, 50, 55, and 60 days. At 60 days of age, the mice were dissected, and the heart, kidneys, liver, spleen, and testes were removed and weighed.

The radiation factors were: 98 pKV, 2 ma., 36.5 centimeters target to mouse, and a dose rate of 22.5 roentgens per 30 seconds. The filtration was that inherent in the glass wall of the Coolidge-type air-cooled tungsten target x-ray tube.

Strain or genetic differences in body weight response to irradiation exist at all age levels in this 20-day period. They are maximum on the fifty-fifth day of age, when they account for 17 per cent of the total variation. The average res-
The second and fifth post-irradiation days, accounting for 43 per cent of the total variation. An empirical method for scaling these six strains for their relative resistance to radiation has been outlined. As a high correlation exists between the weight change from initial weight and dosage, the regressions involved in this relationship form the basis of the scalding procedure. The regressions take into account the strain differences in normal rate of gain, and the rate and time of weight loss and recovery. These response factors are considered the most important in the expression of genetic response differences. The estimated positions of the strains are; RI: 68.1 per cent; Z: 64.8 per cent; S: 64.1 per cent; E: 52.7 per cent; L: 42.5 per cent; Ba: 0 per cent.

It is pointed out that the pre-irradiation body weight is an important variable that must be accounted for when quantitating the radiation response. In addition, evidence is presented to indicate that, on the average, the heavier strains and heavier mice within the strains are more resistant to weight change. The female is concluded to be slightly more resistant than the male, but this variable in weight response is not an important one. The observed body weight response has been postulated to be the result of several known gastro-intestinal, endocrine, and specific cellular disturbances that follow irradiation. It is assumed that genetic differences in weight response may, equally, find their basis in genetic differences in the expression of these physiological alterations.

Strain differences are considered to be expressed by an alteration of the second-ary or indirect effects. Genetic variation in response is assumed to be based upon intrinsic capacities to resist the detrimental indirect effects and to enter more rapidly an effective phase of cell regeneration and/or recovery of normal metabolic levels.

EMBRYOLOGY OF INTERSPECIFIC CROSSES IN MELILOTUS

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The plant breeder frequently finds that the range of variation within a species does not encompass the desired characters or qualities. Interspecific, or intergeneric, hybridization provides a possible method of introducing the desired genes into the species. Twelve species of Melilotus were intercrossed and the embryology of the hybrids was studied. The species involved in this study are M. alba, M. officinalis, M. suaveolens, M. polonica, M. dentata, M. altissima, M. hirsuta, M. taurica, M. messanensis, M. italica, M. sulcata and M. speciosa. Among partially compatible crosses, M. officinalis x M. alba produces the most advanced embryo. Growth of the embryo proceeds normally until about eight days, and more slowly thereafter until the 12th or 13th day, when growth is completely inhibited and the embryo aborts. The reciprocal M. alba x M. officinalis embryo does not grow as

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CERAIN RESPONSES OF DOMESTICATED BIRDS TO INFECTION WITH PLASMODIUM LOPHURAE COGGEHALL, 1938

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The investigations in this research were undertaken to determine some of the responses which domesticated birds make to the malarial parasite, Plasmodium lophurae. Observations were made of the following: (1) degree of parasitemia exhibited; (2) responses of infected birds to different diets; (3) daily variations in body temperature readings; (4) weight changes during parasitemia; (5) appearance of eyelid lesions; (6) phagocytic activity in various host tissues; (7) appearance of malarial pigment in the different organs; and (8) phagocyte stages of the malarial parasite. Emphasis was on Nos. 6 and 8.

The 88 chicks used in the research comprised 10 different groups which varied in number from three to 15. Each group was given the regular starting ration for at least two days before being placed on a special ration. Two groups were given regular rations throughout the investigations. The others were placed on rations designated, respectively, G, O, R and S.

The ten ducks and two turkeys were given regular rations at all times.

1. The dosage of 0.8 x 10^8 parasitized red blood cells from a duck per 100 grams of body weight of chick, injected intravenously, produced different levels of parasitemia in the individual chicks. This was observed even for chicks of the same series whose weights were the same on the day of inoculation. The highest peak parasitemia attained was 100 per cent for chick No. 1686 of the 3 A series on the fifth day following inoculation. Another chick of the 3 A series, No. 1681, weighed the same (93 grams) on the day they were inoculated, and reached the peak parasitemia on the fifth day, but in this case the peak was only 35.85 per cent. The lowest peak parasitemia observed was 12.75 per cent for chick No. 12 of the 5 B series.

A dosage of 0.9 cc of an emulsion made from turkey brain infected with phagocyte stages of P. lophurae, and diluted 1:20 with normal saline, produced demonstrable blood stages of the malarial parasites in seven of the ten ducks inoculated. Apparently this dosage was not sufficient to produce severe parasitemia in any of

1 a. Chairman of Committee, Glory R. Becker, Dept. of Zoology and Entomology.
2 a. B.A. University of Iowa, Iowa City, Iowa, 1929. M.S. Ibid., 1930.
2 b. Instructor, Dept. of Zoology and Entomology.
the ducks. Neither did it result in the production of exoerythrocytic stages of P. lo- phurae prior to the twenty-first day following inoculation.

Parasitized red blood cells from a passage duck produced high parasitemias in the two turkeys used. In addition, phanerozoite stages of the parasites developed in one of the turkeys.

2. By the tenth day after inoculation with malarial parasites, the chicks given the various rations showed mortality rates as follows: those on regular rations, 20 per cent; on G rations, 50 per cent; on Q rations, 16 per cent; on R rations, no fatalities; and on S rations, 70 per cent. Internal organs, especially of chicks given the G and the S rations, appeared soft and somewhat watery, with the liver enlarged and the gall bladder greatly distended. Diarrhea generally was a problem.

3. Body temperatures varied from a low of 96.6° F. for chick No. 1234, series 6 A, on the seventh day following inoculation, to a high of 106.4° F. for chick No. 1228 of the same series on the tenth day following inoculation. Fifty per cent of the chicks of this series had temperatures of less than 102° F. just prior to death. This tendency was much more marked in chicks of the 6 A series than in any other group.

A relationship between peak parasitemias and peak temperatures seemed to exist for individual birds. Frequently the highest temperature recorded for any one chick was on the day just prior to the peak parasitemia. Then on the day of the peak parasitemia the temperature would fall. Generally, the day after the peak parasitemia had been reached, there was a tendency for the temperature to start rising.

Temperature records were not kept for the ducks and turkeys.

4. Chicks were weighed at approximately the same time each day and comparisons made of the weights of birds within each of the groups as well as between groups. No chick weighing less than 63 grams on the inoculation date was alive on the tenth day following inoculation, even though the parasitemia dosage was scaled according to the weight of each bird.

Mean weights on the inoculation date varied from 67 grams for the I B birds fed on regular rations, to 92.8 grams for the 3 A chicks given the G ration. Mean gains in weight for the ten-day period varied from a low of 13 grams for the 5 B chicks on the Q ration to a high of 90 grams for the 6 B chicks fed the S ration, but which had not been inoculated with malarial parasites. The greatest mean gain for chicks which had been inoculated was 46.6 grams for the 2 A chicks given the G ration.

Ducks were given regular rations throughout the investigation. On the inoculation date the mean weight for the ducks was 63.7 grams. Mean on the fifteenth day following inoculation was 402.1 grams. High and low weights on the fifteenth day were 500 and 230 grams.

Weights were not recorded for the turkeys.

5. All test birds were examined for symptoms and presence of eyelid lesions. Definite lesions appeared in four chicks of the 1 A series, fed on the G ration. Slight symptoms were noted in three chicks of the 4 A series, fed on Q rations. None of the ducks or turkeys showed eye lesions. In chicks having both eyes affected, the left eye became sore and light sensitive before the right eye. In severe cases, the eyes were swollen shut and an erosion of the lid followed. Partial replacement of the eroded lid occurred with a consequent thickening of this structure.

6. Sections, smears and imprints were made of the following organs of chicks, ducks and turkeys for observing phagocytic activity in them: (1) adrenals, (2) bone marrow, (3) brain, (4) eyelid, (5) gizzard, (6) gonad, (7) heart, (8) intestine, (9) kidney, (10) liver, (11) lung, (12) pancreas, (13) rectum and (14) spleen. Included were slides made from 50 chicks, 10 ducks and two turkeys. Slides were stained with Giemsa stain or with a combination of Phloxine, Toluidine blue and Orange G. Observations were made using an oil immersion lens. Phagocytic activity were observed in at least one organ in 49 of the 62 birds studied. These included 43 of the 50 chicks, five of the 10 ducks and one of the two turkeys. Activity was greatest in macrophage cells of the spleen, liver, kidneys, and lungs. Birds were examined as early as the first day following inoculation and as late as the ninety-fifth day.

7. Forty-nine of the 62 birds studied had pigment present in some organ. This varied in appearance from very fine granules scattered over the cut surfaces of the organs, to large masses of pigment which were clumped together. This pigment was most prevalent during the first part of the parasitemia but after a period of about two weeks the organs became more and more devoid of pigment. Malarial pigment was found in 50 chicks, seven ducks and two turkeys.

8. The primary aim of the research was to locate phanerozoite stages of the malarial parasites in the tissues of the
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BIRDS. Although 524 organs from 62 birds, including 50 chicks, 10 ducks and two turkeys were carefully observed with an oil immersion lens, phanerozoiotic stages were observed on only one turkey. These were found in the brain capillaries of a smear stained with Giemsa. Apparently this turkey died when the phanerozoite number was at its peak in the capillaries. They were not observed in any other organ than the brain.

In two brain smears of one of the ducks, four rather irregularly shaped, multinucleated, blue-staining bodies were observed. They measured from 41.4 to 46.4 microns in length, with the widest diameters from 14.0 to 22.2 microns. Their appearance did not conform to the classical descriptions of any phanerozoites thus far described, so further investigations should be made before a decision is made as to the true nature of these bodies. They may be pure artefacts, or they may be phanerozoites developing aberrantly in an unfavorable host.

BARLEY SCAB

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Isolations from barley grain, grown in Iowa in 1951 and 1952, revealed that barley scab caused by Gibberella zeae (Schw.) Petch is a major problem in the production of barley in this region. Nine samples of barley seed showed an average of five percent G. zeae infected kernels. The amount of G. zeae varied from none in some samples to as high as 11 percent. In addition to G. zeae, Helminthosporium sativum P. K. B. and Alternaria spp. were isolated most commonly from barley seed. The occurrence of many saprophytic fungi was also recorded. Several lots of Moore barley were heavily infected with the net blotch organism, Helminthosporium teres Sacc.

Cultural studies indicated that G. zeae is favored by warm temperatures. The optimum temperature for vegetative growth and conidia production was between 25° and 30°C. The optimum temperature for spore germination was approximately 30°C.

Eight isolates of G. zeae showed some variation in their ability to parasitize barley spikes and seedlings. One isolate was highly pathogenic, six were moderately pathogenic and one isolate was weakly pathogenic.

Greenhouse studies revealed that spring barley is susceptible to G. zeae from the boot stage until maturity. Hypodermic inoculations into the boot resulted in infections in those spikelets punctured by the needle. Plants inoculated in the flowering, past flowering, milk, soft dough and mature stages were all susceptible to G. zeae. The critical stage of development for scab infection appeared to be from the flowering period through the milk stage. In general, 72 hours incubation time gave a higher incidence of scab than the 48 or 60 hour series. Plants held at 24°C. after inoculation gave a higher percentage of infection than those incubated at 19°C.

The infection of barley spikelets through the dehisced anthers was commonly observed. Anthers which were partially extruded or completely dehisced and caught in the spike were visibly infected by the scab pathogen. The entrance of the fungus through the anthers appeared to be one of the primary means of initial infection.

A collection of 628 spring barley introductions and 30 named varieties were tested for scab resistance at Ames and Kanawha, Iowa, in 1951 and 1952. The plants were inoculated with G. zeae at Kanawha in 1951; the 1951 Ames and 1952 Ames and Kanawha nurseries were not inoculated. In addition to moderate to heavy occurrences of G. zeae headblight, there was considerable blight caused by H. sativum. On the basis of percentage of blighted heads, 15 introductions were classed as possessing some resistance to G. zeae and H. sativum headblight. These introductions were primarily of the Manchuria six-rowed type. The percentages of blighted seeds caused by
G. zeae and H. sativum were determined from plating tests of seeds from the 1951 Ames and Kanawha nurseries. Of the 628 introductions, 125 had five percent or less G. zeae infected seeds. Of this group, 75 introductions also had five percent or less H. sativum infected seeds. There were 368 introductions with five percent or less H. sativum seeds. The most promising introductions were: C. I. Numbers 1113, 2551, 3197, 4427-1, 4445, 4445-1, 4458, 4795, 4820, 4825, 4883, and 4893.

The thirty named varieties were all susceptible to G. zeae and H. sativum head-blight to varying degrees. Chevron, C. I. 1111 and Peatland, C. I. 5267, showed the lowest incidence of blight in 1951 and 1952. Three selections which included Chevron in their parentage were intermediate in their reaction to the headblight organisms. The other named varieties, many of which are grown commercially in Iowa, were very susceptible. There appeared to be no correlation between date of heading and the percentage of head and seed blight in the barley introductions and named varieties.

ABSORPTION AND DIFFERENTIAL TOXICITY OF 2,4-D COMPOUNDS

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Absorption of 2,4-D compounds was studied by spraying soybean and corn plants or dipping them into solutions of 2,4-D and then washing the plants in a series of detergent and rinsing solutions after varying exposure intervals. Reductions in the new growth two weeks after treatment were considered as being directly proportional to the chemical absorbed.

Tests with soybeans and corn indicated that absorption was positively correlated with the length of the exposure interval. The ester form of 2,4-D was absorbed within a few minutes after treatment; the sodium salt entered the tissues slowly, and required hours for effective absorption, while the amine was intermediate in rate. The addition of surface active agents to the spray solutions increased the rate of absorption of all the 2,4-D compounds, but decreased the differential penetration rates.

The effect of leaf carbohydrate supply on absorption of 2,4-D was studied by dipping soybean plants, previously held in darkness, into 2,4-D solutions, and then washing the 2,4-D residues from the plants after specified intervals. Leaf carbohydrates were not a critical factor influencing the absorption rates of 2,4-D.

Concentrations of sodium 2,4-D ranging from 1,000 to 10,000 ppm. were used to evaluate the effect of this factor on absorption by beans and corn. The rate of effective penetration was more rapid as the concentration, and consequently the quantity of 2,4-D applied was increased.

To investigate the effect of temperature on absorption, soybean plants were exposed to different temperatures 2 hours before and 30 minutes after dipping in 2,4-D solutions. The data indicated that the over-all Q_{10}'s for the absorption process were approximately 2, showing that a chemical or physiological reaction limits absorption.

To test the effect of soil moisture on the penetration of 2,4-D, soybean plants were grown with soil moisture held near the field percentage, and others were watered only after the plants had nearly reached the permanent wilting point. More rapid penetration occurred where the plants had been supplied with adequate water and were less differentiated.

Several experiments were performed to evaluate the effect of pH on absorption of 2,4-D compounds. Buffered solutions of 2,4-D at pH's of 5, 7, and 9 were used on soybeans. The sodium and amine forms were less toxic at pH 9 than at 5 or 7.

Absorption differences between the monoethylamine and dioctylamine salts of 2,4-D on soybeans were determined. The monoethylamine form penetrated more rapidly than the dioctylamine during 30 and 60 minute exposures. This result is in agreement with the molecular size or sieve theory.
Erosion continues to be a serious problem on farms in the Ida-Monona soil area of western Iowa even with the aid given farmers by public programs to reduce soil losses. Investigating this problem in 1949, Frey found that four major obstacles appeared to be preventing farm operators from achieving lower soil losses (1). These were the changes required in farm enterprises, rental difficulties and lack of the landlord's cooperation, financial obligations and living costs, and expectations of short tenure. The objectives of this study were to determine what effect changes in these obstacles would have upon soil losses, to determine the factors which create obstacle situations, and to determine how obstacle situations might be overcome.

Data were obtained during 1952 by interviewing operators and landlords on the 144 farms which Frey had studied, giving particular attention to changes which had occurred since then which might have eliminated or lessened a previous obstacle, or might have brought about a new obstacle, or made an existing obstacle worse. Soil losses were calculated on each farm for 1952 and compared with the loss rate in 1949.

The same socio-economic conditions which appeared to be obstacles in 1949 were observed again in 1952. While some changes were observed in all obstacle situations, the greatest improvements came about where the financial situation and where the organization of farm enterprises had been obstacles. There was little difference in the rate of change in soil loss, however, between the farms on which obstacles had made no change, the farms on which they had been overcome, and the farms on which the obstacle was more of a problem than before.

Soil losses for the entire sample were approximately the same as they had been in 1949. Soil losses had decreased on some farms but had increased on other farms with the result that the mean change was a reduction of only 1.5 tons per acre. If operators had put into practice those measures which they indicated were needed in 1949, the reduction in loss might have averaged 5 tons per acre. If they had succeeded in reducing losses to a point consistent with the public interest, the reduction would have averaged 15 tons per acre.

Variations in soil loss changes were greatest where a change in operators had occurred. Attitudes, circumstances of tenure and economic conditions for the new operator were sufficiently different from those of the previous operator to cause important changes in soil loss.

Noteworthy changes in the rate of soil loss occurred on 47 per cent of the farms sampled. Of these, 59 per cent had reduced soil losses by more than 5 tons while on the remainder of these farms soil losses had increased by more than 5 tons. Considering only these two groups of farms, where the operator's share of the marginal costs of an input related to erosion control had changed so it was not the
same as his share of the marginal returns, the rate of soil loss tended to increase. Similarly, where changes had occurred which more nearly equated the portion of those costs and benefits which were borne by the farm operator, erosion losses tended to decrease. Where the pressure of debt had increased, losses tended to increase. Where operators had become more aware of the effect of losses from erosion on yields, losses tended to decrease.

A need for increased educational work exists. Farmers were not making use of means already available which might be used to overcome obstacle situations. This is due in part because they are not familiar with the techniques which might be used or they have been misinformed concerning them and, in part, because custom or habit prevent the use of them. The use of leases which will permit the optimum use and combination of resources in the firm, both during a particular production period and for a series of such periods, will depend largely upon the success of educational efforts, for the initiative to make these changes must be taken by the owners and the operators. Off-site damages or off-site benefits which are not reflected as costs or revenues to the firm require action beyond that which the individual can take. Satisfactory adjustments are possible through group action. One of the most promising developments of this type is that of the conservancy district which makes it possible to tax those who receive benefits to compensate those who must make the investments which yield the off-site benefits.

Beyond the point of private or group profitability, public efforts will be required if erosion losses are to be reduced further. Where costs and benefits can not be associated because of their dispersion, and a change in the use of land is in the public interest, there is a need for public grants, subsidized credit and public investment. A partial alternative might be action to assure a greater degree of certainty in market conditions which, at present, make cattle enterprises hazardous for persons of limited capital.

Changes in legal concepts with respect to damages caused by the flow of water from higher to lower ground deserve consideration in light of what can now be done to control runoff water. Public ownership and the police power stand as the ultimate tools society may use to bring about land use which conforms with the goal of society. These methods, however, should be reserved for the problems of greatest urgency where other techniques are not effective.

REFERENCE


INTENSITIES IN THE HOLLOW CATHODE DISCHARGE

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In addition to the arc and spark as light sources for spectroscopy, electrical discharges through low pressure gases have proved quite useful in the excitation of spectra of many materials. In particular, when the cathode is of a hollow shape, the concentration of the glow within it, and the consequent alteration of the discharge processes contribute special features of value to the spectroscopist. These features include high brightness level, strong excitation of atoms introduced into the discharge by cathode sputtering, and very low electric field throughout the plasma. In addition, if the cathode may be cooled, doppler widths of the spectral lines may be reduced substantially. For these reasons, the tube has been used very effectively for high resolution spectroscopy.

In this research, a hollow cathode tube was built in accordance with the special requirements of such application. The actual cathodes were interchangeable and of various internal diameters. The cathode material was aluminum, and the tube was operated with helium as a carrier gas. The latter was continuously circulated through the discharge and through appropriate purification traps. Following recent practice in the field, the circulation...
was arranged to provide a "gas window" over the open end of the cathode to reduce the loss of sputtered material from the discharge.

The spectrum of singly ionized aluminum emitted from the cathode was examined with the aid of a quartz spectrograph, and observations of the source brightness at selected wavelengths were made. The variations in brightness due to changes in carrier gas pressure, cathode size and temperature, and discharge current were studied. These external parameters were varied over the range customarily practicable with this type of discharge tube. The discharge was photographed using five cathodes from 3.50 to 17.7 mm bore, at three temperatures from -190°C to 100°C, with high and low currents and with helium pressures from 1.0 to 6.0 mm of Hg.

The brightness measurements were made by comparison with the known thermal radiation from a tungsten ribbon-filament in a special quartz and glass incandescent lamp bulb. Both the comparison source and the hollow cathode tube were photographed in the wavelength range from 2490 to 6200 Angstroms, and the blackening of the photographic plates compared photometrically. Brightnesses of the various aluminum lines were then calculated on a scale which was arbitrary in absolute magnitude but uniform throughout the above wavelength region.

The aluminum lines selected for measurement included three from low-lying Al II levels and all detectable members of three line series from more highly excited levels. The results of these measurements showed that the overall excitation of aluminum to ionized states was strongly dependent on carrier gas pressure and on current. Average line brightness varied approximately as the square of the wall current density to the cathode, and increased to a maximum near the lowest pressure at which it was possible to maintain the discharge. The cathode size affected the position of this optimum pressure, and the brightnesses were also found to be somewhat greater at higher temperatures.

The brightnesses of the series lines conformed roughly with the above behaviour, but in addition showed definite non-uniformities in the excitation processes. These were evidenced by much higher brightnesses of some of these lines than their series neighbors, under conditions of high current and small cathode size.

An attempt is made to interpret the variations of brightness of the Al II lines and all detectable members of three line series from more highly excited levels. The results of these measurements showed that the overall excitation of aluminum to ionized states was strongly dependent on carrier gas pressure and on current. Average line brightness varied approximately as the square of the wall current density to the cathode, and increased to a maximum near the lowest pressure at which it was possible to maintain the discharge. The cathode size affected the position of this optimum pressure, and the brightnesses were also found to be somewhat greater at higher temperatures.

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ANGULAR DISTRIBUTION OF PHOTOPROTONS FROM ALUMINUM AND TANTALUM

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Information concerning photonuclear transformations may be obtained from the study of the particles which are emitted from nuclei when irradiated with photons. In order to add to the available information on the emitted protons, aluminum and tantalum have been exposed to the bremsstrahlung radiation of the Iowa State College synchrotron and the tracks of emitted particles have been recorded in photographic emulsions. For this investigation 1 x 3 inch Ilford C-2 500 µ nuclear emulsions were exposed in an evacuated camera provided with a thin window in each end through which the beam passed. Collimation was obtained with two circular apertures in succession which gave a beam approximately 1 cm in diameter at the camera.

The emulsions were processed by a low temperature method using an amidol developer. Scanning was done with a 21X objective lens and 15X eye pieces. Each observed track was checked against four selection criteria and for those which were satisfactory, the position, depth and
length were recorded. The emulsions were exposed at 25°, 60°, 90°, 120°, and 155° to the direction of the collimated X-ray beam and with maximum X-ray energies of 25, 40, and 65 Mev for aluminum and 25, 38, and 65 Mev for tantalum.

The track density in each plate was corrected for relative geometry and used as an indication of the relative number of protons emitted at that angle. In the case of tantalum the angular distribution thus obtained has been plotted and compared to the function \( I = A + B \sin^2 \theta \). Using the best fit of this function to the experimental points, \( B/A = 1.7 \) for protons from 0 to 19 Mev, \( B/A = 8 \) for protons from 18.6 to 28 Mev, and \( B/A = \infty \) for protons from 27 to 40 Mev. For aluminum the function \( I = (\sin \theta + \cos \theta \cos \phi)^2 \) plus a constant portion was fitted to the experimental points. The constant portion comprised the entire group for the 25 Mev exposure while for the 40 Mev exposure \( p = 0.7 \pm 0.1 \) and for the 65 Mev exposure \( p = 0.6 \pm 0.2 \).

From the known range-energy relation for protons in emulsion the energy distribution of emitted protons has been determined. These experimental points have been plotted and in the case of low energy protons where no intervening absorber was used, the distribution predicted by the statistical theory of photoneutron reactions has been superimposed. For aluminum the theoretical curve fits the experimental points quite well when normalized to enclose the same area. Since the fit was not good for tantalum, the theoretical curve has been plotted twice. In one case it has been normalized to enclose the same area as the experimental points while in the other it has been normalized so that the leading edge approximately fits the experimental points. For higher energy protons observed behind absorbers the relative number of observed protons has been plotted against the corrected proton energy. The observed number of protons was found to decrease with increasing proton energy as \( E^{-6.5} \) for protons from 19 to 28 Mev, as \( E^{-7.5} \) for protons from 27 to 40 Mev from tantalum, and as \( E^{-6} \) for protons from 16 to 28.5 Mev, as \( E^{-7} \) for protons from 27 to 43 Mev from aluminum.

From the calculated geometry in which the emulsions were exposed and the observed track density the following yield points were determined. The value of \( (p/mole \text{ Al}) \) to \( (n/mole \text{ Cu}^{63}) \) for aluminum was found to be \( 0.30 \pm 0.02 \) for irradiation at 25 Mev, \( 0.034 \pm 0.002 \) for irradiation at 40 Mev, and \( 0.0084 \pm 0.0010 \) for irradiation at 65 Mev. For tantalum the value of \( (p/mole \text{ Ta}) \) to \( (n/mole \text{ Cu}^{63}) \) was found to be \( 0.062 \pm 0.006 \) for irradiation at 25 Mev, \( 0.0062 \pm 0.0005 \) for irradiation at 38 Mev and \( 0.0045 \pm 0.0004 \) for irradiation at 65 Mev.

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RATIO METHOD OF ESTIMATION IN SAMPLE SURVEYS,

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The ratio method of estimation in sample surveys involves the use of estimators for population parameters which are linear functions of the ratio of dependent random variables. Only large sample approximations for the bias and sampling variance are available for measuring the accuracy of ratio estimators. This study is concerned with three aspects of the properties of ratio estimators as they are used in sample surveys.

First, using a theorem of Cramér, regarding the asymptotic distribution of functions of sample moments for random samples from joint continuous distributions \( f(x,y) \) having finite first and second moments, it was found that the ratio of the sample means was asymptotically normally distributed with mean equal to the ratio of the true means and variance given by usual approximate formula. It is noted that the argument of Fisher for obtaining interval statements about the true quantity can be used, if the \( t \) distribution can be assumed to hold for samples from finite populations. This assumption is probably fairly realistic.

Second, exact expression for the bias and variance of ratio estimators have been obtained under various assumptions regarding the joint distribution of the variables sampled. In particular, these as-
sumptions restricted the types of regression and conditional variance relationships exhibited by \( f(x, y) \). For the variance laws considered and the true mean square regression of \( y \) on \( x \) linear, it was found that exact expressions for the bias and variance of ratio estimators depend on the existence of the first and second moments of the distribution of the reciprocal of the sample mean of the denominator variable. The usual approximate formula for the variance was then compared with the exact expressions when \( f(x) \) followed the Pearson Type III and the truncated binomial distribution. For these distributions and whenever the regression and variance relationships considered prevail, the sample size required to achieve reasonable accuracy with the approximate variance formula depends on the magnitude of the coefficient of variation of the denominator variable of the ratio estimator. The larger this coefficient, the slower is the convergence of the approximation to the exact variance expression.

Third, a systematic comparison of the ratio estimator with other possible methods of estimation using the information available on a supplementary variable was conducted. The comparison was restricted to situations in which specific conditions on the form of the regression and on the residual variance law were satisfied by the joint distribution of the variables involved. The ratio method of estimation, as a general method of estimation, was found to compare favorably.

ELASTIC STABILITY OF THE TOP CHORD OF A THREE-SPAN CONTINUOUS PONY TRUSS BRIDGE

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The object of this investigation was to make an analytical study of the elastic stability of the top chord of a three-span continuous pony truss bridge.

The pony truss bridge that was used as an example was designed by the Iowa Highway Commission in 1947 and erected over the North River on State Highway 60 a few miles southeast of Des Moines, Iowa. The bridge has twenty 15-foot panels with a center span of 150 feet and end spans of 75 feet. For the stability analysis the top chord and end post members were considered as an elastically supported beam-column member. The beam-column member was considered hinged and fixed against lateral deflection at the ends of the span and elastically supported against lateral deflection at the intermediate panel points. The elastic supports were provided by the cross frames composed of the verticals of the trusses and the floor beams framing into the verticals. The entire effect of the diagonal web members and the torsional stiffness of the vertical members were neglected. Also, it was assumed that the top chord members were not deflected out of a straight line, when viewed from above, by the loads applied to the floor system.

Two criteria, series and stiffness, were presented and were used as a basis for checking the elastic stability of the top chord members.

The series in the series criterion procedure is obtained from a moment distribution type of solution. Equations were derived for the necessary constants required for a moment distribution solution of a beam-column elastically supported against deflection at intermediate points. When the moment distribution series converges a condition of stability is indicated, but when the series diverges a condition of instability is indicated.

Equations were derived for use in applying the stiffness criterion to obtain the rotational and translational stiffnesses of one end of a member considering the entire structure beyond its far end. The equations, as derived, for the stiffnesses for the end of a member can be used to determine the rotational stiffness of the hinged end of a beam-column and can be used to determine the rotational and translational stiffnesses of a joint provided that the structure and stress conditions are exactly the same on both sides of the joint. The principles of the stiffness criterion are:

1 a. Chairman of Committee, Frank Kerekes, Dept. of Civil Engineering.
3 a. B.S., Iowa State College, Ames, Iowa, 1941.
   M.S., Ibid., 1949.
4 b. Assistant Professor, Dept. of Civil Engineering.
When an external clockwise moment, under a condition of equilibrium, is required at a joint to rotate the joint in a clockwise direction, there is an indication of stability; but, when the external moment necessary to hold the joint in equilibrium is opposite to the direction of rotation, then there is an indication of instability.

When a lateral force, under a condition of equilibrium, is applied at a joint and when the direction of the deflection of the joint is in the direction of the applied force there is an indication of stability; but, when under a condition of equilibrium, the direction of the force must be opposite to the direction of the deflection of the joint, then a condition of instability is indicated.

The process of determining the load factor that produces a stress condition which causes buckling must be one of trial; that is, the structure must be analyzed for stability with various load factors until a condition of instability is found or until the stresses reach the yield stress. In applying the series and stiffness criteria, the buckling curve corresponding to the minimum load factor must be obtained. If the beam-column buckles with a node at one of the joints, the value of the translational stiffness of that joint may indicate a condition of stability; and, if the beam-column buckles with a point of maximum deflection at one of the joints, the rotational stiffness of that joint may indicate a condition of stability, and the stability factor determined with the use of the series criterion may indicate a condition of stability. Therefore, any results obtained by the use of the series and stiffness criteria must be carefully interpreted.

Of the two criteria, series and stiffness, the stiffness criterion involves a smaller number of equations and when it can be used it is the more practical of the two procedures. The series criterion can be applied to any joint and therefore can be considered as the more general procedure of the two. However, only the rotational stiffness of a joint can be checked by the series criterion procedure.

In checking the top chord of the three-span continuous pony truss bridge, the series and stiffness criteria must be applied to one of the joints in the region of compressive stress. The regions of tensile stress adjoining the regions of compressive stress have a stiffening effect on the members in compression and have a tendency to reduce the possibility of buckling.

The stresses in the top chord members were computed for two live loading conditions. The top chord was checked for stability for these two stress situations in the following manner:

1. For the loading condition that produced a maximum compressive stress in the end spans, the series criterion was used by applying an external moment at the end joint, and the stiffness criterion was used by determining the rotational stiffness of the end joint.

2. For the loading condition that produced a maximum compressive stress in the center span, the stiffness criterion was used by determining the rotational and translational stiffnesses of the joint at the center of the span.

A procedure was presented to determine the elastic constants for the inclined end post member in terms of the horizontal projection of the member. A similar procedure could be used to include the effect of the other diagonal web members in an analysis for stability. If the effect of the diagonal web members were included, the resistance of the top chord members to buckling would be increased.

The top chord of the three-span continuous pony truss was checked for stability for the two conditions of live loading and the member was found to be stable with stresses in the top chord member which were within the elastic strength of the material.
EXPERIMENTAL DETERMINATION AND MATHEMATICAL EVALUATION
OF PHYSICAL CHARACTERISTICS OF BEEF PROCESSED AT
HIGH RETORT TEMPERATURES

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An investigation of physical characteristics of beef (round) and their mathematical evaluation were undertaken with the purpose of safe modification of processing times and temperatures used at present. The range of temperatures investigated (225-315°F.) included relatively high temperatures; correspondingly short times were used as it was thought that in this region of processing conditions a process would be found resulting in safe and palatable product. Twenty-five locations in the 300 x 308 can were investigated covering for all practical purposes the whole can volume.

The study was divided into three major parts: investigation of thermal properties, investigation of thermobacteriological characteristics, and investigation of other physical changes occurring in beef during canning.

Time-temperature-space relationships existing in the container were determined and prediction equations of exponential form were developed for the heating and cooling phases of the thermal process by means of regression analysis. The effects were evaluated of processing variables on the number of terms to be retained in the expansion of theoretical heat conduction equation to approximate the thermal history of the can during the initial phase of cooling. The series was found to converge to its limit for twelve to four terms as the cooling time \( (t_{-1}) \) progressed from 2-10 minutes. The differences from the retort temperature at the end of heating \( (g) \) affected the number of terms to be retained; less terms were required for small \( g \).

From the investigation of this phase of the thermal process it was found that neither the theoretical relationship nor a monotonic function approximation of time-temperature relationship agreed well with the experimental data. The effect of residual heating at the beginning of the cooling phase on the effective processing time has been evaluated by graphical means.

Temperature distribution patterns have been mapped for the heating phase of the thermal process and found in disagreement with theoretical expectations: the locations of greatest heating lag were displaced from the center to form a doughnut shaped volume around the central vertical axis in the central horizontal plane. The isothermals displayed cardioid characteristics. These effects were found to be real and caused most likely by the anisotropy of meat and departure from uniform initial temperature distribution in the can.

Thermal diffusivity of the round of beef has been determined \( (k_{av} = 0.2623 \text{ sq. cm./min.}) \) and found to be affected by processing temperature. The "slopes" of heating \( (f_h) \) and cooling \( (f_c) \) curves were determined and compared. A comparison of visual and regression curve fitting methods and their effects on "slope" values was made.

Sterilizing effects \( (F_0) \) of high temperature short-time processes displayed large variations and precluded derivation of prediction equations; therefore, \( F_0 \) distributions have been presented in graphical and tabular form. A doughnut shaped volume of lowest \( F_0 \) values was found to be a secondary effect of temperature distribution and of residual heating. This phenomenon as well as the contribution of the residual heating to \( F_0 \) values was found to be more pronounced at higher retort temperatures. Processing times equivalent in terms of \( F_0 \) at the center were determined for six temperatures; considerably shorter times at high temperatures than at low ones were necessary to attain the same \( F_0 \) levels.

Objective determinations of tenderness were made. Approximate linear relationship of shear force and processing time and exponential relationship of the slopes of this function and processing temperature were developed by regression technique. Visual interpretation of these relationships was presented by means of a three-dimensional graph. The objective evaluation of juiciness was given in a linear regression of drained juice on a time-temperature transform. Shear force data displayed considerable variation and did not lend themselves to a simple mathema-

1 a. Chairman of Committee, Henry M. Black, Dept. of Mechanical Engineering, and Robert Tischer, Dept. of Food Technology.
M.S. Ibid., 1950.
b. Graduate Assistant, Agricultural Experiment Station.
tical interpretation. Shear force has been found to increase at the beginning of the process, pass through a maximum and then decrease approximately as a linear function of time. Drained juice data showed similar variations and this attribute was found to be a well behaved monotonic function of time.

A comparison was made of shear force and drained juice with sterilizing effects. The shear force for equivalent processes displayed a maximum between 261 and 279°F. retort temperature. For the same F₀ levels the quantity of drained juice increased from 243-315°F.

The precision of estimates of parameters and of prediction equations was evaluated wherever it was feasible.

The inherent variation in the shear force determinations by means of Warner-Bratzler Shear were discussed in an appendix. A new method of computation of thermal process lethality, similar to the "general method" procedure, has been developed to account for continuous exposure of bacteria to heat during processing. This method has been presented in an appendix.

The conclusions drawn on the basis of this investigation were as follows:

(1) The average time - temperature - space relationship in the can may be expressed for heating and cooling phases of thermal process by straight-line function in semi-log coordinates. No simple relationship can be derived for the initial period of the cooling phase.

(2) The residual heating during the initial period of cooling increases the effective processing time. This increase is more pronounced for high-temperature short-time process. The contribution of residual heating to the sterilizing effect shows the same trend and possibly reaches a maximum at 297°F retort temperature.

(3) Thermal diffusivity of beef does not depend on the location in the container; it may be, however, a function of processing temperature and reaches a maximum for 261-279°F.

(4) The "slopes" of heating and cooling curves are significantly different and cannot be used interchangeably. Regression estimates only should be used for thermal process determinations.

(5) The temperature distributions displaying a doughnut shaped volume of lowest temperatures in the central horizontal section of the can are a real occurrence caused by anisotropy of beef and nonuniform initial temperature distribution as reflected by the analysis of intercept coefficients in the heating equation.

(6) The F₀ determination is subject to great experimental variations and, to assure a determination of a safe but not excessively long thermal process, the size of the experimental sample should be determined by statistical methods. The F₀ distribution (similar to temperature distribution) observed emphasizes the necessity of process determination based on volume lethality concept.

(7) Maximum shear force may be expressed approximately as linear function of time. The slope of this function may be expressed as an exponential function of the processing temperature.

(8) The drained juice accumulation may be expressed as a linear function of a time-temperature transform.

(9) Processing temperatures between 261-279°F. display characteristics of a critical range where most of the physical characteristics of beef assume their extrema. This temperature range may prove to be optimal for canning of safe and palatable beef.
Some Derivatives of Dibenzo furan and Dibenzo thiophene

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The announcement by Barry (1) of the considerable antituberculous activity of 2-chloro-7-aminodibenzo furan, the reported activity of derivatives of 4-halo-4'-aminodiphenyl ether, and the antituberculous activity of derivatives of 4,4'-diaminodiphenyl sulfone prompted the preparation of a series of dibenzofuran and dibenzothiophene compounds.

The treatment of 2-bromo-7-acetamidodibenzo furan with bromine gave a monobromination product melting at 235-236° (73 per cent). This compound was hydrolyzed to the amine (90 per cent, m.p. 182-183°). The amine was proved to be 2,8-dibromo-3-aminodibenzofuran by deamination to yield 2,8-dibromodibenzo furan.

An attempt to prepare the amino-dibromo derivative of a different sequence led to the bromination of 2-bromo-3-aminodibenzo furan, giving a dibromo-acet amino derivative melting at 233-236° (32 per cent). A mixed melting point with 2,8-dibromo-3-aminodibenzo furan was greatly depressed; the compound was thus thought to be 2,4-dibromo-3-aminodibenzo furan. Attempted mononitrations of 2,8-dibromodibenzo furan with nitric acid and acetic acid or acetic anhydride were unsuccessful. Nitration of the dibromo derivative with concentrated nitric and sulfuric acids gave a dinitro-dibromodibenzo furan melting at 332-335°.

Alkal fusion of 2-bromodibenzo furan or 2,8-dibromodibenzo furan when carried out in either diethylene glycol or triethylene glycol gave only reductive debromination (2).

2-Bromo-7-nitrodibenzo thiophene-5-dioxide (52 per cent, m.p. 319-321°) was prepared by nitration of 2-bromodibenzothiophene-5-dioxide. Catalytic reduction of this compound gave 2-bromo-7-amino dibenzothiophene-5-dioxide (67 per cent, m.p. 331-333°).

The treatment of dibenzothiophene-5-oxide with bromine yielded 2,8-dibromodibenzothiophene (3). The reaction of lithium with phenothiazine, 10-ethylphenothiazine and carbazole in dioxane was investigated. With phenothiazine, hydrolysis of the dioxane reaction mixture yielded o-mercaptodiphenylamine (29 per cent) and diphenylamine (4.4 per cent); essentially the same results were obtained on carbonation of the reaction mixture. With 1-ethylphenothiazine, carbonation of the reaction mixture gave o-mercaptodiphenylethylamine (33 per cent). With carbazole and lithium in dioxane only starting material was isolated (88 per cent recovery).

A series of heterocyclic sulfides was prepared by treatment of the sodium salt of the mercaptan with the appropriate halogen compound (4). The following sulfides were synthesized: 2-(benzylmercapto)quinoline (82 per cent, m.p. 44-44.5°), 2-(n-dodecylmercapto)quinoline (70 per cent b.p. 185-188°/2 mm.), 2-n-hexadecylmercaptoquinoline (62 per cent, m.p. 43-44°), 2-(n-octadeclmercapto)quinoline (85 per cent, m.p. 53-54°), 2-benzothiazolyl 2-quinolyl sulfide (78 per cent, m.p. 109-111°), 2-(4-phenylthiazolyl) 2-quinolyl sulfide (50 per cent m.p. 88-91°), 2-benzimidazolyl 2-quinolyl sulfide (60 per cent m.p. 32.5-34°) and 4-(7-chloroquinolyl) 2-benzothiazolyl sulfide (44 per cent, m.p. 138-140°).

REFERENCES
The conductances and transference numbers of the perchlorate salts of lanthanum, praseodymium, neodymium, samarium, gadolinium, holmium, erbium and ytterbium were measured. The conductances and transference numbers of the nitrate salts of lanthanum, neodymium and gadolinium were also measured. In addition, the conductances of the sulfate salts of lanthanum, cerium, praseodymium, neodymium, samarium, gadolinium, holmium, erbium, ytterbium, and yttrium were determined. These were all measured in aqueous solutions at 25°C.

The Jones bridge and its accessories were employed to measure the conductances over a concentration range of about 0.0002 N to 0.1 N. The accuracy of the conductance measurements is estimated to be about 0.1 per cent which is the extent to which the concentrations of the solutions are known.

The perchlorate conductances appear to decrease with increasing atomic number except for lanthanum, praseodymium and neodymium. These three salts have very similar conductances. The behavior of the series is attributed to the effective increase in the size of the ions due to hydration, in spite of the fact that the ionic radii from crystallographic measurements are decreasing with atomic number. The three nitrates measured exhibit similar behavior to that of the perchlorates.

However, the conductances of the perchlorates as a whole are higher than those of the nitrates except at very low concentrations. This seems to indicate that the interaction of the perchlorate ions with the rare earths, at concentrations above about 0.01 N, is less than the corresponding interactions of the nitrates and the halides. This behavior would tend to increase the total conductance of the perchlorates as compared with the nitrates. The conductances of the nitrates and the halides are parallel from infinite dilution to 0.1 N; whereas, the conductances of the perchlorates cross those of the halides and nitrates, and are higher than both of them above 0.1 N.

The conductances of the rare earth sulfates are much lower than expected for completely dissociated strong electrolytes. The low mobilities of the sulfates are attributed to the formation of complexes or ion pairs even in dilute solutions. The most prevalent complex at moderate dilutions is proposed to be $\text{MSO}_4^+$ in which M is the rare earth.

The series of rare earth sulfate conductances exhibit a far different order from that of the other salts measured. At appreciable concentrations the sulfate conductances decrease slightly from lanthanum to praseodymium and then rise a little at neodymium. They fall again to a minimum at samarium and finally increase steeply from samarium to ytterbium. Yttrium behaves much like the heavy rare earths in its conductance. This order in the sulfate conductances may be attributed to the relative stabilities of the rare earth complexes as the atomic number is increased.

The conductances of the rare earth sulfates are completely different at infinite dilution. They are completely dissociated at infinite dilution and they behave as do the other rare earth salts.

The ionic equivalent conductances at infinite dilution were calculated for these salts and the values are in good agreement with those previously calculated from the rare earth halide data.

The transference numbers of the rare earth perchlorates and nitrates were measured by the moving boundary method. The accuracy of the method is estimated to be about 0.1 per cent. However, it is conceivable that the errors in the measurement of time, volume and current could add up in such a way as to give an overall accuracy of only 0.2 per cent.

The order of the perchlorate transference numbers is in relative agreement with the rare earth halide transference numbers. Lanthanum is a little lower than expected but still quite close to the light rare earths. However, samarium appears to behave contrary to its conductance. The transference number is close to that for praseodymium while its conductance is much lower than that of praseodymium.

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from the conductance data and the transference numbers. They provide a cross check with the conductances, since the ionic conductances of the anions fall on relatively the same curves.

The use of the Onsager equation for the extrapolation of the conductances to infinite dilution indicated that a further correction on the conductances would give much better agreement with theory. This agreement was obtained when the extended Onsager equation was used. The extended equation includes a dependence on the mean distance of closest approach in the electrophoretic effect correction. This led to a method for determining the distances of closest approach for the rare earth perchlorates and nitrates from conductance data. The \( a_j \) values determined from the conductance data were quite reasonable and were used to calculate activity coefficients. The activity coefficients appear to be satisfactory and compare favorably with those of the rare earth halides which were determined from e.m.f. measurements. Since the activity coefficients for the rare earth perchlorates and nitrates are not available from experimental measurements, the conductance method affords a convenient and reasonably accurate method of obtaining them.

The data on the transference numbers and conductances presented in this thesis should be of valuable importance in the study of equilibria and kinetics of rare earth salt solutions. It is hoped that these data will help point the way towards extensions in the present theories and provide a better understanding of the physical chemistry of electrolytic solutions.

EFFECTS OF ANTIBIOTIC AND LYSINE SUPPLEMENTATION ON GROWING-FATTENING PIGS FED AT DIFFERENT PROTEIN LEVELS

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The purposes of these studies were to determine the optimum levels of protein in corn-soybean oil meal rations for growing-fattening pigs and to study the effects of antibiotic and lysine supplementation on different protein levels.

Data from 336 pigs, including purebred Duroc and Poland China x Landrace x Duroc pigs group-fed in drylot, showed that with nutritionally balanced rations optimum growth and feed efficiency were obtained on protein levels which were lower than those previously recommended. It was further shown that with the antibiotic aureomycin included in the rations at a level of 10 milligrams per pound, growth response was obtained which was equal to that realized from non-aureomycin rations containing two or more additional percentage units of protein.

Under these drylot conditions, levels of 16, 13, and 10 per cent protein for the periods of growth from weaning to 75, 75 to 150, and 150 to 200 pounds, respectively, produced growth rates equal to and greater than those obtained with either 2 or 4 added percentage units. With 10 milligrams of aureomycin added per pound of ration, the protein level series of 14, 11, and 8 per cent produced growth rates equal to that obtained with 6 per cent more protein.

Corn alone, with a protein content of approximately 8 per cent, supplemented with vitamins and minerals, resulted in a daily gain of 1.54 pounds during the period from 150 to 200 pounds live weight, while with the addition of 10 milligrams of aureomycin per pound of ration the daily gain was 1.88 pounds. Forty-one pounds less feed were required per 100 pounds of gain in the presence of the antibiotic during this period.

This same type of ration, with and without aureomycin, was definitely inadequate for pigs from weaning to 75 pounds live weight. These pigs averaged 37 pounds at the start of the feeding period and after eight weeks had gained only an average of 0.32 pound per day. The diet appeared to be unpalatable, and the reduced feed intake accentuated the inadequacy of the ration. The addition of enough soybean oil meal to raise the protein per cent from 8 to 12 resulted in a ration which produced 0.84 pound greater daily gain and which required 318 pounds less feed for each 100 pounds of gain. When vitamin B12 and the antibiotic aureomycin were added to the

1 a. Chairman of Committee, Damon V. Catron, Dept. of Animal Husbandry.
M.S. Ibid., 1950.
b. Graduate Assistant, Agricultural Experiment Station.
latter ration, growth response and feed efficiency were further improved.

When pigs were fed the same protein levels (10, 12, 14, 16, 18 or 20 per cent) from weaning to 200 pounds live weight, 10 per cent protein levels were inadequate for optimum growth whether fed with or without either aureomycin or terramycin at 5 milligrams per pound of ration. In the absence of an antibiotic, 16 and 18 per cent protein level rations produced the most rapid rates of gain. In the presence of either aureomycin or terramycin, the most rapid gains were obtained on those rations containing 14 per cent protein. In this experiment, from weaning to 75 pounds live weight, those pigs receiving terramycin gained significantly faster than the pigs not receiving the antibiotic. When the pigs had reached 200 pounds, however, there were no significant differences due to antibiotic treatment. Considering the different protein levels fed, growth rates increased significantly with increase in protein level up to 14 per cent, and then decreased slightly on the higher protein levels.

Hogs from each of the protein levels fed, except 20 per cent, from weaning to market weight, were slaughtered and the following measurements were recorded: back-fat depth (both live probe and carcass measure), specific gravity, per cent lean cuts, weight of leaf fat, area of loin muscle, and carcass length. Of these measurements, specific gravity values and per cent lean cuts were the most indicative of a carcass composition. Thickness of back-fat was not sufficiently sensitive to use as a criterion for measuring carcass fatness.

Neither aureomycin nor terramycin adversely affected the quality of the carcass of hogs slaughtered at a live weight of approximately 200 pounds. There were no detectable differences between the antibiotic and non-antibiotic treatments. The protein level of the ration did affect the proportion of fat to lean. Considering the specific gravity values, there was a significant increase in values from the 10 per cent protein level up to the 16 per cent, and then a slight decrease at the 18 per cent protein level. Although not significant, the per cent lean cuts values supported this trend, indicating an inverse relationship of protein level in the ration to fat content of the carcass.

Data from 128 Duroc pigs individually fed in wire-bottom cages indicated that 10 per cent protein level corn-soybean oil meal rations were nutritionally inadequate for the period of growth from weaning up to 75 pounds. The addition to these rations of a synthetic DL-lysine, 40 per cent L-lysine, did not improve growth rate or feed efficiency. In fact, when 0.1 per cent L-lysine equivalent was added there appeared to be a decrease in palatability.

With the 12 per cent protein level rations, however, satisfactory growth rates and feed efficiencies were obtained. When 0.069 per cent L-lysine equivalent was added to this protein level, average daily gains were significantly increased and 21 pounds less feed were required for each 100 pounds of gain. This strongly supported the supposition that in the 10 and 12 per cent protein level corn-soybean oil meal rations lysine was the primary limiting amino acid.

Calculated biological values from the nitrogen balances determined on the pigs receiving the 12 per cent protein rations did not give a clear cut picture of the effect of lysine supplementation upon the utilization of the protein consumed. With the addition of 0.017 per cent L-lysine equivalent an apparent decrease in nitrogen utilization occurred. With 0.034 or 0.069 per cent addition of the amino acid higher biological values were obtained than were realized from the basal 12 per cent protein ration. No significant differences existed, but the trend toward higher values with increased lysine was evident.

The biological values obtained while the animals had feed and water ad libitum were significantly higher than when the animals received water ad libitum and feed at the rate of 1.5 pounds twice daily. The reason for this was not readily apparent.

The presence of 10 milligrams of aureomycin per pound of ration did not affect daily gain, feed efficiency, feed consumption, or biological values.
ABSTRACTS OF DOCTORAL THESES, 1952-53

MASS SPECTROMETRIC DETERMINATION OF LATENT HEATS OF METALS

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A mass spectrometric technique has been developed which permits the measurement of latent heats of vaporization and the determination of transition temperatures and energies for solid to solid and solid to liquid phase changes in metals at high temperatures. The technique is applicable to a number of metals whose first ionization potentials are less than 6.5 volts and whose vapor pressures are greater than $10^{-6}$ millimeters of mercury at a temperature of 1200°C. The technique of a modification of the Knudsen effusion method of measuring vapor pressures.

The metal under study is heated in the bottom of a closed tantalum crucible and the metal vapor is allowed to effuse out through a small orifice in the top. Some of the effusing atoms strike a hot tungsten filament and are immediately evaporated. Some of the atoms become ionized in the evaporation process. These ions are analyzed and the ion current is measured in the mass spectrometer. Under constant conditions in the instrument the measured ion current of the metal under study is strictly proportional to the vapor pressure in the effusion crucible.

The vapor pressure and the crucible temperature are related to the latent heat of vaporization by the well known thermodynamic equation

$$\frac{d \ln P}{d \frac{1}{T}} = -\frac{\Delta H_T}{R}$$

where $P$ is the saturated vapor pressure at temperature $T$, $\Delta H_T$ is the heat of vaporization at temperature $T$, $R$ is the gas constant, and $T$ is the absolute temperature. Since the ion beam current in the mass spectrometer is maintained strictly proportional to the vapor pressure in the effusion crucible.

The vapor pressure and the crucible temperature are related to the latent heat of vaporization by the well known thermodynamic equation from which the heat of vaporization is found. The curve can be approximated by a straight line in the short interval of $T$ over which a set of experimental data is usually taken.

Phase transitions in the condensed state are found by noting the temperature of the crucible at which the ion current and consequently the vapor pressure remain constant for a short time during cooling or heating. This constant ion current results from the constant temperature of the metal maintained by the energy absorbed or released in the transition process.

The metals used in this investigation were aluminum, praseodymium, and neodymium. The aluminum was stated by the supplier to be 99.75 per cent pure. Spectrographic analysis of the praseodymium and neodymium showed the presence of minute quantities, less than 0.1 per cent, of other metals, principally other rare earths.

An average latent heat of vaporization of aluminum metal was found from six determinations to be $78.70 \pm 0.39$ kilocalories per mole at a temperature of $1059^\circ$C. This determination is in agreement within experimental error with a single previous determination made using a controlled boiling point method at $1676^\circ$C. No other direct experimental values were found in the literature.

The heat of vaporization of praseodymium metal was measured and values were found which agreed within experimental error with a previously reported value of $79.5 \pm 1.1$ kilocalories per mole. However, under some conditions of sample treatment anomalous values were obtained.

The melting point phase transition was observed at a temperature of $919 \pm 1.5^\circ$C. The heat of vaporization of neodymium metal was found to be $69.3 \pm 0.4$ kilocalories per mole at $1075^\circ$C and $72.9 \pm 0.5$ kilocalories per mole at $963^\circ$C. No previous measurements were found in the literature. A phase transition in the condensed state was found to occur at a temperature of $1019 \pm 2.5^\circ$C. This transition had not been previously reported.

Others at this laboratory have shown that this transition is the true solid to liquid phase change. From the above difference in the two heats of vaporization values the heat of fusion is found to be $3.6 \pm 0.7$ kilocalories per mole.

1 a. Chairman of Committee, Donald B. Hudson, Dept. of Physics.
2 a. B.S. Case Institute of Technology, Cleveland, Ohio, 1947.
b. Research Assistant, Institute of Atomic Research. This work was performed under contract with the Atomic Energy Commission.
to solid phase transition was observed in neodymium at a temperature of 869 ± 2.5°C.

The mechanism of ionization by evaporation from the surface of the hot filament was of considerable interest in the development of the mass spectrometric technique. The efficiency of the ionization process for a given metal determines the practicability of the application of the method. In addition, the present technique, when used in conjunction with the theory of surface ionization, permits the determination of unknown first ionization potentials, provided the work function of the surface is known. Work of this nature yielded values of the first ionization potentials of praseodymium and neodymium of 5.4 volts and 5.5 volts, respectively.

INHERITANCE OF RESISTANCE TO CERTAIN PHYSIOLOGIC RACES OF LOOSE SMUT, USTILAGO NUDA (JENS.) ROSTR., IN WINTER BARLEY

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Objectives of this study were to determine the mode of inheritance of resistance to specific physiologic races of Ustilago nuda in certain winter barley crosses and to determine if there were associations between resistance and morphological characters. From a long-time point of view, the ultimate objective was to obtain segregates of value for commercial production and/or further use as breeding stocks. A major portion of this study was conducted as a part of the barley improvement program of the Department of Agronomy, Oklahoma Agricultural Experiment Station, Stillwater, Oklahoma.

At the inception of this research little information was available on the reaction of winter barley varieties to specific physiologic races or collections of loose smut, U. nuda. Seven winter barley varieties that possessed either smut resistance or adaptation in Oklahoma were selected as parents and nearly all possible crosses among them were made to study mode of inheritance of smut resistance.

Inoculum of eight tentatively designated races of U. nuda was furnished by Dr. V. F. Tapke, Division of Cereal Crops and Diseases, U. S. Department of Agriculture, Beltsville, Maryland, in the form of seeds from hand-inoculated florets. Based on the smut reactions of the parent varieties seven sets or cross-race combinations were selected for the inheritance study. Parent and F₂ plants were inoculated with appropriate races by means of a continuous flow hypodermic syringes with a spore suspension in a 2 per cent dextrose solution.

Emergence of the fall-planted inoculated seed from F₂ and parent plants averaged 75.3 per cent. Correlation coefficients were calculated and all but two coefficients between seed set and emergence were positive. Only two of these values were significant. Seed set and infection percentages were significantly correlated in only three instances. Most correlation coefficients between emergence and infection percentage were negative and several exceeded the 0.01 or 0.05 level of significance.

Daily heading notes indicated no appreciable difference in time of heading between smutted and healthy plants.

Reaction of parent varieties to each of the 8 races in 1952 differed somewhat from their reaction in 1950. Harbine, which had given a resistant reaction to most races in 1950, showed susceptibility to at least 5 races. Results by other workers and from this study indicate that some of these races are very similar if not the same.

Analyses of variance indicated no appreciable difference in emergence among lines of a given parent with one exception. However, highly significant differences existed among lines in four of the seven hybrid combinations.

Analyses of data on smut infection showed no significant difference among lines of any resistant parent. Lines from the susceptible parent Ward were significantly different in all five sets in which Ward occurred. Highly significant differences among lines were obtained for the hybrids of each of the seven cross-race combinations.

1 a. Chairman of Committee, I. J. Johnson, Dept. of Agronomy.
2 a. B.S. University of Nebraska, Lincoln, Nebr., 1940.
b. M.S. Ibid., 1942.
Resistant reactions of F₁ plants from crosses in which N.C.H. 26 was the pollen parent indicate that resistance in N.C.H. 26 was dominant, and substantiate the findings of previous workers who reported that the reaction of an F₁ plant was dependent upon the nature of the embryo rather than the maternal tissue.

Infection percentages were based on the total number of smutted and clean plants in each line. Partially smutted plants were considered only half smutted for the resistant parent and hybrid lines in four sets since the total numbers of smutted and healthy heads on the "partials" were almost equal.

No genetic interpretation could be made for the N.C.H. 26 x Ward cross inoculated with race 6.

Resistance of Dohadak to race 4 in the cross with Ward appeared to be due to relatively few genes. An acceptable fit was found to a 9 resistant to 7 susceptible ratio.

The crosses N.C.H. 26 x Dobaku and N.C.H. 26 x Dohadak were inoculated with race 7. When the infection range of the resistant parent, N.C.H. 26, was used to establish the resistant class for the F₃ lines in the Dobaku cross, then an acceptable fit to a 9 resistant to 7 susceptible ratio was obtained. However, this method of establishing the resistant class may not be justifiable since the F₃ distribution indicates a more or less continuous variation. In the cross with Dohadak, when the infection range of N.C.H. 26 was used to delimit the combined homozygous and heterozygous resistant class, an acceptable fit to a 3 resistant to 1 susceptible ratio was obtained. However, this would mean that the segregating class would fall within the infection range of the resistant parent and such an explanation does not appear sound.

Hybrid and parent lines of the cross Harbine x Ward were tested against races 3, 4, and 6 but both parents proved to be susceptible to races 3 and 6. By using the point where the distribution curves of Harbine and Ward intersect (25 per cent infection) to divide the F₃ lines into classes, a good fit to a ratio of 9 susceptible to 7 resistant was obtained from the inoculations with race 4. However, since the distribution curve for the F₃ lines does not show a definite break, this classification and possible genetic interpretation may not be justified.

All morphological characters studied appeared to be independent of reaction to loose smut although the probability value for the association between smut reaction and seed covering was only 0.05 to 0.10.

Individual F₃ plants were saved from many of the lines which showed a resistant reaction. Certain of these are being grown for further selection of desirable agronomic types having resistance to one or more races of loose smut.

ANOPLURA AND MALLOPHAGA INFESTING MAMMALS OF IOWA

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The known Anoplura and Mallophaga affecting the mammals of Iowa number 61 species and subspecies. Of this number, 36 belong to the order Anoplura, the sucking lice, and 25 to the order Mallophaga, the chewing lice. The Anoplura are distributed among 4 families and 11 genera and the Mallophaga among 3 families and 13 genera. Lice are of considerable economic importance, since some species are capable of transmitting disease, some serve as intermediate hosts for other parasites, and all species when abundant may cause irritation and loss of weight to the host.

The chief purpose of this work it to bring together the records of lice species which occur on mammals in this region, to present their synonymy together with a brief description of all species concerned, and to develop a usable well-illustrated key to these species.

Various sources were utilized in compiling the Iowa list. The literature was examined for records from Iowa host species. Museum skins were inspected for lice, and field collecting of mammals was done. In addition, a study was made of various mounted slide collections of other workers.

This is not a revisionary work. The tax-
onomy is conservative and does not depart radically from that of accepted present-day authorities. There are noted a number of instances where the taxonomy is still unsatisfactory, but must await later revision.

The family Haematopinidae of the order Anoplura is represented by one genus, Haematopinus Leach, which includes 4 species that occur on domestic animals. One of these has not been reported from Iowa but is differentiated because of its possible extension into this area.

The Hoplopleuridae is represented by three subfamilies, Enderleinellinae, Hoplopleurinae, and Polyplacinae. In the first subfamily, 4 species of Enderleinellus Pfenningholz, all ectoparasites of the family Sciuridae, are included. One species of Haematopinoides Osborn from the mole and 6 species of Hoplopleura Enderlein, with a broad distribution among the Rodentia, comprise the representatives of the Hoplopleurinae. The Iowa Polyplacinae consist of 4 species of Polyplax Enderlein on members of the Muridae and Cricetidae and three species of Neoaeematopinus Mjöberg on the Sciuridae.

The genera Haemodipsus Enderlein, Linognathus Enderlein, and Solenopotes Enderlein, with 2, 6, and 3 species, respectively, represent the family Lino- gnathidae. Haemodipsus occurs on rabbits and hares of the family Leporidae, Linognathus on domestic animals of the order Artiodactyla with the exception of one species found on the dog, and Solenopotes on deer and cattle, families Cervidae and Bovidae, respectively.

The family Pediculidae is divided into the subfamilies Pediculinae and Phthirinae which are represented by Pediculus Lin- naeus and Phthirus Leach, respectively. These genera include the sucking lice of man.

The suborder Amblycer.a of the Mallo- phaga contains representatives of the families Boophilidae and Gyropidae. The first family contains a single species of the genus Heterodoxus Le Souef and Bullen, found on the dog. The latter family is represented in Iowa by the two genera Gy- ropus Nitzsch and Gliricola Mjöberg each having a single species found on the guinea pig.

The other 22 species of Mallophaga present in Iowa are distributed in 10 genera of the family Trichodectidae. Trichodectes Nitzsch contains species from the dog and raccoon. The 4 species of Neotrichodectes Ewing are restricted to members of the family Mustelidae. Two species of Stachiella Kéler are found on Mustela species. The Suricatoecus Bedford is represented by one species on Canidae, Feli- cola Ewing by two species on Felidae, Geomyoecus Ewing by one species on Geomyidae, and Eutrichophilus Mjöberg by a species on porcupines of the family Erethizontidae.

Six species are considered in the genus Bovicola Ewing, 5 of which are economically important species on domestic animals. One species of Holakartikos Kéler from the goat and two Tricholipeurus Bed- ford species from deer complete the known representatives of the Trichodectidae of Iowa.

Some of the important key characters for the identification of the Anoplura are the thoracic sternal plate, the paratergal plates, the second abdominal sternite, and the structures of the genitilia. The female genitalia characters found to be of most value are the shape and bristling of the gonopod and the apical lobe. In the male, the shape of the genital plate, the shape and bristling of the genital tubercle, and the shape of the parameres are of paramount importance in distinguishing the species.

For the Mallophaga, the spiracles, the shape of the head, the antennae, the bris- tling of the abdomen, and the characters of the genitalia are valuable diagnostic character- acters. The female gonopod usually offers good generic characters and is very useful in the identification of species. The sclerotized parts of the male genitilia, parameres, basal plate, endomeral piece, and the aedegus, offer valuable key char- acters.

Fifteen plates containing 146 figures are contained in the thesis. One of these plates depicts the structural details of an anopluran, Neohaematopinus scurinus Mjö- berg, showing a labelled full dorsal- ventral view. Another plate shows the structural parts of a typical trichodectid, Trichodectes canis (de Geer). In the other plates, only certain structural details of value in identifying the various species, such as genitalia, head, paratergites, or sternal plate, are illustrated.

Keys for the ready identification of fam- ilies, subfamilies, genera and species of both the Anoplura and Mallophaga of Iowa are included. Each species is accompa- nied by the type-host designation, a de- scription which includes the more impor- tant recognition characters, and a brief general discussion of its distribution, Iowa recor- de, economic importance, and sys- tematic position.

A host-index to the lice found on mam- mals of Iowa is also presented, along with tables depicting the distribution and host association of the lice on the various groups of mammals.
ABSTRACTS OF DOCTORAL THESES, 1952-53

ALUMINUM-VANADIUM SYSTEM

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Department of Chemistry

The nature of the aluminum-vanadium system has been reported on the basis of thermal, microscopic, chemical and X-ray evidence. The system contains six different solid phases at ambient temperatures: the four intermediate phases being peritectic in nature. Phase properties are summarized in Table 1.

The effect of composition upon density can be represented by a series of straight lines; the phase boundaries of the aluminum-vanadium system seem to have some correlation with the discontinuities in slope of these straight lines. The addition of 20 weight per cent aluminum has little effect on the hardness of either as-cast or cold-worked vanadium. All hardness values observed for alloys containing up to 20 per cent by weight aluminum fell within 10 points of 60 on the Rockwell "A" scale.

On the other hand, the addition of vanadium to aluminum has a profound effect on the hardness of the metal. The arc-melted alloys were cold pressed under 50 thousand psi. and reduced as much as 50 per cent in thickness. A surprising feature of these alloys is that upon annealing in vacuo at 600°C for 24 hours the cold-worked metal became harder rather than softer. This is attributed to the development of a brittle peritectic compound (such as Al₁₁V) whose formation was suppressed during the rapid cooling of the arc-melting furnace.

Aluminum will dissolve less than 0.5 per cent vanadium in solid solution, while vanadium will dissolve up to 25 per cent aluminum at room temperature. A maximum solid solubility of 35.3 per cent aluminum in vanadium occurs at 1670°C. Of the four intermediate phases, only δ (Al₁-V) shows an appreciable solid solubility range (47 to 55 per cent vanadium at 1360°C); this solubility range decreases with decreasing temperature and is almost negligible at room temperature. The solid solution phase, (V), is the primary phase to crystallize from the melt in all alloys containing more than 50 per cent vanadium.

The crystal structure of each phase was pursued short of quantitative intensity measurements, and an unambiguous formula is provided for each of the intermediate phases. A correlation of the various phase structures indicates that a marked tendency toward super-lattice formation exists in the aluminum-vanadium system. An aluminum atom exhibits a preference for four nearest vanadium neighbors and four nearest aluminum neighbors arranged tetrahedrally.

Table 1. Summary of Phase Properties

<table>
<thead>
<tr>
<th>Phase</th>
<th>(Al)</th>
<th>a(Al-V)</th>
<th>b(Al-V)</th>
<th>Y(Al-V)</th>
<th>6(Al-V)</th>
<th>(V)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Formula</td>
<td>Al₁₁V</td>
<td>Al₈V</td>
<td>Al₈V</td>
<td>Al₈V</td>
<td>Al₈V</td>
<td></td>
</tr>
<tr>
<td>Lattice const. (Å)</td>
<td>a₀ = 4.0496</td>
<td>a₀ = 14.586</td>
<td>a₀ = 7.718</td>
<td>a₀ = 5.3434</td>
<td>a₀ = 9.207</td>
<td>a₀ = 3.031</td>
</tr>
<tr>
<td>Space group</td>
<td>T₄h - Fd3</td>
<td>D₄h - C2dìc</td>
<td>D₄h - F4/mmm</td>
<td>T₄₄ - I₄₃m</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Atom/unit cell</td>
<td>4</td>
<td>4</td>
<td>56</td>
<td>16</td>
<td>52</td>
<td>2</td>
</tr>
<tr>
<td>Structure</td>
<td>A₁</td>
<td>D₀₂</td>
<td>D₄₃</td>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Paritectic temp.</td>
<td>660°C</td>
<td>685°C</td>
<td>735°C</td>
<td>1360°C</td>
<td>1670°C</td>
<td>1825°C</td>
</tr>
</tbody>
</table>

a Melting point of pure vanadium.
b Lattice constants of (V) saturated with δ (Al₁-V) and (Al) saturated with a (Al₁-V).
c Highest symmetry group of three possible groups.
d Strukturbericht designation.
e No analogous compound reported.
The Hall effect in metallic lanthanum, cerium, praseodymium, neodymium, dysprosium, and erbium was studied in the temperature range from 20.3°K. to 300°K. Gadolinium, erbium, and dysprosium, which become ferromagnetic, were studied quantitatively only above their respective Curie temperatures, with gadolinium being studied from 30°C. to 350°C. Below the Curie temperatures, only the sign of the Hall effect was determined.

The Hall effect was measured using an a.c. method operating at 100 c.p.s. A high gain, low noise, narrow band amplifier was used to amplify the Hall voltage. Temperature control was achieved by varying the boiling rate of either liquid nitrogen or liquid hydrogen and passing the evaporated gas over the sample. Temperatures throughout the range from 20.3° K. to 300° K. could be attained in this manner.

Hall coefficients were measured at various temperatures and the results were plotted as functions of temperature for each metal. Results of the investigation for each metal are summarized below.

1. Lanthanum exhibited an unknown crystal structure and the magnitude of the Hall coefficient was strongly dependent on heat treatment. As the metal was received, its Hall coefficient at room temperature was 0.35 x 10^-12 volt-cm/amp-oersted; after annealing it was about 0.8 x 10^-12 volt-cm/amp-oersted, and it was changed by further annealing. The Hall effect showed some rather large variations in magnitude with temperature but remained negative in sign at all temperatures studied.

2. Cerium showed only the face-centered cubic structure at room temperature after either annealing or cycling to low temperatures. The room temperature value of the Hall coefficient after annealing was 1.81 x 10^-12 volt-cm/amp-oersted and this was reproducible for various samples to better than 1 per cent. The value at room temperature after the first and subsequent cycles to low temperatures was +1.41 x 10^-12 volt-cm/amp-oersted. Reannealing raised this back up to the higher value.

The Hall coefficient, which was positive at all temperatures, showed a thermal hysteresis with sharp changes in magnitude near 100°K. on cooling and near 180°K. on warming. These sudden changes could be considered evidence for the postulated shift of a 4f electron to a 5d state.

3. Praseodymium was of undetermined structure. The room temperature Hall coefficient was +0.709 x 10^-12 volt-cm/amp-oersted and was not sensitive to annealing and cooling. There was little temperature variation of the coefficient except below nitrogen temperatures and this may be due to a magnetic effect.

4. Neodymium was found to have a room temperature Hall coefficient of +0.971 x 10^-12 volt-cm/amp-oersted which was not affected by annealing and cooling. A rather complex temperature dependence was found at the lower temperatures with a small maximum near 70°K. and a sudden rise near 20°K. Both may be due to magnetic effects.

5. Gadolinium was studied in the temperature range from 30°C. to 350°C. and the Hall effect was negative throughout. After taking account of the extraordinary effect which is associated with magnetization, a value was obtained for R_0, the ordinary coefficient, of -0.4 x 10^-12 volt-cm/amp-oersted.

6. Dysprosium showed a negative Hall effect at room temperature and this increased in magnitude down to about 200°K. below which temperature it decreased and reversed sign. This reversal was attributed to the extraordinary effect. An approximate value for the ordinary coefficient, R_0, was found to be -1.0 x 10^-12 volt-cm/amp-oersted.

7. Erbium was found to have a negative Hall effect from room temperature down to 20.3°K. The magnitude of the coefficient at room temperature was -0.341 x 10^-12 volt-cm/amp-oersted.
ABSTRACTS OF DOCTORAL THESSES, 1952-53

SOME APPLICATIONS OF ENGINEERING VALUATION-INDUSTRIAL ENGINEERING THEORY TO COST REDUCTION IN INDUSTRY

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Department of General Engineering

An investigation was conducted, combining certain applications of the theory of engineering valuation and industrial engineering into an industrial training program. The program was designed especially to assist smaller industrial companies toward more effective cost reduction work. The purpose of the program was to secure company-wide cooperation in identifying and eliminating wasted costs from industrial products and processes. It had practical application to production planning and control, and to purchasing procedures. Problems of financial policy, selling methods, organizational changes within the company, methods of wage payment, and studies designed to make workers work harder were considered as outside the scope of this investigation.

The experimental procedure used to attain the objective was as follows: The personnel who could most effectively use the training were selected. Authority and responsibility of the trainees as a group were determined. Essential portions of the theory of engineering valuation and industrial engineering were selected, and parts not relevant to the accomplishment of the objective were excluded from the training program. Keeping in mind the limited facilities available for conduct of the program in smaller companies, training aids were examined, and those which might be used effectively were selected. A training manual was developed for the guidance of the personnel participating.

The training program was experimentally tested in two industrial plants. Following completion of the tests, an evaluation of the results was undertaken, together with description of new applications which have been made since the program was completed.

It was found that smaller industrial concerns could benefit financially by use of the training program. The training could be effectively undertaken within the plant, and without the use of elaborate training aids. Personnel with widely varied training and experienced backgrounds were able to participate effectively in the same training group. The training program appeared to act as a "catalyst" in securing improved inter-departmental cooperation by those participating, and it furnished a definite procedure which facilitated effective use of personnel in the problems investigated.

THE EFFECT OF VITAMIN B12, COBALT, AND ANTIBIOTIC FEEDING ON THE COMPOSITION OF PORK TISSUE

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Department of Animal Husbandry

Investigators in the field of Animal Husbandry have contributed vast volumes of information on the effect of rations on the growth performance of pigs, but limited data is available on the effects of dietary supplements on tissue composition. These studies were designed to study the influence of feeding vitamin B12, cobalt, phosphorus, and antibiotics on the composition of pork tissue.

In the first experiment, two groups of twelve pigs each were fed and watered ad libitum from weaning to 100 pounds in individual wire floored crates. The pigs were selected from sows that were main-
tained throughout lactation on corn-soybean oil meal rations fortified with only vitamins A and D2 and minerals containing no added cobalt. When placed on experiment, the pigs were fed a purified basal ration, consisting of Ortho 220 protein, dextrinized cornstarch, cornstarch and corn oil fortified with methionine, a complex vitamin mixture containing no vitamin B12, C.P. minerals, and trace minerals containing no cobalt. This basal ration was deficient in vitamin B12 but not deficient in cobalt, since it contained 0.10 ppm. of cobalt. To this ration vitamin B12, when added, was added at the rate of 10 micrograms per pound of ration, and cobalt, when added, was added at the rate of 3 milligrams per pound of ration. One group of pigs received 100 milligrams each of aureomycin hydrochloride, streptomycin, terramycin hydrochloride, procaine penicillin G, and sulfathalidine per pound of final ration.

The growth and performance of all pigs on all rations was quite satisfactory and no nutritional deficiencies were produced. Growth was improved by the addition of vitamin B12 in the absence of antibiotics. The apparent vitamin B12 content of the liver, spleen and kidney was increased by the addition of vitamin B12 to the ration, but the vitamin B12 content of the loin muscle was not affected. When a combination of vitamin B12 and cobalt was added to the basal ration, the vitamin B12 content of the glandular tissues was lower than when vitamin B12 was added to the ration.

The addition of cobalt, 3 ppm., to the basal ration did not improve growth, although more cobalt was found in the livers of the pigs receiving additional cobalt.

In the absence of antibiotics, the total phosphorus in the tissues increased when vitamin B12 was added to the ration.

The carcass quality, as measured by length of body, back-fat thickness, specific gravity, and per cent of lean cuts was not appreciably influenced by these treatments. The feeding of a mixture of antibiotics at high levels did not influence the vitamin B12 content of the tissues studied.

Under the conditions of these experiments, the feeding of a combination of antibiotics, 500 mg. per pound of ration, did not appreciably effect the microbial populations of the intestinal tract; if anything, the total count was increased.

In the second experiment, twenty-four pigs were individually fed from weaning to 95 pounds. The basal ration consisted of soybean oil meal, dextrinized cornstarch, cornstarch, and corn oil fortified with minerals and trace minerals, and all known vitamins except vitamin B12. This basal ration contained 0.50 per cent calcium and 0.25 per cent phosphorus. Additions of di-calcium phosphate, at the expense of some calcium carbonate and starch, to this low phosphorus ration permitted developing a high phosphorus ration containing 0.50 per cent phosphorus. Vitamin B12, when added, was added at the rate of 10 micrograms per pound of ration. One-half of the pigs received an antibiotic supplement which was the same mixture and was fed at the same level as in the preceding study. During this experiment, six pigs, on various ration treatments, were lost, one was diagnosed as having rickets and the other five as having symptoms of leptospirosis.

The growth and performance of all pigs, with the exception of those animals removed because of disease, was quite satisfactory and no nutritional deficiencies were produced. Growth was improved by the addition of the antibiotics to the rations. The feeding of phosphorus at the 0.50 per cent level improved both rate and efficiency of gain as compared to the feeding of phosphorus at the 0.25 per cent level. The feeding of antibiotics produced fatter carcasses as measured by back-fat thickness. The feeding of phosphorus produced leaner carcasses as measured by specific gravity; however, no difference in back-fat thickness resulted.

The feeding of vitamin B12 resulted in a decrease in liver weights and adrenal weights.

The phosphorus content of the liver was increased as a result of feeding vitamin B12. No difference in liver phosphorus was noted due to feeding phosphorus or a mixture of antibiotics.
A REVISION OF THE NEARCTIC SPECIES OF FUNGIVORA MEIGEN (DIPTERA, FUNGIVORIDAE)

JEAN L. LAFFOON

Department of Zoology and Entomology

Fungivora Meigen is found on all the continents and is a common genus in North America. The Nearctic species have not been treated comprehensively for more than 40 years and the existing systematic literature is inadequate for their accurate identification.

A taxonomic study was made of the Nearctic species of the genus. Over 9,500 Nearctic and 500 Palaearctic specimens were studied. This material was obtained from 31 institutional and 18 private collections in North America and from five institutional and three private collections in Europe. The most important depositories of the Fungivora used in the study are the British Museum, California Academy of Sciences, Canadian National Collection, Cornell University, Museum of Comparative Zoology at Harvard College, Iowa State College, University of Massachusetts, Academy of Natural Sciences of Philadelphia, United States National Museum, and the personal collection of the writer.

Ninety-six Nearctic species are recognized, and a description of one additional unrecognized species is included. Forty-six new species are characterized. Thirty-three new cases of synonymy are established in the genus. Two other names previously included are made synonyms of a species in another genus. One species is definitely transferred to another genus for the first time. Comparisons of European and Nearctic specimens showed that 21 species of North American Fungivora also occur in Europe. Twenty of these 21 are recorded from either Alaska or Canada, or both. Only four of the 21 have previously been recognized as occurring in both the Nearctic and Palaearctic regions.

Several characteristics previously unused for diagnosis of North American Fungivora were found to be of taxonomic value. The numbers of setulae on the radial vein before the radial sector and on the medial vein before the radial-medial crossvein are frequently helpful in species recognition. The ratio of height to length of the anepisternum shows considerable variation within the genus. Some species possess a mid tibial anterodorsal bristle which is absent in other species. The length of the setae on the central portion of the posterior surface of the hind coxa is sometimes useful in identification.

Within a species the coloration of the hind tibial setulae is fairly constant, nearly all the setulae being dark brown in some species, while others possess pale setulae on some areas of the tibia.

The primary criterion used for distinguishing between species is the presence of differences in the male terminalia. Some of these structures are figured for all except two of the recognized species. The female cerci of 18 species are illustrated. Several other figures of characters of taxonomic value are included.

A satisfactory scheme for dividing the genus into subgenera was not found. For purposes of convenience in the construction of the keys, the genus is divided into six artificial groups. Some species assigned to one group are probably more closely related to species in other groups on the basis of certain characteristics, especially the male terminalia.
The dietary essentiality of unsaturated fatty acids for young dairy calves was studied by feeding a lipid-free, semi-synthetic milk containing vitamin-test casein, C. P. Lactose, minerals and vitamins. Five of the calves on the lipid-free ration received lipid supplementation subsequent to eight weeks of age; three other calves in this group received lipid supplementation after the twelfth week. Twelve other calves received a similar diet plus various lipids from birth. Weight records were kept and clinical observations were made daily on each calf. Blood plasma samples were analyzed for total fatty acids, "Allen fat", phospholipids and for linoleic, linolenic, and arachidonic acids.

Fat deficiency syndromes first appeared in the calves after six weeks on the lipid-free diet, and were quite severe in 50 per cent of the calves after about eight weeks. The calves receiving no fat had a scaly dandruff which was most concentrated across the shoulders and along the back and tail. The hair remaining on the body was long, dry and lacked the luster of the hair on the calves receiving lipids. Also, alopecia was occasionally noted on the neck and tail of calves on the lipid-free diet. Diarrhea became more common as the calves approached 56 days on the lipid-free milk. After various lipids were introduced into the rations of calves on the lipid-free diet at 8 and 12 weeks the dandruff condition was alleviated, the skin became more oily, a smooth hair coat began to appear, the calves seemed to become more alert. The loss of hair ceased and new hair soon appeared on denuded areas. Satisfactory response to 15 g. of methyl esters and 15 g. of pork liver fat were observed although the responses were not so spectacular as when butter oil or hydrogenated soybean oil plus lecithin was fed.

Gain in weight of calves on the lipid-free ration was greatly retarded. The mean weight gain from 0 to 56 days was 10.9 pounds for calves fed the lipid-free milk as compared to 30.4 for those which received an isocaloric diet containing 1.8 per cent hydrogenated soybean oil and 0.2 per cent lecithin. Inclusion of only hydrogenated soybean oil promoted greater weight gains than the lipid-free diet but this fat singly was not so effective as when lecithin also was included. Results indicated that lecithin is ineffective as the sole lipid source.

The mean blood plasma "Allen fat" values during the period from 21 to 56 days were 23 and 162 mg. per 100 ml. for calves on lipid-free and lipid containing rations, respectively. The blood fat levels increased very rapidly when lipids were introduced into the rations of calves subsequent to the lipid-free ration. Calves receiving hydrogenated soybean oil as the only lipid supplement had lower total plasma "Allen fat" values than did calves receiving hydrogenated soybean oil and lecithin.

Blood plasma phospholipids were consistently lower in the calves on the lipid-free diet. The mean phospholipid values of calves on the lipid-free ration and on the lipid-containing ration during the 21 to 56 day period were 54 and 138 mg. per cent, respectively. It is also noteworthy that calves which had received hydrogenated soybean oil plus lecithin had slightly higher phospholipid values than calves which had received only hydrogenated soybean oil.

The mean total fatty acid values during the period from 21 to 56 days were 22 and 143 mg. per 100 ml. for calves on the lipid-free milk and lipid-containing milk, respectively. During the same period, the linoleic, linolenic, and arachidonic acid values, respectively, expressed in mg. per cent, were 75.6, 1.8, and 4.1 for calves fed lipids and 2.2, 0.3, and 1.3 for calves on the lipid-free diet. The plasma linoleic acid values of calves on the lipid-free ration declined sharply after one week and remained consistently low throughout the experimental period. Linoleic acid values were significantly lower in the lipid-free group, and arachidonic values were only slightly lower in the lipid-free group. The linolenic acid values, however, were low and variable in every instance regardless of diet.
Cotton defoliation is the removal of leaves by chemical treatment, a relatively new cultural practice brought to prominence by the advent of harvesting machinery. Defoliation is necessary for successful machine harvesting, but also produces other benefits such as aiding insect control, preventing boll rot, and hastening the opening of bolls. Defoliation trials have been in progress for a little over a decade, but, overall, the previous attempts have been too variable to be satisfactory. The study reported here involved field and greenhouse experiments in an attempt to obtain an indication of the nature of chemically induced abscission.

Applications of commercial and experimental defoliants were made by airplane, tractor, and hand sprayer, and by immersion of blades or distal tips of petioles. The morphology of natural and induced abscission was studied from sections of cotton nodes, and the effect of maturity, temperature, girdling, and anti-auxins on the abscission of leaves or deblated petioles was studied.

It was noted that all of the compounds tested caused varying amounts of damage to the tissues. A few of the newer compounds stimulated leaf-fall with a minimum of killing but with pronounced color changes which are like the changes of senescence. It is thought that defoliants of this type will prove most satisfactory.

As has been a general observation in defoliation, leaf maturity was found to be the most critical factor in obtaining good results. When expanding leaves and mature leaves were treated, the immature leaves dropped more slowly, and 20 per cent fewer such leaves had dropped at the end of the experiment. In the field, anything which caused the plants to make excessive growth or set fruit irregularly, such as insect damage or dry weather, reduced defoliation about 20 per cent. Relative fruitfulness also seemed to be important, as perfect defoliation was obtained only in heavily fruited, mature cotton.

Induced abscission was found to have a Q10 of about 2 over the range from 20°C to 30°C. From 10°C to 20°C, the Q10 was greater than 2, and at 5°C the defoliant used had no apparent effect on abscission. Temperature is critical in certain areas, such as the High Plains region of Texas, where growers usually wait two or three times longer for the leaves to fall as compared to warmer areas.

Induced and natural abscission appeared to be alike in morphology. The first sign of abscission, either naturally or chemically induced, was a break on the abaxial surface of the petiole base. The break usually extended inwardly to the vascular strand, but abscission beyond this point, although involving separation of intact cells, followed some cell division. It could not be determined which aspect of the process is the most important, but both phenomena are associated in good defoliation responses because only green, living petioles are ever completely severed.

Experiments with the treating of deblated petioles with certain anti-auxins and defoliants indicated that the anti-auxins used are ineffective abscission agents, whereas all defoliants tested promoted abscission of the petioles. Further tests, including the removal of a strip of bark above and below the node, showed that certain defoliants apparently move to the abscission zone and seemed to be abscission inducing agents per se.

The likeness of defoliation and natural abscission in terms of maturity requirement, temperature requirement, and morphology leaves no indication that the two processes differ. The apparent ineffectiveness of anti-auxins in inducing abscission is further evidence that the lack of auxin does not fully explain leaf-fall. Natural leaf-fall is known to follow senile changes in the blade, and it is thought that a thorough study of the physiology of senescence may help in determining the nature of basic defoliation processes.
VARIATION AND ITS EVALUATION WITHIN AND AMONG STRAINS OF BROMUS INERMIS LEYSS1

KENNETH LEROY LEBSOCK,2
Department of Agronomy

Agronomic performance of a number of seed lots of different strains of smooth bromegrass, Bromus inermis Leyss., was studied in replicated nurseries, space-planted, broadcast alone, and broadcast with alfalfa. The space-planted nursery consisted of seed lots of Fischer, Lincoln, Achenbach, and Eisberry, produced in different areas in the United States, together with eleven other strains from the United States and Canada, five introductions from Turkey, and three clones. Individual plant measurements were taken in this nursery for fall vigor in the year of establishment, hay vigor, height, spread, leaf width, recovery, and disease resistance. The broadcast nursery consisted of 34 entries and was designed as a split-plot with planting methods as whole plots and entries as sub-plots. Two forage harvests were made in 1952 in this nursery to obtain a measure of agronomic performance. In addition, the first harvest of the brome-alfalfa mixtures was separated into grass and legume components for a study of composition. Thirty-two seed lots were common to all methods of planting. Objectives were to study plant-to-plant variability, extent of genetic variation, and degree of relationship among agronomic characteristics in the space-planted nurseries, to compare strain performance under the different methods of planting, and to determine whether genetic alterations had occurred in any of the varieties as a consequence of seed production in areas away from the point of origin.

In the broadcast experiment entries differed significantly for first and second harvest and for annual total yields of bromegrass sown alone. First harvest yields varied from 1.46 to 2.26 tons of dry weight per acre. Southern strains were superior to those of northern origin at both harvests, but actual differences in second cutting yields were small. At the first harvest of the grass-alfalfa mixtures, entries varied significantly in quantities of grass produced in combination with alfalfa. Percentages of alfalfa ranged from 62.2 to 85.9 per cent, with Mandan 404 the highest and Fischer (Jensen) the lowest. The more vigorous southern strains produced greater quantities of grass in the mixtures than intermediate and northern types. No significant differences among entries were found when first, second, and annual total yields of the mixtures were considered. It appeared that alfalfa tended to mask bromegrass strain differences.

In the spaced-planted nursery highly significant mean differences among entries were obtained for all characters studied. Southern strains exceeded northern strains in mean fall vigor, hay vigor, height, spread, and recovery. Superiority of southern strains in capacity to establish vigorous seedlings was especially outstanding. Some seed lots of Lincoln and Achenbach differed significantly in mean fall vigor, hay vigor, and spread in comparisons with the experiment station standards. Fischer seed lots differed significantly in rate of spread. However, all seed lots of each of the four varieties performed similarly with respect to yield in all aspects of the broadcast experiment. Thus, it was concluded that one or two generations of seed production in areas away from the source of origin had essentially no effect on inherent forage production capacity.

Relative plant-to-plant variability of clones and of plants from cross-pollinated seed was studied by analyses of variance for fall vigor, hay vigor, height, spread, and leaf width. Seed-derived plants exhibited much more variability than the clones. Estimates of genetic variation obtained by comparison of mean-within plot variances of clones with that of seed-derived plants were 60, 71, 67, and 67 per cent for hay vigor, height, spread, and leaf width, respectively. More than one-half of the observed total variability for fall vigor was environmental in nature. These high estimates of genetic variation indicate that some genetic advance might be expected by phenotypic selection for such characters.

Intercharacter associations were studied by calculation of simple, genetic, and en-

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ABSTRACTS OF DOCTORAL THESES, 1952-53

Vigor and environmental correlation coefficients. Phenotypic associations of hay vigor with fall vigor, height, spread, and recovery were positive and highly significant ("r" values ranged from 0.757 to 0.945). It was concluded that spaced-plants can be evaluated adequately by assigning a single vigor score at hay stage. A low, non-significant negative association (r = -0.297) between hay vigor and leaf width was obtained. More detailed calculations of genetic correlations provided little additional useful information.

Methods of planting were compared by calculation of correlation coefficients and analyses of entries x methods of planting interactions. Interactions were non-significant for first cutting and total annual yields, indicating that seed lots performed similarly whether broadcast alone or with alfalfa. However, a significant interaction at the second cutting was obtained, indicating that entries reacted differentially to the two methods of planting at that time. First harvest yields of brome alone were significantly associated with the grass fractions and with total first cutting yields of the mixtures (r = 0.580 and 0.349, respectively). A low correlation of 0.198 indicated little association between total annual yields of entries sown alone and with alfalfa. Variations in grass fractions appeared to be more important than alfalfa components in determining differences in total first harvest yields. Hay vigor and its associated traits observed in the space-planting were positively and significantly correlated with first and second cutting and total annual yields of brome sown alone in solid stands ("r" values ranged from 0.351 to 0.774). Hay vigor also was highly correlated with the brome fractions of the mixtures. Hay vigor was only weakly correlated with total annual yields of the mixtures (r = 0.231). It was concluded that the diverse group of strains was evaluated similarly by the three planting methods if only grass components were considered, but strain differences were concealed by the relatively large contribution of alfalfa to the total yields of the grass-legume mixtures.

STRUCTURES OF SOME BRIDGE TYPE COMPOUNDS

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The low temperature, single crystal X-ray study of trimethylaluminum showed that the molecule is a bridge type dimer, the point group symmetry of which is D_{4h}:

\[ \begin{align*}
\text{H}_3 \text{C} & \quad \text{Al} & \quad \text{C} & \quad \text{CH}_3 \\
\text{H}_3 \text{C} & \quad \text{C} & \quad \text{Al} & \quad \text{CH}_3
\end{align*} \]

The four methyls external to the four membered ring and the two aluminum atoms are in a plane, the two other methyls being symmetrically placed above and below this plane. The configuration about the aluminum atoms is roughly tetrahedral. This structure is in agreement with the rule that in 'electron-deficient' bonding the metal atom will tend to utilize all its low energy orbitals. The predictions of Rundle as to molecular shape and dimensions are completely satisfied. The thesis goes on to show that all the following are erroneous: the ethane type structure supported by the electron diffraction study of the gaseous phase, the trimer suggested by Longuet-Higgins involving "protonated" double bonds, and Pitzer's concept of hydrogen bonding. Longuet-Higgins' "methylated" double bond is viewed as nebulous and Gillespie's recent suggestion that the bridge carbon is using d-orbitals in bonding is unreasonable.

The angles within the four membered ring, 70° at the bridge carbons and 110° at the aluminum, are analogous to those found in dimethylberyllium; this would suggest that they characterize 'electron-deficient' compounds. The external angle between the two aluminum to nonbridge carbon bonds is quite large, 124°. An explanation for this in terms of the orbital configurations is set forth. The aluminum-carbon distances within the four membered ring, 2.23 Å, are different from those external.
ternal to it, 1.99Å. The latter is to be compared with 2.03Å, the sum of the normal tetrahedral radii. If Pauling's rule is used to calculate bond orders: R(1)-R(n) = 0.300 log n, then the bonds within the ring are of bond order one half.

The aluminum-aluminum distance of 2.55Å versus the 2.52Å, which is double the tetrahedral radius of aluminum, suggests metal-metal interaction. This is, however, to be viewed as unlikely; the distance is a consequence of the tendency of the aluminum atoms to achieve maximum orbital overlap with the single bridge carbon orbital. A molecular orbital treatment suggests that there is sufficient binding energy to hold the dimer together without utilizing metal-metal interaction.

Pertinent crystallographic data follow:

- \( a_0 = 13.0 \text{Å} \)
- \( b_0 = 6.96 \text{Å} \)
- \( c_0 = 14.7 \text{Å} \)
- \( \beta = 125^\circ \)

The space group has been shown to be unambiguously \( C_{2v} - C2/c \). There are four trimethylaluminum dimers per unit cell.

The simple compound, beryllium chloride, offers an opportunity to study halogen bridge bonding. Beryllium chloride is isomorphous with dimethylberyllium and silicon disulfide. The configuration about the beryllium is essentially tetrahedral. The Cl-Be-Cl bond angle within the four-membered rings is 98.2°, which is less than the tetrahedral angle, instead of more, as in dimethylberyllium. The closeness of the bond angles in beryllium chloride to those in the covalent compound silicon disulfide would indicate that each beryllium-chlorine bond contains an electron-pair. This is shown to be entirely reasonable by examination of the orbit configuration. Orbital and bond directions are not viewed as coincident. Hence, chlorides isomorphous with 'electron-deficient' metal alkyls are not to be classified as 'electron-deficient' compounds.

METAL CHELATES OF CYCLOHEXENEDIAMINETETRAACETIC ACID

THOMAS CLEMENT LOOMIS

Department of Chemistry

The sequestering agent ethylenediaminetetraacetic acid (EDTA) has become, in recent years, an important reagent in the field of analytical chemistry. The present work was undertaken to investigate the chelating properties and possible analytical applications of the analogous compound 1,2-cyclohexenediaminetetraacetic acid (CDTA).

The ionization constants of CDTA at 25.0°C. and an ionic strength of 0.1 were determined from pH titration curves of the acid with potassium hydroxide. Similar pH titration curves of CDTA in the presence of a fifteenfold excess of a salt of lead or an alkaline earth metal provided data for the calculation of the stability (association) constants of the complexes formed by CDTA with these metals. These constants were likewise measured at a temperature of 25.0°C. and an ionic strength of 0.1.

The stability constants of the complexes formed by CDTA with some heavy metals were determined from measurements of the equilibrium constants of reactions involving competition between CDTA and a polyamine complexing agent, triaminotriethylamine, for ions of the heavy metal. These reactions were followed by means of pH measurements made at 25.0°C. and an ionic strength of 0.1. In order to evaluate these equilibrium constants in terms of the stability constants of the CDTA-
heavy metal complexes, the ionization con-
stants of triaminotriethylamine trihydro-
chloride and the stability constants of some
heavy metal complexes of triaminotriethyl-
amine also had to be determined at 25.0°C.
an and an ionic strength of 0.1 from pH
measurements.

A comparison of the measured stability
constants of CDTA chelate complexes with
those reported in the literature for corres-
ponding EDTA complexes shows that CDTA
forms more stable complexes with nearly
all of the metals investigated than does
EDTA. The complexing action of CDTA
appears to be no less general than that of
EDTA. The CDTA complexes studied (in
order of increasing stability) were those
formed with barium, strontium, magnes-
ium, calcium, manganese (II), lead (II),
zinc, cadmium, cobalt (II), copper (II),
and nickel (II). The order of magnitude of
these stability constants was found to vary
from $10^7$ for the barium complex to $10^{24}$
for the nickel complex.

The investigation of the possible analy-
tical applications of CDTA was limited to
the study of the complexometric titration
of various common metals. The direct
titration of copper in ammoniacal solution
with CDTA using Murexide (ammonium
purpurate) as the indicator was found to
yield a very sharp end-point. Similar di-
rect titrations of magnesium and zinc us-
ing F241 (Eriochrome Black T) as the in-
dicator also provided highly sensitive end-
point indication. Calcium, strontium, lead,
zinc, cadmium, manganese, iron, cobalt,
and nickel were all titrated indirectly by
the addition of an excess of CDTAfollowed
by titration of the excess CDTA with a
standard magnesium solution. Due to their
lack of specificity, however, all of these
titrations listed above are of practical use
only if the metal to be determined has been
isolated by a suitable separation procedure.

A method was developed for the separa-
tion of lead and copper from complex mix-
tures by simultaneous electrodeposition
from a nitrate-perchlorate-persulfate sol-
ution. The copper was determined gravim-
etrically and the lead was determined
volumetrically by the indirect CDTA titra-
tion mentioned above. Using this lead and
copper determination in conjunction with
conventional gravimetric separation pro-
cedures, a rapid method for the analysis
of tin, lead, copper, iron, nickel, and zinc
in brass and other copper-base alloys was
devised. The lead, iron, nickel, and zinc
determinations were all concluded volume-
trically using indirect CDTA titrations.
The described method offers the advantage
of speed and convenience with no sacrifice
in accuracy compared to the usual tedious
gravimetric procedures. Results obtained
on three typical copper-base alloys are
shown.

Standard solutions of CDTA were found
to show an appreciable loss in strength
during the first few days following prepara-
tion of the solution. Thereafter, such
solutions did not seriously deteriorate on
standing for periods exceeding two months.

End-points obtained in complexometric
titrations with CDTA were found to be
sharper than those encountered in corres-
ponding EDTA titrations. The titration of
magnesium with EDTA was shown to be
considerably more affected by variations
in the pH of the sample solutions than was
the corresponding titration with CDTA.
In both of these respects, CDTA appears
to be the superior reagent for complexo-
metric titrations.

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THE REACTIONS OF RADICALS PRODUCED IN THE DECOMPOSITION
OF ALIPHATIC AZO COMPOUNDS AND DI-ALKYL PEROXIDES

GEORGE BOND LUCAS
Department of Chemistry

In the study of free radicals in solution,
those steps which affect the rate of reac-
tion frequently do not influence the nature
of the products formed. Thus, in any in-
vestigation directed towards elucidating
the course of reaction of free radicals in
solution, both the rate determining and
product determining steps must be consi-
dered. The nature of the work herein
presented is the investigation of the pro-
duct determining steps in the decomposi-
tion of two types of organic free radical
sources, azo-bis-nitriles and tertiary al-
ky1 peroxides. Both are known to cleave,
in the rate determining step in the solu-
tions used, by a first order process. The

1 a. Chairman of Committee, George S.
Hammond, Dept. of Chemistry.
b. Doctoral Thesis No. 1352. Submitted
December 12, 1952.

2 a. E.F. Tulane University of Louisiana,
New Orleans, La., 1948.
b. Graduate Assistant, Industrial
Science Research Institute.
nature of the products are determined by fast reactions of these radicals which are produced by a unimolecular scission. Both azo-bis-diethylacetonitrile and azo-bis-dimethylacetonitrile, when decomposed in pure toluene or tetralin, evolve a quantitative amount of nitrogen. The radicals produced, dimethylcyanomethyl and diethylcyanomethyl, will not attack these solvents since no products derived from solvent could be found. However, when a molar amount of chloranil equal to the molar amount of azo-bis-nitrile is present, attack upon solvent occurs and the products in Table I are obtained. The structures of all products were definitely established.

The high percentage yield of dimer is explained on the basis of a "cage effect". The two radicals, produced by the scission of one molecule, collide, not only with solvent but with each other approximately $10^{11} - 10^{12}$ times before diffusing apart. Thus there is a high probability that they may react with each other by dimerization before leaving the immediate vicinity. The high yield of dialkyl ethers of tetrachlorohydroquinone is explained by a "modified cage effect". In this case the two radicals simultaneously react with a third body, chloranil, before diffusion separates them. The mono alkyl ethers of tetrachlorohydroquinone is considered to be produced by radicals which have become kinetically free. The fact that toluene is attacked when chloranil is present but not in its absence is explained by the facile addition of a kinetically free alkyl radical to chloranil followed by a rapid hydrogen atom abstraction from solvent (toluene). A chain reaction is thereby generated.

Further evidence for a modified cage effect, or at least three body collisions, being operative in some radical reactions, is shown by the variation in the product yield when two peroxides are decomposed in the presence of each other. The tertiary alkyl peroxides studied are known to undergo the following reaction in hydrocarbon solvents (2):

$$(\text{C}_8\text{H}_{15})_2\text{COOC}(\text{CH}_3)_3 + 2\text{S} \rightarrow x(\text{CH}_3)_2\text{C} = \text{O} + y(\text{CH}_3)_2\text{COH} + \text{S-S}$$

where $x + y = 2$. Kharasch (2) had found that the ratio, $x/y$, varied over a wide range when $R$ was changed in the peroxide, $(\text{CH}_3)_2\text{COOCR}_3$. Table 2 shows the variation in $x$ when the two peroxides $(\text{CH}_3)_2\text{COOC}(\text{CH}_3)_3$ and ROOR' were mixed.

These data are interpreted to mean that there is a termolecular process occurring which involves two alkoxy radicals and a molecule of solvent. This termolecular reaction can produce either alcohol or ketone but not both and must be in competition with the bimolecular processes. No

\[ \text{C}_8\text{H}_5\text{CH}_2 + \text{C}_6\text{H}_{14}\text{O}_2 \rightarrow \text{C}_8\text{H}_5\text{CH}_2\text{OC}_6\text{H}_{14} \]

**Table 1**

<table>
<thead>
<tr>
<th>R</th>
<th>Additive</th>
<th>$R_2C(CN)N$</th>
<th>$R_2C(CN)OC_6H_{14}OH$</th>
<th>$R_2C(CN)OC_6H_{14}OC(CN)R_2$</th>
<th>$C_6\text{H}_5\text{OC}<em>6\text{H}</em>{14}OH$</th>
</tr>
</thead>
<tbody>
<tr>
<td>CH$_3$</td>
<td>None</td>
<td>73</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>CH$_3$</td>
<td>chloranil</td>
<td>46</td>
<td>2.5</td>
<td>27</td>
<td>-</td>
</tr>
<tr>
<td>CH$_3$</td>
<td>chloranil</td>
<td>38.5</td>
<td>1.9</td>
<td>28.7</td>
<td>1.7</td>
</tr>
<tr>
<td>C$_2$H$_5$</td>
<td>none</td>
<td>73</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>C$_2$H$_5$</td>
<td>chloranil</td>
<td>31</td>
<td>-</td>
<td>45.3</td>
<td>8.0</td>
</tr>
<tr>
<td>C$_2$H$_5$</td>
<td>chloranil</td>
<td>37</td>
<td>6.3</td>
<td>44.7</td>
<td>-</td>
</tr>
</tbody>
</table>

*Based on one mole of $R_2C(CN)N = NC(CN)R_2$.

*bChlorobenzene used as solvent, no toluene present.*
ABSTRACTS OF DOCTORAL THESES, 1952-53

Table 2

Percentages of Acetone in Various Systems at 127.5°C

<table>
<thead>
<tr>
<th>R</th>
<th>R'</th>
<th>Acetone</th>
</tr>
</thead>
<tbody>
<tr>
<td>(CH₃)₃C</td>
<td>(CH₃)₃C</td>
<td>16.9-17.7</td>
</tr>
<tr>
<td>(CH₃)₃C</td>
<td>(CH₃)₃C</td>
<td>23.4</td>
</tr>
<tr>
<td>(CH₃)₃C</td>
<td>(CH₃)₃C</td>
<td>20.3</td>
</tr>
<tr>
<td>C₆H₅(CH₃)₂C</td>
<td>C₆H₅(CH₃)₂C</td>
<td>20.5</td>
</tr>
</tbody>
</table>

a Equimolar in ROOR' and (CH₃)₃COOC(CH₃)₂.

b [ROOR] = 0.2[(CH₃)₃COOC(CH₃)₂]

c Concentrations such that \( k_1 [(CH₃)₃COOC(CH₃)₂] = k_2 [ROOR] \).

Suggestion is given as to which product is produced by this termolecular collision. The large variation in ketone yield from the unsymmetrical peroxides (2) compared to the significant but rather small variation obtained from mixtures of peroxides suggests that a modified cage effect is operative and of importance in determining the products.

REFERENCES


USEFULNESS OF THE HERD AVERAGE IN ESTIMATING BREEDING VALUES OF DAIRY CATTLE

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Department of Animal Husbandry

The usefulness of the herd average in estimating breeding values of dairy cattle where the cows are in a single herd may differ from the usefulness when animals from different herds are being compared. In both instances, however, the type of use and the usefulness of the herd average depend on how much of the differences between averages is genetic variation.

The material used to study the usefulness of the herd average was mainly from 293 Jersey herds on HIR test from 1943 to 1947. Records of production of Holstein, Guernsey, and Jersey herds at Iowa State College from 1938 to 1950 were used briefly. Also, sets of artificial material formed from tables of normal deviates were used to clarify some topics.

An approximate maximum-likelihood procedure appeared effective for dividing changes in yearly averages into changes in average producing ability and changes in environmental conditions from year to year. The trends for the Iowa State College herds were measured, and the Holstein herd, for example, showed an increase in average ability of 2.4 pounds of fat per year and an improvement of average environmental conditions of 2.6 pounds per year. The year to year changes in the herd averages showed considerable irregularity. The yearly herd average seemed not to measure the change in average ability of the herds at all well.

Devices such as "most probable producing ability" for adjusting cow's production records for incomplete repeatability offer only about 2 per cent to 4 per cent increase over the lifetime average in accuracy of ranking true producing abilities or breeding values of cows in the same herd. The extra labor required to attain this small increase in accuracy makes the average of the cow's records generally more useful to compare animals in the same herd. "Most probable producing ability" may be useful if the average ability of the herd has changed rapidly, if \( r \) is low, if the number of records per cow varies widely, or if information
about a cow's relatives is being used in an index.

A simple and effective use of the yearly average in a herd is to correct each record for yearly differences in environment, especially if the yearly average of the herd is changing irregularly. This can be done readily by subtracting from each record the herd average for the year in which it was produced. Improvement by selection based on an average of deviations from the yearly averages for each cow may progress as much as 20 per cent faster than that based on single records.

Differences between averages of Jersey HIR herds which exchange bulls were composed of about one-third differences in average breeding value and about two-thirds differences in average management or environmental conditions. The partitioning of the differences between herd averages was done by analyzing the variance between sisters in different herds. When the ratio of the genetic variation to the total variation is about the same as the differences between herd averages as it is within herds, which it was for the Jersey herds, the herd average has negligible usefulness either negatively to correct for differences in environments of cows in different herds or positively as credit to cows in herds producing higher than the average for the breed.

AN APPLICATION OF SEQUENTIAL TESTS TO A PROBLEM OF QUALITY CONTROL

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This investigation is concerned with the problem of quality control in situations in which 100 per cent inspection is feasible. The situation is considered in which the production process arises from a stochastic process with a finite set of states.

A particular state is the control state and certain assumptions concerning the probabilities of transitions between states are made. The produced articles are modeled by a sequence of independently distributed random variables. The distribution of the random variable corresponding to the j-th article produced is determined by the state of the production process at the time of production. The random variables corresponding to the production are observed, one at a time, in order. It is assumed that the process is initially in the state of control. The problem is to determine, on the basis of the observed random variables, when the production process has left the state of control. When it is decided that the process is no longer in control, the production is stopped and returned to the control state.

A cost structure is imposed by considering a penalty cost as a function of the measured characteristic of interest of the produced articles. A fixed cost is incurred when the production process is stopped. A cost is associated with a control procedure by considering the expectation of the present value of the cost incurred if production continues indefinitely.

It is shown that, relative to this model, a cost minimizing control procedure exists and is of a type which is termed recurrent. The idea of a recurrent control procedure is that the decision to stop the production process at any given time depends only upon the variables observed following the immediately preceding time that the process was stopped. In the course of the proof it is shown that the problem may be reduced to a conventional decision problem which considers the behavior of the procedure only until the production is stopped for the first time. The Bayes nature of the cost minimizing control procedure is proved.

Indirect use is made of these results in considering control procedures based on sequential tests. The basic idea underlying this class of control procedure is that of repeating a test until a test is conducted which terminates, with rejection of the hypothesis, that the sequence of observed random variables have the common distribution determined by the control state. For models involving two and three production states, approxima-
tions of the control procedure cost are given. These approximations are in terms of the sampling characteristics of the underlying sequential tests.

For the special case in which the random variables corresponding to the produced articles have binomial distributions, a modification of the Armitage three alternative sequential test (1) is considered as an underlying test. Approximations to the sampling characteristics of this test are given. These approximations have the same order of accuracy as the approximations given by Wald for the two alternative probability ratio test.

REFERENCE


FORECASTING COMPLETION OF THE PRE-ENGINEERING CURRICULUM AT THE UNIVERSITY OF OMAHA.

ALLEN D. MILLER,
Department of Vocational Education

The present study was devised to determine the relative importance of various factors related to student achievement, aptitude, and interest in predicting survival of students entering the pre-engineering curriculum at the University of Omaha. Probabilities of survival were computed in such a manner that the student could determine his chances in 100 of successfully completing the pre-engineering curriculum immediately after graduating from high school, after taking the university entrance examinations or, at the latest, after completing the first semester college mathematics.

The 375 students included in the investigation were graduates of Omaha, Nebraska, and Council Bluffs, Iowa, public high schools who entered the pre-engineering curriculum at the University of Omaha from September 1946 through September 1949. The criterion of survival was a passing mark in second semester calculus. Eighty-six students fell in the survival group and the remaining 289 in the attrition group.

Eighteen variables designed to measure achievement, aptitude, and interest conceivably associated with attrition-survival were available from university records. Biserial correlations were computed to determine which of the eighteen variables would be most valuable in predicting attrition-survival tendency. Eight highly significant correlations were obtained. These correlations with attrition-survival at the three stages of educational progress for which predictions were made were:

1. Upon graduation from high school, Mean high school mathematics mark 0.478,
Units of high school mathematics 0.306;

2. Upon completion of college entrance examinations, Ohio University Psychological Examination 0.386,
Cooperative English test 0.356,
Minnesota test of reading speed 0.212,
Minnesota test of reading comprehension 0.323,
Wrenn study habit inventory 0.213,
Kuder scientific interest 0.236;

3. Upon completion of first semester college mathematics First semester college mathematics mark 0.586.

Probability tables giving chances in 100 of successfully completing the pre-engineering curriculum were prepared at each of the three stages by means of the discriminant function.

A discriminant function based on the two high school variables yielded a multiple
biserial correlation of 0.498. As mean high school mathematics mark increased from 1.00 to 4.00 and the number of years of high school mathematics experience increased from one to four, chances of survival ranged from 10 in 100 to 40 in 100 predicted from the two-variable combination. A significant loss in predicting efficiency resulted when either of the high school variables was eliminated from the discriminant function. However, since the biserial correlation, based on mean high school mathematics mark alone, was much higher than that obtained from units of high school mathematics and was nearly as great as the biserial correlation from the two-variable equation, a probability table, based only on high school mathematics average, was derived. Here, probabilities of survival ranged from 12 in 100 to 38 in 100 as mean high school mathematics mark increased from 1.00 to 4.00.

In order to predict probability of survival on the basis of the college entrance test battery, a six-variable discriminant function was developed. The multiple biserial correlation corresponding to the six-variable equation was 0.430. No significant loss in forecasting efficiency occurred when cooperative English test score, Minnesota reading speed and comprehension scores, and study habits inventory score were dropped from the prediction scheme. The multiple biserial correlation based on the two remaining prediction variables, Ohio State University Psychological Examination score and Kuder Scientific Interest score, was 0.411. Since the biserial correlation based on the Ohio State University Psychological Examination score was 0.386, almost as great as the multiple biserial correlation obtained from the two-variable discriminant function, two probability tables were prepared for predicting survival from the college entrance test battery.

The probability table based on Ohio State Psychological Examination score and Kuder Scientific Interest score indicated from 6 to 46 chances in 100 of survival as scientific interest score increased from 10 to 100 and the Ohio State Psychological Examination score increased from 10 to 140. Chances of survival predicted from first semester college mathematics mark ranged from 12 in 100 to 44 in 100 as the mathematics mark increased from failure to A. When mean high school mathematics mark was used in combination with first semester college mathematics mark alone, the multiple biserial correlation was 0.630. This was the highest correlation found between survival tendency and the various combinations of variables investigated. Chances of survival ranged from 13 in 100 to 49 in 100 as mean high school mathematics mark increased from 1.00 to 4.00 and first semester college mathematics mark increased from failure to A.

According to the evidence presented in the present investigation, the most effective prediction of survival in pre-engineering is available after the student has completed the first semester of college mathematics. Although the prediction of successful completion of the pre-engineering curriculum at the University of Omaha cannot be carried out with more than a reasonable degree of accuracy, it is still possible to give advice, within limitations, to a student concerning his probability of success based on certain evidences of his ability and past achievement.
ABSTRACTS OF DOCTORAL THESES, 1952-53

EQUIVALENT FUNCTIONS OF STRATEGIES
IN THE THEORY OF GAMES

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Department of Mathematics

Consider a zero-sum two-person game with the payoff matrix A, and typical strategy vectors x and y for the two players. Let X and Y be the sets of all mixed strategies of the players, respectively, X' and Y' the sets of optimal strategies, and \( \Delta \) the value of the game.

For convenience, let all entries of a vector e, or matrix E, be 1. Matrix operations are understood throughout, and the size of e, or E, is given in context. The intersection of sets U and V is written \( U \cap V \), and the null, or empty, set is 0. Let X' be the set of all x such that \( xe = 1 \), and Y' the set of all y such that \( ye = 1 \).

Let \( U \) be the set of all u such that \( uA = \rho e \) for some \( \rho, \rho = 1 \), and V the set of all v such that \( Av = \rho e \) for some \( \rho, \rho = 1 \).

If \( U \neq 0 \), \( V \neq 0 \), then \( \rho = 0 \) or \( uA \). Conditions that \( U \neq 0 \), \( V \neq 0 \) reduce, when A is square, to the condition that the sum of the cofactors of A is not zero.

Let \( F \) and \( G \) be matrices with constant rows and constant columns, respectively, but otherwise arbitrary. Then, the following results are obtained:

1. Let \( U \neq 0 \) and \( V \neq 0 \) and \( u \in U, v \in V, B = A + F + G \).

2. Let \( u \in U \) and \( v \in V \). Then, \( X = \{ x : xA = u \} \), \( Y = \{ y : yA = v \} \).

The latter result disposes of a certain class of games, including the completely mixed games, insofar as the value and optimal strategy sets are concerned.

Two functionals are suggested by the first result. They are,

\[
m(x) = \operatorname{Min}_y (x - u)B(y - v), \quad x \in X', \quad y \in Y \quad \text{and} \quad n(y) = -\operatorname{Max}_x (x - u)B(y - v), \quad x \in X, \quad y \in Y',
\]

The following definitions are made:

If \( m(x) < 0 \) or \( n(y) < 0 \), \( x \) or \( y \) is a point of punishment.

If \( m(x) = 0 \) or \( n(y) = 0 \), \( x \) or \( y \) is a point of limbo.

If \( m(x) > 0 \) or \( n(y) > 0 \), \( x \) or \( y \) is a point of reward.

The minus sign in \( n(y) \) serves to symmetrize the wishes of the two players, for the first player will wish to maximize \( m(x) \) while the second will wish to maximize \( n(y) \). Hence, a single discussion of punishment, limbo, and reward applies equally to either of the players' viewpoints.

Let the set of all points of punishment for either player be \( P \), the set of all points of limbo be \( L \), the set of all points of reward be \( R \). In addition, let the set of all points with punishment not more than \( \rho \) be \( P(\rho) \), and the set of points with reward not less than \( \rho \) be \( R(\rho) \). Then, \( \rho > 0 \) always in either case, \( P(\rho) \) a subset of \( P \), etc. Then, the following results are shown with regard to punishment, limbo, and reward.

3. \( U \) and \( V \) are subsets of \( L \).

4. \( m(x) \) or \( n(y) \) is a homogeneous functional along a half-ray with origin \( u \) or \( v \). That is, if \( \gamma > 0 \),

\[
m(\gamma(x - u)) = \gamma m(x), \quad m(u + (x - u)); \quad n(\gamma(y - v)) = \gamma n(y), \quad n(v + (y - v)).
\]

5. \( R(\rho) \) is convex. If \( X' = X \) or \( Y' = Y \), \( X'(\rho) \) or \( Y'(\rho) \) is convex.

By means of these results, criteria for playing the game can be easily established. Let a player be required to select a strategy from a closed subset of a half-ray with origin \( u \) or \( v \). On a punishment half-ray, the player should select the strategy closest to \( u \) or \( v \), on a limbo half-ray, he may select any strategy of the subset, and on a reward half-ray, he should select the strategy farthest from \( u \) or \( v \).

It is shown that the set of all points with reward of punishment exactly \( \rho \) is the boundary of \( R(\rho) \) or \( P(\rho) \). Then, if \( XR \neq 0 \), the best way to play is to select a strategy from the convex set of tangency between \( X \) and \( R(\rho') \), where \( R(\rho') \) contains no point within a neighborhood in \( X \). Similarly, if \( XP = X \), the best way to play is to select a strategy from the convex set of tangency between \( X \) and \( P(\rho') \), where \( P(\rho') \) has no interior points of \( X \). Identical criteria hold for the other player.

The use of von Neumann's Main Theorem makes the results below easy to show.

6. \( XR \neq 0 \) if and only if \( YP = Y \).

7. \( YR \neq 0 \) if and only if \( XP = X \).

Then, by means of these results, and the criteria given above, every game which possesses an expansion is in one and only one of the following classes, and has the value and optimal strategy sets listed below.
A PROPORTIONAL COUNTER SPECTROMETER STUDY OF THE BETA-DECAY OF RADIOACTIVE S$^{35}$, Pm$^{147}$, Ni$^{68}$, and C$^{14}$

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Department of Physics

A proportional counter spectrometer, hereinafter denoted as a p.c.s., of unique design has been constructed for the purpose of measuring beta-spectra whose energies lie below a few hundred KeV. The p.c.s. is well suited for the problem in that thin and uniform radioactive sources which are essential for accurate low energy spectral measurements can be employed. The utilization of radioactive sources of low surface densities is made possible by an allowable source area of a few square centimeters and an ~ 100 percent geometrical efficiency for particle detection by the p.c.s. In addition, the p.c.s. obviates a Geiger-Muller counter window of finite thickness which is often associated with the magnetic spectrometers. The penetration of beta-particles through the Geiger-Muller counter window can lead to distortion of the beta-spectrum at low energies.

The proportional counter was filled with a 90-10 percent admixture of argon and methane to a pressure necessary for the complete stopping of all beta-particle in the counter gas. The resolution of the p.c.s. for electrons of energies above 50 KeV was better than 10 percent. Energy determination of beta-particles in the range 10 KeV to 200 KeV could be determined to within ± 3 percent. The spectrometer was calibrated with monoenergetic x-rays and the linearity of the electronic equipment associated with the spectrometer was tested with a mercury relay pulse generator. A total probable error of 4.5 percent in counting rate at a given energy was induced by counting statistics and electronic fluctuations in the single channel pulse height analyzer of the spectrometer. The upper energy end points of beta-emitters were determined with p.c.s. to within ± 2 percent of previous magnetic spectrometer measurements. The radioactive source strength required for beta-spectral studies with p.c.s. was less than 10 millimicrocuries.

The beta-spectra of S$^{35}$ and Pm$^{147}$ were measured with the p.c.s. The estimated source surface densities including source mounting material of these two carrier-free activities was approximately 10 $\mu$g$\cdot$cm$^{-2}$. The upper energy end point determinations were in excellent agreement with previous magnetic measurements on these two nuclides. The data yielded a straight Fermi plot from the upper energy end point.

1 a. Chairman of Committee, B.J. Zafferano, Dept. of Physics.

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to 10 Kev for $^{14}$C and from the upper energy end point to 15 Kev for Pm.$^{147}$

The beta-spectra of $^{14}$C and Ni.$^{60}$ were also measured with the p.c.s. A $^{14}$C source of high specific activity was prepared from CF$_3$H$_2$O$_2$ uniformly labeled. A Ni.$^{60}$ source of considerably lower specific activity was prepared from Ni$^{60}$Cl$_2$. The estimated average surface densities of these two water soluble sources including source mounting material were: $^{14}$C, 11 µgm/cm$^2$ and Ni.$^{60}$, 50 µgm/cm$^2$. The end point of Ni.$^{60}$ was found to be 63 Kev with the Fermi plot concave toward the energy axis below, 30 Kev.

The upper energy end point of C$^{14}$ was found to be in good agreement with previous magnetic measurements, but the Fermi plot of the data was concave toward the energy axis below 50 Kev. The A$^1$ correction (1) for a second forbidden transition with Fermi selection rules tended to straighten the obtained Fermi plot of C$^{14}$.

REFERENCE


STERIC AND ELECTRONIC INFLUENCES IN ORGANOLITHIUM METALATIONS;

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A survey of the history of organolithium metalations showed that little heed has been paid to steric effects in such reactions. Also, with some exceptions, (1) the role of electronic factors in bringing about secondary reactions subsequent to metalation has not been extensively studied.

It was found that 2, 4, 6-triphenylphenyllithium could be prepared from 2, 4, 6-triphenylbromobenzene by reaction either with lithium (92 per cent yield) or with n-butyllithium (7 per cent yield). This hindered RLi compound was converted into the corresponding acid by treatment either with Dry Ice (53 per cent yield) or with gaseous carbon dioxide (63 per cent yield).

2, 4, 6-Triphenylphenyllithium metalated thiophene in the 2-position in 46 per cent yield, p-bromoanisole in the 2-position in 25 per cent yield, dibenzofuran in the 4-position in 4 per cent yield and resorcinol dimethyl ether in the 2-position in 1 per cent yield. Mesityllithium metalated the latter ether in the 2-position in 35 per cent yield. In each case, the yield was determined by the amount of acid formed by carbonation of the reaction mixture.

Fluorene reacted with various RLi compounds under identical conditions to give, after carbonation, the following yields of fluorene-9-carboxylic acid: from phenyllithium, 78; from o-tolylithium, 85; from mesityllithium, 54; from 2, 4, 6-triphenylphenyllithium, 65. Similarly, triphenylmethylene gave the following per cent yields of triphenylactic acid; from phenyllithium, 6; from o-tolylithium, 8; from mesityllithium and from 2, 4, 6-triphenylphenyllithium, none. In the latter two cases, only the acid corresponding to the original RLi compound was isolated.

The reaction of trityl methyl ether with certain RM compounds was studied. The following yields of products were obtained, using in each case two equivalents of the RM compound: from n-butyllithium (mild conditions, followed by hydrolysis), 20 per cent of 9-phenylfluorene; from n-butyllithium (mild conditions, followed by carbonation), 18 per cent of 3, 3-diphenylphthalide, from n-butyllithium (forcing conditions, followed by hydrolysis), 4 per cent of 9-phenylfluorene; from phenyllithium (forcing conditions, followed by hydrolysis), 34 per cent of 9-phenylfluorene; from phenyllithium (forcing conditions, followed by carbonation), 13 per cent of 9-phenylfluorene-9-carboxylic acid; from benzylmagnesium chloride, 14 per cent of 1, 1, 1, 2-tetraphenylethane; from t-butyllithium (forcing conditions, followed by carbonation), 13 per cent of 9-phenylfluorene-9-carboxylic acid; from phenylcalcium iodide, a tar from which only triphenylcarbinol was isolated, but whose infrared absorption spectrum suggested the presence of 9-phenylfluorene.

A possible mechanism for the reaction of trityl methyl ether with RLi involves 1)
the metalation of the ether in an ortho-position; 2) attack by the resulting anion on an ortho-position of one of the other phenyl groups, with expulsion of methoxide to form a quinoidal intermediate; 3) removal of a proton from the quinoidal intermediate to yield the 9-phenyl-9-fluorenyl anion.

The reaction of trityl phenyl ether with n-butyllithium gave an unworkable tar. 9-Phenyl-9-fluorenyl methyl ether gave a 10 per cent yield of 9-phenylfluorene when treated with phenyllithium under forcing conditions, and an 8 per cent yield of 9-phenylfluorene when treated with n-butyllithium under mild conditions. Benzopinacol diphenyl ether gave a mixture of unidentified products when treated with phenyllithium under forcing conditions.

Benzothiazole with n-butyrmagnesium bromide at room temperature gave, after carbonation, 3 per cent of a product tentatively identified as benzothiazole-2-carboxylic acid. The same reaction at 0° gave a 2 per cent yield of bis-2-benzothiazolyl, but no acid.

Phenylcalcium iodide reacted with triphenylamine to give, after carbonation, a small amount of impure acidic material which was not identified. Phenylcalcium iodide failed to metalate dibenzothiophene-5-dioxide at -30°. n-Butylmagnesium bromide reduced this dioxide to dibenzothiophene; the yield was 2 per cent at room temperature and 15 per cent at 100°.

Phenyllithium metalated 9-phenylfluorene to give an 80 per cent yield of 9-phenylfluorene-9-carboxylic acid. Lithium aluminum hydride was without effect on fluorene when the mixture was heated in ether or in ether-benzene.

2-Methoxynaphthalene reacted with mercuric nitrate at room temperature to give 48 per cent of 2-methoxy-1-naphthylmercuric nitrate, which melted at 143-145° with decomposition after extraction with water and with ether. This compound reacted with bromine to give an 8 per cent yield of 1-bromo-2-methoxynaphthalene, and with iodine to give a 94 per cent yield of 1-iodo-2-methoxynaphthalene. The reaction of 2-methoxynaphthalene with mercuric nitrate at 100° yielded a tarry oxidation product which was not identified. Attempts to mercurate 2-methoxynaphthalene with mercuric bisulfate yielded no well-defined product. Similar failures were encountered in the reaction of dibenzothiophene with mercuric nitrate and with mercuric bisulfate.

Indium chloride failed to react with refluxing thiophene.

Methyl o-iodobenzoate was prepared in 70 per cent yield from sodium o-iodobenzoate and dimethyl sulfate. An attempt to prepare 2-iodophenyldiphenylcarbinol from this ester by treatment with phenylmagnesium bromide yielded a tar which could not be purified.

REFERENCES

ECOLOGY OF NATIVE PRAIRIE IN IOWA

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From the few scattered tracts of prairie which still persist as parts of undivided estates, the State Conservation Commission has purchased two quarter-section prairie reserves: The Hayden prairie, located in northeastern Iowa, in 1945, and the Kalsow prairie, located in northwestern Iowa, in 1948.

An ecological investigation of these two native prairie tracts was begun with an inventory which included the taxonomic identity, floristic composition, stability of prairie, distribution of species, forage yield, amount of mulch and roots, and soil structure. On this basis it becomes possible to characterize each area and prescribe management practices most likely to be successful in maintaining the prairie in its native condition.

Prairie is characterized by the abundant...
and dominant grasses which constitute the prevailing life form. Intermingled with the grasses is a great variety of forbs. This floristic complex of grasses and forbs can be described more simply and clearly through the use of the plant family as a unit than by an enumeration of species. A total of 149 plant species representing 106 genera in 35 families was found on the Kalsow prairie. The 134 species of plants on the Hayden prairie were distributed in 99 genera and 36 families. On the Kalsow area 20 families included 90 per cent of the species in the flora. The remaining 10 per cent of the flora included 15 families, each represented by only one species. On the Hayden tract the 17 largest families included more than 86 per cent of the total number of species, and 19 other families made up the remaining 14 per cent. Over 50 per cent of the species of the two prairies were included in the three largest families, Compositae, Gramineae and Leguminosae. About 40 per cent of them were in either Compositae or Gramineae.

Stability of prairie vegetation was shown by its resistance to invasion by weedy plants from the surrounding cultural vegetation. The frequency percentages of the species encountered in the quadrat survey of the two prairies were tested by Raunkiaer's law of frequency. The percentage of species in the frequency classes agreed rather well with the "normals" of Raunkiaer and Kenoyer, especially with that of Kenoyer.

The distribution of plant families in the various frequency classes on the Hayden prairie tapered from 16 in Class A to 8 in Class B, 5 in Class C (Gramineae, Compositae, Leguminosae, Umbelliferae, and Santalaceae), 2 in Class D (Gramineae and Compositae), and 1 in Class E (Gramineae). On the Kalsow prairie, Class A had 20 families, Class B, 5 families, Class C, 5 families, Class D, 3 families (Gramineae, Compositae and Umbelliferae), and Class E, 1 family (Gramineae).

Percentage composition by weight was determined for species on the basis of weight-estimate percentage and frequency percentage. The three families of Gramineae, Compositae and Leguminosae furnished over 90 per cent of the percentage composition of each prairie. Gramineae, alone, made up over 80 per cent of the forage by weight.

Plants found in the weight-list quadrats were arbitrarily classed into dominant, principal and secondary groups based on the contribution of each species to the forage yield.

Forage and mulch yields were higher on the Hayden than on the Kalsow prairie. There was no difference between the two prairies in the amount of roots in the upper 18 inches of soil.

An evaluation of the physical condition of the soil profile under prairie and cultivated lands included a determination of volume weight, porosity and aggregation. The two prairies did not differ significantly with respect to these indices of soil structure. The soil in both prairies was superior in structure to that in adjacent cultivated fields. Aeration porosity and aggregation were higher and volume weights lower than in the cultivated fields.

There seemed to be a direct relationship between the quantity of roots and the percentage of water-stable aggregates greater than 2 mm in the 0-6 and 6-12 inch soil levels of both prairies. On the Kalsow prairie the linear root-aggregate relationship was highly significant in the 0-6 inch soil depth and significant in the 6-12 inch depth. On the Hayden tract the relationship was highly significant in the upper 6 inches of soil, but not significant in the 6-12 inch level of soil.
It was intended originally to employ the Ling (1936) titration procedure as a means of evaluating the "true serum acidity" (that is, the acidity resulting from non-casein components) in skimmilk, buttermilk and butterserum (the aqueous phase of butter). Ling's procedure involves titration of oxalated and non-oxalated samples of milk and its rennet whey. Early in the investigation it became apparent, however, that butterserum, even from unsalted butter, did not yield a normal coagulum with rennet and that buttermilk frequently formed a weak coagulum.

These findings prompted the present study the objectives of which were (1) to determine the reason for the inability of casein in some of these products to coagulate with rennet, (2) to determine whether a study of the protein fractions in skimmilk, buttermilk and butterserum from a single milk source would throw further light on the adsorbed materials in the fat globule-serum interphase, (3) to determine whether differences could be shown among the casein and non-casein protein preparations from skimmilk, buttermilk and butterserum from a single milk source, (4) to determine the distribution of calcium, phosphorus and the common protein fractions in these products and (5) to obtain, if possible, further information with regard to the mechanism of the reaction between rennet and casein.

Incomplete Ling titrations and titrations of the sera resulting from alcohol-acetone (7:3) precipitation of the proteins in skimmilk, buttermilk and butterserum suggested that the calcium phosphate-caseinate complex in buttermilk and butterserum from a single milk source would throw further light on the adsorbed materials in the fat globule-serum interphase, (3) to determine whether differences could be shown among the casein and non-casein protein preparations from skimmilk, buttermilk and butterserum from a single milk source, (4) to determine the distribution of calcium, phosphorus and the common protein fractions in these products and (5) to obtain, if possible, further information with regard to the mechanism of the reaction between rennet and casein.

On the basis of fat-free products, the total protein and casein contents of skimmilk and buttermilk were practically alike while total protein and casein contents of butterserum were only 81.6 and 84.8 per cent of that in skimmilk. On a fat-free solids basis, total protein and casein contents in skimmilk and buttermilk were also alike while in butterserum they were 110.6 and 113.9 per cent, respectively, of that of skimmilk.

On both the fat-free product and the fat-free solids basis, the albumin contents of buttermilk and butter serum were 110 and 29 per cent, respectively, of that of skimmilk. The proteose-peptone and globulin fractions showed no significant variations among the products although the former tended to be lowest in buttermilk and the latter highest in butterserum.

The hypothesis is offered that albumin, as one of the labile components of the fat globule-stabilizing material in milk and cream, is removed from the fat globule-serum interphase during churning and released in the buttermilk. The low albumin content of butterserum, in itself, offers no explanation of the non-coagulability of butterserum unless it be assumed that colloidal calcium phosphate, adsorbed on the albumin, is removed simultaneously. Current rennet coagulation theories include the concept of di- or tricalcium phosphate associated with casein as a prerequisite to coagulum formation.

Casein and whey proteins prepared from skimmilk yielded transparent suspensions in veronal-citrate and phosphate buffers. Casein and whey proteins prepared from buttermilk and butterserum yielded turbid suspensions suggesting the presence of lipid material. Attempts were made to remove the lipids from the protein preparations by a procedure used by Blix (1941) for removing lipids from blood sera. In this procedure the protein material was extracted at -23°C. twice with acetone, once with a mixture of acetone and ether (2:1) and twice with ether.

Insignificant quantities of lipid material were found in the ether extracts of skimmilk and buttermilk casein and of the skimmilk whey proteins. The ether extracts of
two buttermilk whey protein preparations contained lipid material to the extent of 2.0 and 3.7 per cent, respectively, of the original preparations. The lipid residues from two butterserum caseins were 6.7 and 9.3 per cent, respectively, of the original protein. The lipid residues recovered from the ether extracts of several preparations of butterserum whey protein were from 14.0 to 25.0 per cent of the original weight of protein.

In general, the lipid residues from the ether extractions of water suspensions of the proteins contained little or no phosphorus while residues resulting from extraction of two whey protein preparations in phosphate buffer contained 1.74 and 4.00 per cent phosphorus.

The phosphorus content of buttermilk casein was slightly lower than that of skim milk casein. The P/N ratios in extracted skim milk and buttermilk caseins were 0.049 and 0.046, respectively. Extracted butterserum casein contained 11.71 per cent nitrogen (compared with 14.27 and 14.31 per cent in skim milk and buttermilk casein, respectively). The phosphorus content of butterserum casein increased from 0.73 to 0.92 per cent as a result of acetone-ether extraction, and the P/N ratio increased from 0.067 to 0.079.

Electrophoretic patterns of extracted and non-extracted buttermilk and butterserum caseins in veronal-citrate buffer at pH 8.45 gave evidence of components which were not apparent in skim milk casein. The α-fraction in extracted butterserum showed a tendency to resolve into two separate components; the peak area of the major α-component was smaller than that of the α-component in skim milk and buttermilk casein and had lower mobility.

Electrophoretic patterns of skimmilk whey proteins in phosphate buffer at pH 7.7 indicated the presence of six or seven components. The components of buttermilk whey protein did not resolve as well as those of skimmilk whey protein. Butterserum whey protein yielded incomplete patterns because of an opacity which seemed to be associated with the major component. It is possible that non-coagulation of butterserum with rennet is due to changes in the α-fraction of its casein or to changes in the α(Φ+γ) ratio. If phospholipid-casein complexes are formed, it may be that certain groups in the casein molecule, which are normally involved in the rennet reaction, are not available for this type of reaction. Emphasis is placed on the involvement of the α-fraction because Nitschmann and Lehmann (1947), Gonashvili (1949) and Kerns (1951) have presented evidence to the effect that the α-casein fraction is the one primarily involved in rennet coagulation.

REFERENCES


The molecular weight of ribonucleic acid (RNA) from tobacco mosaic virus (TMV) has been measured by the technique of light scattering. The scattering instrument measured the intensity of scattered light at all angles from 2° to 155° with respect to the direction of incident light. The 4358 Å line from an AH-4 mercury arc lamp was the source of light.

The scattering instrument was calibrated with colloidal silica solutions. Both the turbidity of these "Ludox" solutions and the scattering by them was determined as a function of concentration. To obtain the calibration constant, the ratio of turbidity to scattering was extrapolated to zero concentration so as to eliminate particle interaction and multiple scattering effects.

A differential refractometer which employed an optical lever principle was used to obtain the refractive increment of the RNA solutions, a quantity needed to convert light scattering data to a molecular weight. The refractometer was calibrated with KCl and NaCl solutions of known index of refraction. The refractive increment of the RNA was found to be 0.194 ml·gm⁻¹.

The RNA was separated from the TMV by heating a virus solution in boiling water for times ranging from 60 seconds to 5 minutes. This treatment coagulated the protein, which was then centrifuged off. The RNA, which remained in the supernatant, was cleaned of dust by filtration through Corning "ultrafine" porosity filters. These filters, which were cleaned in concentrated HNO₃, had to be neutralized by soaking for 2.4 hours in 1 N NaOH. Filters not so neutralized caused degradation of the RNA.

It was found that the RNA prepared by this heat method disintegrated rapidly at room temperature. The disintegration could be halted by cooling the RNA to 2°C. Since the molecular weight of undisintegrated RNA increased slightly as the preparative heating time was increased from 60 seconds to 5 minutes, the observed disintegration at room temperature could not have been solely a thermal collision process, but must have been enzymatic. Several attempts were made to remove or poison the enzyme. No completely effective method was found. However, after extraction of the RNA solution with chloroform-octyl alcohol, the decrease in molecular weight was about 25 per cent, in place of the 80 per cent or more which occurred with unextracted RNA. The source of the enzyme was not definitely established. The experimental evidence indicated that it was a part of the virus, rather than a contaminant in the original virus preparation.

The "extrapolation" method of obtaining molecular weights from scattering data was used. This method gives a molecular weight which is not based on any assumption concerning the molecular shape. Correction for anisotropy of polarizability of the RNA molecules was made at all angles. It was found that this correction was of sufficient magnitude that its omission would cause serious error in determining molecular shape from the angular distribution of scattered light. However, a shorter wavelength than 4358 Å would be needed to learn the shape of the RNA molecule.

The molecular weight of the RNA corresponded to the weight of all the RNA in a virus rod. For by means of phosphorus analyses the TMV was found to contain 5.6 ± 0.5 per cent RNA by weight. The light-scattering molecular weight of the TMV was 40.0 x 10⁶ and the molecular weights of twelve RNA preparations ranged from 1.87 x 10⁶ to 2.25 x 10⁶ for preparative heating times in the range of 60 seconds to 2 minutes. The higher weights seemed to go with the longer heating times. Heating for 5 minutes gave a weight of 2.70 x 10⁶, perhaps as a result of aggregation during prolonged heating.

Since all of the RNA was removed in one piece, it is likely that the RNA is contiguous in the TMV rod, rather than scattered in discrete sites.
The objectives of this study were to estimate, for a specified population of farms:

1. The economically optimum combinations of forage and grain under alternative soil management systems.

2. The relative profitability of alternative livestock systems for the utilization of the feed produced under alternative soil management systems.

Empirical data were secured from a random sample of 30 farms in the east loess hills region of northeast Nebraska. The sample was drawn from a population of farms which were restricted to 160 acres to Moody-Crofton soils, and by certain topographical limitations. Several tests were made to determine the homogeneity of the sample with respect to certain factors which might have influenced the results. The analytical procedure consisted of two major steps: (1) a descriptive analysis by means of regressions and tabular comparisons; (2) a budget analysis of alternative systems of soil management and feed utilization. The proportion of forage acreage in the cropping system (called the forage index) was used as the independent variable in these analyses.

A highly significant relationship was found between the yields of corn and the forage index. Such a relationship results from (1) the direct effect of legumes in the rotation and (2) the indirect effect of manure. The amount of manure hauled per year was directly associated with the forage index on the sample farms. Despite fewer acres of grain in 1950, the high-forage farms produced more feed units of grain than the low-forage farms. The relationship between the total feed production and forage index was curvilinear; within a proportion of 35 per cent of forage acreage in the rotation the feed production was positively related to the forage index; in the higher range of forage index the relationship was negative.

Farms with low acreages of rotated forage tended to sell more grain for cash. High-forage farms had higher investments in milk cows and other forage-consuming livestock and bought some additional hay. The low-forage farms raised more hogs and fattened more feeder cattle in drylot. High-forage farms had larger volumes of business as well as larger net incomes than those in the low-forage range. These differences were not statistically significant, however, due to the wide variance of the data.

The first phase of the budget analysis involved the estimation, on the basis of detailed yield estimates, of the types and quantity of feed which could be produced on the sample farms with the adoption of each of the following alternative soil management systems: (a) control of erosion by the use of rotations only; (b) rotations with contouring and terraces to control erosion; and (c) rotations with contouring, terraces, and fertilizers. Rotations were selected for the alternative soil management systems under the criteria of (1) annual soil loss per acre and (2) the relative prices for crops.

Under a soil management system which would control erosion by rotations alone, the acreage of grain would be limited. The rotation CO5 could be used on Judson silt loams, while COMM to COMMMM combinations could be used on Moody soils of less than 10 per cent in slope. The steeper Moody soils, as well as the Croftons, would have to be left under grass continuously, except for reseeding. Where contouring and terraces are a part of the soil management system, more grain could be raised. CO5 would be most profitable on Judson soils; CO5 or COMM would maximize gross value on Moody soils of less than 10 per cent slope. On the steeper Moody soils and the Croftons, rotations of COMM to COMMMM would maximize gross returns within the limit of erosion control.

The production of feed would average 432 units (corn equivalents) less per farm under a soil management system of rotations alone than under present systems on the sample farms. The second alternative soil management system would increase the annual feed unit production to 4022, or 125 in excess of the present system. The application of fertilizer would yield a further increase of 1250 feed units.

Analyses were made of nine alternative systems of soil management and feed utilization. The objective of this study was to estimate the economic optimum combinations of forage and grain under alternative soil management systems.
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systems of feed utilization in conjunction with the first and third soil management systems. These livestock systems were dairy cows, beef cows, three calf and three yearling steer feeding systems, and a two-year feeding system. Under each system the cattle would use the forage; hogs would use any remaining grain.

The capital requirements for livestock would be higher under a "rotation only" soil management system than under one including the mechanical practices and fertilizer. Also, the capital requirements for the feeding systems would exceed those for the dairy or beef cow systems.

Higher net income would result from livestock used with a soil management system of rotations, terraces, contouring, and fertilizers than one of rotations alone. The beef cow and feeding systems would be most profitable under 1950 prices; under 1938-1944 prices, dairy products were relatively higher, and consequently dairy cows would be more profitable.

With a soil management system of rotations, contouring, terraces, and fertilizers, the net incomes from all livestock systems would exceed those of the present systems on the sample farms. However, losses would result from several livestock systems used with the soil management systems of rotations only; this would be especially true under 1939-1944 prices.

DIFFUSION IN ALPHA BRASS

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The present investigation was undertaken for the purpose of determining the diffusion coefficients of radioactive zinc in copper and alpha brass single crystals at selected high temperatures. To carry out this program the author designed and constructed various pieces of equipment for the operations required in the investigation.

A Bridgman furnace was built for growing single crystals. Approximately half of the runs with this furnace were successful in producing large single crystals of alpha brass. In the remainder of the runs either biocrystals or very coarse-grained polycrystals were produced.

Single crystals of copper and alpha brass were sectioned into wafers, polished, coated with radioactive zinc, sealed off in evacuated vycor tubes and allowed to diffuse in a high temperature furnace for a certain time.

The furnaces used for the diffusion anneal were of novel design. Two separate windings, one over the other, were used as the heating elements. In one of the windings the current was always on; in the other the current was alternately on and off according to the demands sensed by the temperature controller.

Two types of temperature controllers were used: a commercial thermocouple-actuated controller and a platinum resistance-thermometer-actuated controller. These served to maintain the temperature within the furnaces constant to within ±1°C. The platinum resistance-actuated controllers were not used above 900°C as conductivity difficulties were encountered in the ceramic furnace components which resulted in a loss of temperature control.

The diffusion of zinc into single crystals of copper in the temperature range from 600 to 1000°C. was found to obey the following Arrhenius equation:

\[ D = 0.067 e^{-\frac{42,100}{RT}} \]

An Arrhenius equation of the same form was found to represent the diffusion of radioactive zinc into single crystals of 13.2 atomic per cent Zn alpha brass in the temperature range from 600 to 850°C. It was found to be

\[ D = 0.18 e^{-\frac{41,600}{RT}} \]

Reasonable agreement has been found between the value of \( D_0 \) obtained in this investigation and that calculated from Zener's \( D_0 \) theory. Close agreement has been found with Dienes' proposed equation for \( D_0 \), thus giving his empirical correlation added significance.

On the basis of Seitz and Huntington's
calculations of the energy required by various mechanisms for obtaining self-diffusion in copper, it is concluded that the mechanism for the diffusion of radioactive zinc in copper single crystals is probably a vacancy mechanism.

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The calculations of the energy required by various mechanisms for obtaining self-diffusion in copper, it is concluded that the mechanism for the diffusion of radioactive zinc in copper single crystals is probably a vacancy mechanism.

ABSORPTION SPECTRUM OF THULIUM SULPHATE OCTAHYDRATE

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Department of Physics

An investigation was carried out to see if the term splitting of thulium sulphate octahydrate could be understood in terms of crystal field effects.

The effect of the crystal potential on the energy levels was calculated according to first order perturbation theory. It was assumed that the local point symmetry for thulium sulphate is $D_{h}^{3}$. For ease of calculation, the crystal potential was expanded in terms of spherical harmonics $Y_{\ell}^{m}$. The appropriate matrices were evaluated by group theoretical methods. From these matrices the energies of splitting were found in terms of four parameters which involve mean radii and crystal fields. The mean radii were approximated with the aid of screened hydrogenic wave functions. The crystal fields were determined from present knowledge of the local structure of the rare-earth sulphate octahydrates. Unfortunately, present data only allowed the field contributions to be calculated for nearest neighbor contributions. In these calculations the oxygen ions were treated as point charges.

Matrix calculations were modified to take into account departures from Russell-Saunders coupling and the term splittings then found in terms of these modified matrices and the estimated values of the four parameters. It was found that only the parameter involving the $Y_{2}^2$ field term was important in thulium.

In order to calculate an absorption spectrum it is not only necessary to know the relative position of the energy levels but also the transition mechanism and hence the appropriate selection rules. If it is assumed that the $4f^{n}$ configuration is the only important configuration for the rare-earths ions studied, then the most important transition mechanisms are magnetic dipole and electric quadrupole. The intensity and selection rules for these two transition mechanisms were calculated. These calculations were first made neglecting crystal coupling effects and then with the coupling effects included. It was found that the crystal coupling effects were important and that transitions induced by these effects were often more important than transition processes calculated neglecting crystal coupling. Thus, electric quadrupole transitions were found to be less likely than either direct or induced magnetic dipole transitions and the latter in turn were found less likely than crystal induced electric dipole transitions. The most likely process of all was found to be the direct magnetic dipole transition.

Zeeman patterns were also studied for the several interesting directions of propagation and polarization of the light relative to the magnetic field direction. It was found that these patterns may be of some use in the identification of levels, which in turn should allow an empirical determination of the four parameters which are necessary for crystal splitting calculations.

For further study of the crystal fields, calculations were made of the magnetic susceptibility of thulium. Susceptibility calculations were also made for praseodymium and neodymium sulphate octahydrate. Comparison of theoretical and experimental data for the latter salts indicated that the sign of the $Y_{2}^0$ field term is in error. This error is attributed to the nearest neighbor approximation used in field calculations.

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1 a. Chairman of Committee, Joseph M. Keller, Dept. of Physics.
3 b. B.S. South Dakota School of Mines and Technology, Rapid City, S. Dak., 1948.
4 b. Research Assistant, Institute of Atomic Research.
A review of the literature on the subject of catalytic hydrogenation reveals the fact that, in favorable cases, a study of the adsorptive capacity of the catalyst for the reactants and products of the hydrogenation reaction can lead to an elucidation of (a) the mechanism of the reaction and (b) the role of the catalyst.

Previous work by Menzel (1), Stewart (2), Lefrancois (3) and Stanerson (4) had shown that cuprous oxide, promoted by calcium oxide and stabilized by vanadium tetroxide, is an active catalyst for the hydrogenation of furfural to furfuryl alcohol. Stanerson had investigated the adsorptive capacity of the catalyst for hydrogen.

Some of Stanerson's work was repeated and it was found that the adsorption of hydrogen did not begin at 60°C. and was not rapid at 100°C, as Stanerson had reported. Instead, adsorption proceeded slowly at 100°C. It was shown that pre-heating the catalyst to constant weight at 190°C had no particular effect on the adsorptive capacity of the catalyst, whereas the rate of adsorption was much slower on the pre-heated catalyst than on an unheated sample. The volume of hydrogen adsorbed was enormous compared to that found by Stanerson.

The irreversibility of the adsorption of hydrogen, as reported by Stanerson, was confirmed, but it was found that the adsorption was also complicated by reduction of cuprous oxide to copper.

The adsorptive capacities of the catalyst for furfural and furfuryl alcohol were also investigated. It was found that the catalyst would not adsorb furfural at temperatures below 190°C. At this temperature, adsorption did occur, but it was immediately followed by reaction, since no furfural could be recovered from the catalyst. It was shown that the furfural was not converted to either furoin or furil.

In the case of furfuryl alcohol, it was found that irreversible adsorption occurred at temperatures as low as 75°C and that most of the furfuryl alcohol was converted to some compound which does not contain an hydroxyl group.

Thus, it may be concluded that the mechanism of the liquid phase hydrogenation of furfural to furfuryl alcohol in the presence of a cuprous oxide catalyst involves the chemisorption of hydrogen, followed by reaction with molecular, unadsorbed furfural to form unadsorbed furfuryl alcohol.

Attempts to prepare pure cuprous oxide by the reduction of cupric nitrate solutions by means of a mild inorganic reducing agent in both water and methanol media failed to yield a preparation free from copper and cupric oxide.

Attempts to prepare pure vanadium tetroxide by the reduction of pervanadyl sulfate solutions failed to yield a preparation free from vanadium pentoxide, even though precautions were taken to assure complete reduction of the vanadium to the tetravalent state before precipitation, and contact with air was avoided during all the filtering, washing, and drying steps.

REFERENCES


ABSTRACTS OF DOCTORAL THESSES, 1952-53

INFLUENCE OF ENROLLMENT AND EXPENDITURES UPON QUALITY OF EDUCATION IN IOWA SCHOOL DISTRICTS MAINTAINING HIGH SCHOOLS1

RODERICK B. PECK2
Department of Vocational Education

Since 1900, expenditures for public education in the United States have increased from 2.15 million dollars to 4,311 million dollars in 1948. Much of this increased expenditure is attributable to the fact that schools are educating more pupils, the number enrolled having increased from 15.5 million pupils in 1900 to over 23.9 million pupils in 1948. A considerable portion of the increased expenditures was attributable also to more services provided by the public schools and a decline in the purchasing power of money. At the same time there has been a growing criticism of the property tax as the major source of school revenue and accompanying demands for state financing of education. The states in turn have insisted on more efficient expenditure of school funds through more adequately organized local school districts. Like other states, Iowa has been a part of this broad movement. It was important, therefore, to determine the relationships between the size of schools, the cost of education, and the quality of education among the school districts of Iowa.

The purpose of this study was to determine the relative influence of both size of school and cost of education in determining quality of education in the school districts of Iowa which maintain high schools. The study was primarily concerned with the following specific questions:

1. What is the relationship (a) between size and quality, (b) between cost and quality, and (c) between size and cost?
2. What is the relative influence of both size and cost upon quality?

A review was made of previous studies relating to the problem to determine the status of studies on the size-cost-quality relationship. It was found, in school systems considerably larger than the average in Iowa, that, as the size of the school increased, the per pupil cost declined; that increases in expenditures generally produced an improved quality of education; and, finally, that the size of a secondary school may have a greater effect upon the quality of education than per pupil cost differences if the school is smaller than 500 pupils. It was questionable, however, whether these results were applicable to the schools of Iowa, varying as they do from extremely small, obviously inefficient schools to large well-ordered school systems.

The study was confined to the high schools, grades 9 through 12, of those 831 Iowa school districts which maintained four-year approved high schools in 1950-1951. The data used in the study were secured from the official records in the Iowa Department of Public Instruction.

The quantitative measure developed for determining the quality of education was the "unit of educational opportunity", this being defined as one subject counting toward graduation carried by a student for one year. The quality of educational opportunity provided in the individual school districts was the total number of units of educational opportunity, and/or the score received by each respective school district on a community school criteria check list, consisting of 100 items. Per pupil cost was the cost per pupil in average daily attendance in high school, and size of school was based upon the total average daily attendance in high school.

The investigation revealed the following relationships between the size, the cost per pupil, and the quality of education in the 831 Iowa school districts maintaining high schools in 1950-51.

1. The size of school had a positive relationship to the quality of educational opportunity. As the size of the school increased, the average number of units of educational opportunity also increased.
2. There was a higher degree of relationship between community school score and number of units of educational opportunity than between community school score and size of school.
3. Schools with richer programs were more likely to approach the community school ideal than schools with poorer programs.

1 a. Chairman of Committee, M. L. Cushman, Dept. of Vocational Education.
3 a. A.B. Nebraska State Teachers College, Wayne, Nebr., 1941.
b. A.B. Nebraska State Teachers College, Iowa, 1950.
4 a. Graduate Assistant, Dept. of Vocational Education.
4. As the cost per pupil increased, the average number of units of educational opportunity decreased, except for a very few schools on the lower range of the expenditure scale. These findings are not necessarily inconsistent with the findings of other studies which have shown that educational opportunities increased as expenditures increased since these studies have not generally included small schools, or schools that varied widely in size, as does the present investigation.

5. There was an inverse relationship between size of school and cost per pupil; as the size of the school increased, the per pupil costs declined.

6. As the size of the school increased, the average cost per pupil per unit of educational opportunity decreased.

7. The average cost per pupil per unit of educational opportunity in school districts having the lowest average daily attendance was between four and five times as large as that of the largest school districts.

8. Although size of school and community school score were both reliable predictors of quality of education, the former was 30 times as important as the latter.

9. Although size of school and cost per pupil were both reliable predictors of quality of education, the former was 7 times as important as the latter.

10. In most of these relationships there were only minor differences between consolidated school districts and independent town and city school districts, the relationships generally holding true for either or for both together.

The general conclusion is that size of school was a more important determinant of the quality of education in the 831 Iowa high schools than was educational cost. While this conclusion might imply that, in terms of state policy, the state might spend considerably more effort in reorganizing its school districts, such an implication should not be drawn until a similar study of these relationships among elementary schools has been made.

USE OF AND DEMAND FOR ELECTRICITY IN SIXTEEN FARM HOMES
IN MARSHALL AND JASPER COUNTIES, 1950-1951

MABEL KATHRYN PHILSON
Department of Household Equipment

A field project on demand and diversity of use of electricity on sixteen farms in the eastern livestock area of Iowa was carried out by the Agricultural Research Administration of the United States Department of Agriculture in cooperation with the Iowa Agricultural Experiment Station. The following data were obtained:

1. Records of the electric current used on the 16 farms, in eight of the farm homes and by ranges used in the homes.

2. Records of the voltage of the whole farm.

3. Tabulations of descriptive information on families, house facilities, and household electric equipment.

4. Information on use of household electric equipment.

The original project, planned primarily for the use of rural power suppliers, did not fully exploit the data related to use and demand of household electric appliances: this study further develops the data on household appliances, especially the data on ranges, refrigerators, freezers, laundry equipment, water heaters, and vacuum cleaners.

The farms were so selected that four had electric ranges and water heaters, four had electric ranges but not electric water heaters, four had electric water heaters but not electric ranges, and four had neither electric ranges nor water heaters.

Data on electric current and voltage were obtained by recording meters installed at the yardpole and in the house and range circuits. Four farms were metered each week. The meters were moved from farm to farm so that each farm was metered one week in four. Metering of farms was carried on for a year. Ranges and homes were metered for eight months.

The eight months' meter data for ranges are presented in the following ways:

1. Graphs of average electric demand per half hour for all ranges for the metered
week in each month, of seven-day average demand by months, and of eight-month average demand by days.

2. Tabulation of demand characteristics, including highest demand of one minute or more, highest average 30-minute demand, and demand factor for each range.

3. Tabulations of total minutes in use of ranges and ovens and minutes "on" of ovens by three-hour intervals for seven days for each month.

4. Ratios of oven use to range use and oven operation to oven use by individuals and by months.

5. Operation factor for all ranges.

6. Energy consumption for each range for a metered week of each month and estimated consumption for each month.

Maximum one-minute demands of individual ranges varied from 4,400 to 9,504 volt-amperes; average 30-minute demands from 2,945 to 8,098 volt-amperes. Demand factors based on one-minute demands varied from 0.246 to 0.497. The operation factor for all ranges for all metered periods, 0.102, shows that, during the periods considered, average use of ranges was about two hours and 27 minutes per day. Estimated average monthly energy consumption per range varied from 54 to 283 kilovolt-ampere-hours.

By inspection of ammeter records it was possible to identify the operation of many of the electric appliances and to determine when and how long they were used.

Information on refrigerators and freezers is reported individually for each home. Descriptive information, data on use, and minimum per cent operating times are given. All of the families had electric refrigerators and all had either freezers, rented lockers, or both.

Eight months' meter data for water heaters with thermostatic control only are presented in graphs showing seven-day average minutes of operation by 30-minute intervals. These water heaters operated more when the demand of farms was high and less when it was low.

Two water heaters controlled to be off from 7:00 a.m. to 11:00 p.m. did not add to peak loads but operated at times of low general demand when their controls were properly set. The average operation time of all water heaters was 300 minutes per day.

Minutes of use per hour are tabulated for laundry equipment, vacuum cleaners, and other appliances. Tables made for each home for each metered period show the information for appliances whose operation could be identified on meter records.

Descriptive data and information on use of laundry equipment are reported individually for each cooperator. Fifteen homes had electric washers. In twelve of these homes, water heaters of some type supplied hot water for washing; in two others a tank connected to the kitchen range supplied hot water when the range was fired; in one, water was carried from an outside pump and heated on the range. Nine of the ten owners of nonautomatic washers reported doing the entire washing in the same suds and rinse waters. Owners of nonautomatic washers had from four to fifteen loads per washing and seven to fifteen loads per week. All of the homemakers had at least one thermostatically controlled electric iron; seven homemakers had ironers; one ironer was rarely used.

It was possible to identify the operation of tank vacuum cleaners on many of the metered records; the operation of upright cleaners could not be identified.

Meter records were obtained for toasters, a waffle iron and sandwich toaster, a roaster, four cream separators, a hair dryer, two space heaters, and a circulator fan for an oil space heater.

Minutes of use of three water pumps and one stoker are given by 24-hour intervals for the metering periods for which records of operation were available.
Samples of field-grown Cobbler potatoes were dug during the late spring and summer and the growth of the tubers from 0 to 200 gm. was studied in terms of cellular components and chemical constituents.

The number of cells per tuber was determined by dividing the volume of typical pith-storage and cortical cells into the volume of the tissue from which the cell was obtained. Both tubers and cells making up the tuber were considered to be spherical. The cell volume was determined by counting the number of cell images that fell in a circle of known diameter, when prepared slides of tuber tissue were mounted in a projection microscope. Soluble nitrogen, reducing, and nonreducing sugars were determined from the 80 per cent alcohol soluble portion; and insoluble nitrogen, starch, wall material, and ash from the residue of the alcohol extraction. The green and dry weights per cell were computed from cell numbers and tuber weights.

Growth of the potato tuber was found to be associated with both increase in cell number and in cell size. Unlike some fruits that have been studied, tubers show no initial period of cell multiplication followed by a period of cell enlargement, for cell multiplication accompanied enlargement over the range of the tuber weights studied. The number of cells per tuber and the volume of individual cortical and pith-storage cells followed a linear relationship when plotted against tuber weight on a log-log basis. The relationship between increase in tuber weight and time showed an initial period of slow accumulation of weight, followed by a period of rapid increase.

Factors considered to be associated with growth, such as volume of individual cortical and pith-storage cells, green weight, wall material, and protein nitrogen in mg. per cell unit, gave high correlation coefficients when plotted as a function of tuber weight on a log-log scale. The regression coefficients for increase in cell number with increase in tuber weight was 0.73, indicating a relatively rapid rate of cell division. The other growth factors had regression coefficients between 0.23 and 0.28 with an average of 0.25. The antilog of the regression equations gave a set of equations which described similar parabolas.

Factors associated with differentiation or maturity, such as starch, soluble nitrogen, ash, dry weight, and nonreducing sugars in mg. per cell unit, showed high correlation coefficients when plotted as a function of tuber weight on a log-log scale. The regression coefficients for these curves were higher than those for growth factors, averaging 0.33. The antilog of these equations yielded a set of equations which described similar parabolas, but with the larger regression coefficients these parabolas rose more sharply than those described by the equation for growth factors.

The parabolas for growth and differentiation factors indicate a period of rapid accumulation of these factors, followed by a longer period of slower but more constant rate of accumulation. The period of rapid accumulation took place in tubers varying in weights from 39 mg. to 2.0 gm. and is considered to be a transition from stolon to tuber growth.

The persistence of cell division at moderately high rates in a tissue which has many of the characteristics of maturity places the growth of the potato tuber in a special category. Both the growth pattern and the histology of the potato are those of tumorous growth normally associated with high auxin levels. Many of the problems of potato production, such as second growth and hollow heart, appear to be dependent upon this growth relationship.
This report investigates the efficiency of family selection as a means of isolating strains of chickens, which are considerably above or under average in resistance to lymphomatosis tumors. Information is likewise given on the virulence of the tumor cells as they undergo a series of successive passages through living birds.

Table 1 gives a summary of the data obtained by testing three consecutive generations of chicks with an inoculum containing intact cells. The average percentage of survival for the initial population was 36.0. Resistant breeding birds were selected on the basis of family percentage of survival to inoculation, and all birds used as parents had been tested.

Table 1
Summary of Data for Testing of Three Generations of Chicks with Lymphomatosis Tumor Inoculations

<table>
<thead>
<tr>
<th></th>
<th>Numbers of transfers of tumor</th>
<th>Number of chicks tested</th>
<th>Mean number of days between inoculation and death</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Generation I</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(unselected)</td>
<td>2 to 4</td>
<td>1996</td>
<td>36.0</td>
</tr>
<tr>
<td><strong>Generation II</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Resistant</td>
<td>1 to 5</td>
<td>1180</td>
<td>60.2</td>
</tr>
<tr>
<td>Control</td>
<td>1 to 5</td>
<td>95</td>
<td>27.3</td>
</tr>
<tr>
<td>Susceptible</td>
<td>13 to 15</td>
<td>384</td>
<td>23.9</td>
</tr>
<tr>
<td>Control</td>
<td>13 to 15</td>
<td>17</td>
<td>17.7</td>
</tr>
<tr>
<td><strong>Generation III</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1st experiment</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Resistant</td>
<td>17 to 23</td>
<td>518</td>
<td>23.9</td>
</tr>
<tr>
<td>Control</td>
<td>17 to 23</td>
<td>43</td>
<td>4.6</td>
</tr>
<tr>
<td>2nd experiment</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(virulent tumor)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Resistant</td>
<td>41 to 47</td>
<td>92</td>
<td>13.0</td>
</tr>
<tr>
<td>Control</td>
<td>41 to 47</td>
<td>93</td>
<td>2.1</td>
</tr>
<tr>
<td>Susceptible</td>
<td>41 to 43</td>
<td>30</td>
<td>0.0</td>
</tr>
<tr>
<td>2nd experiment</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(reduced tumor)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Resistant</td>
<td>2 to 7</td>
<td>93</td>
<td>61.3</td>
</tr>
<tr>
<td>Control</td>
<td>2 to 7</td>
<td>91</td>
<td>40.6</td>
</tr>
<tr>
<td>Susceptible</td>
<td>2 to 6</td>
<td>50</td>
<td>34.0</td>
</tr>
</tbody>
</table>

When inoculated with a comparable tumor, the second generation gave 60.2 per cent survival and the third generation 61.3. The method of preserving the tumor has produced an increase of virulence in some of the inoculums used. Birds of the resistant selection in Generation III were tested with the more virulent tumor and they showed better survival than either a random group of chicks or lines select-
ed for susceptibility. The differences were statistically significant. The mean number of days between inoculation and death of positive birds was significantly larger for the resistant group than for the control and susceptible groups. These results point to a considerable success in the first year of selection for resistance followed by an apparent standstill in the second year.

Selection for susceptibility was done on the basis of family performance of sibs and the birds used for breeding were not themselves tested. Generation II susceptible selections showed a survival percentage of 23.9, which was lower than that of the original population. But in the same test, a group of random chickens, used as control, had a lower survival rate of 17.7 per cent, indicating that the reduction in the susceptible group was probably due to an increase in the virulence of the tumor which had gone through a large number of transfers. The testing of the third generation confirmed this opinion. The birds selected for susceptibility were compared with a control when tested with both the virulent and the reduced inoculums. In both cases, the differences in survival rates were not statistically significant. When mean numbers of days from inoculation to death were investigated, the selected group had more days of survival than the control.

The tumorous material was kept by serial passages through living birds. Changes in tumor virulence, noticed during these passages, appeared to come about suddenly, and they were usually in the direction of increased virulence.

Many important differences were noted in the behavior of these two kinds of inoculums. Rates of survival were compared on a large group of chickens. The virulent had a survival percentage of 6.5, whereas the reduced had 47.4 per cent. In the same experiment, a comparison of number of days between inoculation and death of positive birds gave 13.6 days for the virulent and 28.7 days for the reduced inoculum. The virulent inoculum caused a generalized effect, observed in the internal organs, in 84.6 per cent of the positive birds, while with the reduced inoculum only 19.8 per cent of the cases became generalized. Breast tumors, livers and spleens were weighed in a number of positive birds and these weights were compared to those of normal chicks of the same age. The virulent inoculum, on the average, has increased the breast muscle 2.3 times, whereas the reduced has produced a tumorous muscle weighing 7.5 times the normal. With the liver, the situation was reversed. The virulent inoculum caused an average increase of 2.5, whereas with the reduced inoculum the livers averaged 1.1 times the normal. For the spleen, the virulent inoculum seems to have increased the mean weight to some extent, whereas the reduced changed the weight very little.

A study on the immunizing effect of the inoculated tumor has shown that survivors of highly lethal doses could resist further inoculation of the same number of cells. This phenomenon may be interpreted as a real instance of immunization, or it may be argued that the birds, with the necessary genotypes to resist a first inoculation, had the same genotypes to protect them against further testing. Dosages of the order of N/100 to N/10, where N is the normal dose, did not immunize the survivors against reinoculation with dose N.

Sex differences were lacking in the reaction of the chicks to the inoculated tumors. With the reduced inoculum, tumors regressed in some birds, leaving them with no apparent aftereffects. It seems likely that regression of a tumor and the absence of all neoplastic growth are two different modes of resistance. However, when progenies of both kinds of survivors were tested simultaneously, the rates of survival were indistinguishable.
During the last half-century the uses of ethanol have increased to such an extent that it has become one of the most vital raw materials in the world's chemical industry. Ethanol is produced mainly by the fermentation of blackstrap molasses and by synthesis from ethylene. Fermentation of grains is generally a minor source of industrial alcohol, but during periods of increased alcohol demand grain-fermentation becomes of extreme importance.

Starchy substrates, such as grains, must be converted to fermentable sugars, a process called saccharification, before alcoholic fermentation by yeast is possible. barley malt, although it has been used for centuries for saccharification, is relatively expensive and does not effect complete conversion into sugars. Fungal preparations have been found to be efficient, economical replacements for malt. Investigation of the preparation of fungal saccharifying agents and of methods for the evaluation of their saccharifying efficiencies is of considerable interest.

A preliminary study of the effect of different concentrations of acid for the cooking of whole corn mashes and mashes composed of the various mill fractions of corn was made. The minimum concentration of acid necessary for proper thinning of the mashes was found to be 0.06 normal sulfuric acid. No evidence was found indicating the production of a toxic factor by the action of such a concentration of acid on whole corn or any mill fraction during cooking.

Mold brans and submerged culture preparations were made from Aspergillus niger NRRL 330, Aspergillus niger NRRL 337, and Aspergillus oryzae ISG 38-b. At optimum levels, the alcohol yields from corn mashes saccharified by submerged culture and mold bran from A. niger 330 were, respectively, 5.44 and 5.38 proof gallons per standard bushel, from A. niger 337 were 5.28 and 5.30 proof gallons, and from A. oryzae 38-b were 5.13 and 5.38 proof gallons per bushel. Submerged cultures of the two A. niger strains were grown on a medium consisting of 5 per cent corn and 5 per cent distillers' dried solubles. The optimum medium for A. oryzae 38-b, determined experimentally, consisted of 3 per cent corn and 3 per cent distillers' dried solubles. The initial pH in all submerged cultures was adjusted to 5.2.

The results of the experimental fermentations are found in Table I, in which the optimum level of each mold preparation is indicated as per cent, on a dry basis, of the total grain bill. The data for enzyme activity determinations and graphical intercepts, according to the method of Reese, Fulmer, and Underkofler (1), are also included in the table.

Analysis showed submerged and bran cultures of A. niger 330 were highest in

<table>
<thead>
<tr>
<th>Table I. Summary of Data for Mold Preparations</th>
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<tbody>
<tr>
<td>-------------------</td>
</tr>
<tr>
<td><strong>Mold Brans</strong></td>
</tr>
<tr>
<td>Sub. cult.</td>
</tr>
<tr>
<td>330</td>
</tr>
<tr>
<td>337</td>
</tr>
<tr>
<td>38-b</td>
</tr>
<tr>
<td><strong>Mold Brans</strong></td>
</tr>
<tr>
<td>330</td>
</tr>
<tr>
<td>337</td>
</tr>
<tr>
<td>38-b</td>
</tr>
</tbody>
</table>

*Values in parenthesis are in units per ml.
maltase activity and lowest in alpha-amylase. Cultures of \textit{A. oryzae} 38-b were highest in alpha-amylase and lowest in maltase and limit dextrinase. Cultures of \textit{A. niger} 337 were highest in limit dextrinase and intermediate in alpha-amylase and maltase.

Slight correlation seemed to exist between alcohol yields and maltase activity, but there was no correlation for the other enzymes. However, the optimum level of a saccharifying agent for maximum alcohol yield cannot be predicted from the maltase activity.

Although the short fermentation test method of Reese, et al (1) is applicable for determining the optimum levels of similar fungal saccharifying preparations from the same mold strain, results indicated that it cannot be used to compare preparations produced by different mold strains nor by the same strain cultivated in different manners.

\textbf{REFERENCE}


\textbf{ROLE OF CALCIUM AND RELATED IONS IN PROLIFERATION OF LACTIC STREPTOCOCCUS BACTERIOPHAGE}$_1$

\textbf{NORMAN N. POTTER$_2$}

Department of Dairy Industry

The effects and mode of action of calcium and several additional ions in the lactic streptococcus bacteriophage system were investigated. A calcium-deficient, partially chemically defined medium prepared from tryptophane assay medium (Difco Laboratories) supplemented with xanthine, glutamine, asparagine, sodium thioglycolate, and sorbitan monooleate was used. Mode of action of stimulatory ions was studied using techniques that determine such characteristics of virus multiplication as rate of adsorption to host cells, length of time from adsorption to liberation of new virus (latent period), period over which virus is liberated (rise period), and number of virus particles produced per infected cell (burst size).

The calcium-deficient medium supported continued growth of all lactic streptococcus cultures studied. Increase in numbers of bacteriophages on actively growing host bacteria occurred in no case unless the medium was supplemented with calcium or certain related ions. Rate of bacteriophage proliferation was related to concentration of calcium added, up to a limiting calcium level. Calcium requirement for rapid virus increase was associated not with the bacteriophage or host bacterial strain alone, but was characteristic of the bacteriophage-organism combination. Several bacteriophages attacking the same host may have different calcium requirements, and the same bacteriophage acting on different hosts may require different levels of this ion for rapid multiplication on each of the several hosts. Greater amounts of calcium were required for rapid proliferation as indicated by mass lysis, when small numbers of bacteriophage particles were added than when a heavier inoculum was used. This probably was due to greater ability of the larger inocula to overgrow the host culture, at a given calcium concentration, before the bacteria became unsuitable as bacteriophage substrate. Proliferation of a bacteriophage on a host growing in different media, or in medium containing various levels of calcium, failed to influence calcium requirement of virus progeny in the limited studies that were undertaken. Propagation of a bacteriophage on various susceptible hosts in some cases resulted in virus progeny with different calcium requirements than the parent bacteriophage. This is evidence for host-induced virus change.

A given bacteriophage was found to produce different titers against various cultures susceptible to it. The pattern of these titers was constant. However, virus progeny from propagations of bacteri-
phage on different susceptible hosts produced different titer patterns against a series of susceptible cultures than the parent bacteriophage. Such change in the bacteriophage was rapid, and following the first propagation on a new host, subsequent propagations failed to alter, titer pattern of virus progeny. Host-induced virus change would be expected to be extremely significant from a genetic as well as epidemiological standpoint.

All of the experiments on mechanism of ion action led to the conclusion that the relationship between calcium concentration from 2x10^{-4} M to 48x10^{-4} M and rate of bacteriophage proliferation was due to a dependence of bacteriophage on calcium for "invasion" of host cells. The term invasion as used here means penetration by attached bacteriophage or orientation of reactive groups of bacteriophage and host leading to penetration.

A function of calcium in bacteriophage invasion was suggested by the following observations. The requirement for calcium by lactic streptococcus bacteriophages could not be explained by an effect of this ion on rate of host bacterial growth, on stability of free bacteriophage, or by the slight influence of this ion on rate of bacteriophage adsorption (attachment) to host cells. Further, calcium functioned in the very early stages of the bacteriophage growth cycle, some virus-host complexes producing new virus after calcium had been available for as little as 38 seconds. Using one-step growth curves and single infected cell experiments, it was reasoned that if calcium functioned principally in some stage of the intracellular multiplication process, then the greater bacteriophage proliferation rate with increased calcium concentration should be associated with either a shortened latent period or an increased burst size at the higher levels of calcium. No such effects were observed. Similarly, if calcium functioned in the process of virus liberation following intracellular multiplication, a shortened rise period or increased burst size might occur with increased calcium concentration. This, too, was not observed. On the other hand, if calcium were concerned in the process of invasion, then concentration should have little effect on the characteristics of the bacteriophage growth cycle as such, rather should influence the number of these cycles that could occur. This was found to be the case. The conclusion that calcium functions in bacteriophage invasion is supported by the nature of bacteriophage growth curves obtained when calcium was added to systems containing bacteriophage adsorbed to cells in absence of this ion, the lack of a killing action on cells by bacteriophage adsorbed in absence of calcium, and the early requirement for this ion. Suspension of either virus or host in calcium-containing medium did not result in irreversible binding of sufficient calcium to satisfy the requirement for proliferation of the virus when organism and bacteriophage so treated were combined in calcium-deficient medium.

Strontium, barium or manganous ion replaced calcium as a requirement for proliferation of several bacteriophages studied. However, at equimolar concentration, these ions were less effective than calcium. Mechanism studies indicated that these ions function in the same manner as calcium. Magnesium, nickel, cobaltous, zinc, cupric, cadmium, ferrous, aluminum, chromic, and lithium ions failed to replace calcium in the calcium-free medium.

None of thirteen cations studied in combination with calcium (with the possible exception of potassium in very high concentration) appeared antagonistic to calcium action in a manner that could not be explained by direct toxicity to either virus or host. In contrast, magnesium or cobaltous ions combined with a minimal concentration of calcium, resulted in more rapid bacteriophage proliferation than calcium alone. The nature of this effect was studied in some detail because these ions appeared ineffective in absence of calcium.

Stimulatory action of magnesium or cobaltous ions combined with calcium could not be explained through an effect upon rate of host bacterial growth, bacteriophage adsorption, length of latent or rise periods, or burst size. They did not appear to increase the physiological capacity of bacteriophage-host complexes to produce virus, for when combined with optimum concentration of calcium they had no noticeable stimulatory effect. As in the case of calcium, they appeared to exert their effect within the early minutes of virus-host association. Their action appeared closely associated with that of calcium, and they perhaps function through a sparing action for calcium, substituting for part of the calcium requirement in presence of sub-optimum levels of this ion.
The elution of neodymium from Nalcite HCR resin beds with 0.1 per cent citric acid-ammonium citrate solutions was investigated and quantitative measurements were made to determine the distribution of ions between the aqueous and resin phases.

In preliminary experiments it was found that the adsorbed neodymium bands could be observed and photographed under blue light and that the formation of the insoluble compound, NdCit·2H₂O, in the resin bed could be prevented by using a small initial load, a fast flow rate during the first stages of development or excess hydrochloric acid during the adsorption step.

The rate of movement of the front edge of the adsorption band was found to be dependent solely upon the rate of addition of ammonium ion from the eluant; this fact allowed the break-through volumes to be calculated precisely. The break-through volume, in liters, was calculated by dividing the number of equivalents of hydrogen-form resin remaining in the column after the neodymium was adsorbed by the number of equivalents of ammonium ion per liter of eluant.

The capacity of the resin for monovalent and trivalent ions was determined. Since in both cases a capacity of 4.26 meq. per gram of air-dried hydrogen-form resin was observed, it was concluded that neodymium was adsorbed only as a tripositive ion. This conclusion was substantiated further by quantitative analyses for both ammonium ion and neodymium in the resin during elution.

From theoretical considerations and the behavior of the adsorbed bands the following quantitative relationships were formulated:

\[
\begin{align*}
\text{Nd}_{3}^{+} + 3 \text{NH}_4^{+} &= \text{H}_2 \text{R} = Q \\
\text{Nd}_{5}^{+} &= \text{NH}_4 \text{R} \\
\text{NH}_4^{+} &= \text{H}^+ \text{S} \\
\text{S} &= \text{NH}_4^{+} \\
\end{align*}
\]

in which Q is the capacity of the resin; \(\text{NH}_4^{+}\) is the concentration of ammonium ion in the eluant; the subscripts, R and S, refer to the resin and aqueous phases, respectively; and the superscript, \(T\), indicates the total neodymium concentration of the eluate. Experiments showed that these relationships were valid for the pH range studied.

Analytical data from five experimental runs were plotted and it was found that the concentration of ammonium ion and total neodymium in the eluate and the concentration of ammonium ion in the eluant were linear functions of one another. Equations were derived which related the slopes of the curves to each other.

It was shown that the concentration of hydrogen ion in the resin phase was so low, compared to the concentration of ammonium and neodymium ions in the equilibrium band, that it could be neglected in the material balance equation for the resin phase. From a knowledge of the total amount of neodymium adsorbed and the ratio of neodymium to ammonium ion in the eluate, it was possible to calculate the approximate length of the adsorbed band under equilibrium conditions.

From the material balance equation for the aqueous phase it was shown that the sum of the ammonium-ion and total neodymium concentrations in the eluate was always equal to the concentration of ammonium ion in the eluant in the pH range investigated.

Evidence was presented to show that the predominant complex neodymium ion was \(\text{NdCit}^5\), by making the oversimplified assumption that this was the only neodymium-citrate complex present, the pH values of the eluates and other pertinent data could be calculated with a fair degree of accuracy. It was pointed out, however, that for highly precise calculations one must consider the ionization of \(\text{NdCit}^5\) and the association of this complex with hydrogen ion at lower pH values to give \(\text{HNdCit}^5\).

In order to completely solve the fundamental equations for this system it is necessary to know either the values of the equilibrium constants and the ionic activity coefficients, or to know the concentration of either the ammonium ion or the total neodymium in the eluate as a function of the pH or the ammonium-ion concentration of the eluant. The latter relationships were determined experimentally.
The mechanism of self-sharpening of the rare-earth bands and the effects of channeling upon narrow bands were discussed in detail.

THE TITANIUM-VANADIUM SYSTEM

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A survey has been made of the titanium-vanadium system and a fairly complete phase diagram is presented. Most of the alloys were prepared by arc melting together the component metals under purified argon. Sponge titanium used for this purpose was obtained from two commercial sources, while the vanadium was prepared in the laboratory by calcium reduction of vanadium, using sulfur in one case, and iodine in the other as booster.

In addition, a few alloys were prepared directly by coreduction of the mixed oxides with calcium, and the use of sulfur as booster. The alloys, while fairly satisfactory in the high vanadium range, were unsatisfactory in the high titanium region. The high titanium alloys were low in yield, and, perhaps due to dissolved oxide, extremely brittle. Coreduction of the mixed oxides of titanium and vanadium yielded alloys enriched in vanadium, which makes it difficult to control composition by this method. For example, a mixture of oxides which, if completely reduced should have given a 60 per cent vanadium alloy, yielded instead an 80 per cent vanadium alloy. Consequently, this method is not an entirely satisfactory one, and was not employed as the principal one for preparing alloys to be used in these studies.

At high temperatures, the body-centered cubic titanium and vanadium were found to be completely miscible, and gave a complete series of solid solutions from pure titanium to pure vanadium. The microstructures of the solid solutions did not appear to be entirely single phase, due perhaps to the presence of some impurities in small amounts. The results of x-ray studies, however, clearly indicate that the lattice parameter of the body-centered cubic beta phase of vanadium is increasingly expanded as the larger titanium atoms are added in substitutional solution. The most titanium that it was found possible to retain in the beta form on water quenching to room temperature corresponded to approximately the 18.5 per cent vanadium (81.5 per cent titanium) alloy. More titanium than this in solid solution apparently caused the beta solid solution to undergo a martensitic type transformation, to give secondary alpha and beta solid solution with a lattice parameter corresponding to that of the 18.5 per cent vanadium alloy.

As a result of metallographic studies, the transition that takes place in pure titanium at 885 °C was shown to be progressively lowered by additions of vanadium to titanium. Thus, the beginning of this transition on cooling is lowered to approximately 600 °C by addition of 23 per cent vanadium to the titanium. The presence of about 0.25 per cent oxygen in the titanium-vanadium alloys was indicated to raise the beta to alpha plus beta transition temperature. This amounted to about 50 °C at the 10 per cent vanadium composition, and is in accord with the elevation of the transition temperature of pure titanium by additions of oxygen.

The solid solubility of vanadium in the hexagonal form of commercial titanium, containing about 0.25 per cent oxygen, was indicated from x-ray and metallographic evidence to be less than 1 per cent at 700 °C.

The melting point of pure vanadium produced by calcium reduction of the pentoxide, using either sulfur or iodine as booster, was determined as 1860 ± 20 °C. This high melting point of vanadium is in line with the theoretical considerations of Pauling. Vanadium, with an intermediate number of cohesion electrons, should have a melting point between that of titanium and chromium. Appreciable amounts of oxygen in vanadium definitely increase its melting point.

The melting point of crystal bar titanium was determined at 1680 °C under a 0.03 to 0.08 micron vacuum by the same method as that employed for vanadium. This melting point is lower than literature values for titanium metal. Slight amounts of oxygen or nitrogen in titanium produce a decrease in its melting point. For ex-
ample, three successive meltings of this crystal bar metal under similar vacua to that of the first melting reduced the melting point to 1635° C.

The solidus curve and the approximate liquidus curve were determined for this alloy system. A minimum of about 1570° C was found in the liquidus at the 30 per cent vanadium composition. Reaction of the high vanadium alloys with appreciable amounts of oxygen, nitrogen, or both, caused by heating the alloys in a 1.1 micron vacuum, resulted in a marked increase in melting temperature and hardness of these alloys. In the case of the 51.7 per cent vanadium alloy, the increase in melting temperature amounted to about 85° C, and the increase in hardness to 10 points of the Rockwell "A" scale, i.e., from 65 to 75.

The emissivities of the metals and alloys were determined in a 0.1 micron vacuum in order to follow the progress of surface oxidation during the melting temperature determinations, and for estimating the melting temperature of the alloys. The alloys and metals heated under the above conditions usually showed a decrease in the emissivity as the temperature was increased. Vanadium showed, in addition, an initial increase in emissivity before this decrease. The alteration of the emissivity of each alloy or metal as the temperature is increased, is assumed to be due to progressive superficial absorption of oxygen or nitrogen. The initial increase in emissivity observed for vanadium may be explained by the effect of low impurity level on this property, and the eventual decrease observed under the conditions of continued oxidation may be attributed to the loss of free electrons by the metal. Other high melting reactive metals may be expected to behave in a similar manner when heated in the presence of traces of reactive gases. Melting temperatures, as estimated from the highest observed surface temperature (related to emissivities), and reference to a plot of observed surface temperature against true temperature for the metal or alloy were found to be comparable to those determined by the method of hole closure, in most cases.

The approximate surface tensions of the metals and alloys were determined by the method of sessile drops on the solidified arc melted buttons. This method gave lower values than the absolute values of the literature, when applied to several metals. For the titanium-vanadium alloys, the surface tensions and the estimated surface enthalpies, as determined on approximately constant volume drops, appear to parallel the liquidus curve and, correspondingly, exhibit a minimum at about the 30 per cent vanadium composition. The equation of Stefan, suitably modified, appears to be a satisfactory relationship between surface tension and melting temperature for the titanium-vanadium alloys. It should be possible to modify the sessile drop method and thus obtain absolute values of the surface tension of metals and alloys.

The alloy densities were measured. The curve of density against composition may be interpreted as indicating some slight incompatibility of the two metals.

Electrical resistivities of the annealed metals and alloys in the beta solid solution region show an almost linear increase from vanadium to a maximum at about the 20 per cent vanadium (80 per cent titanium) alloy, which is apparently close to the maximum amount of titanium that can be retained conveniently in beta solid solution. From this composition, the alloy resistivity decreases regularly to the limiting value for commercial titanium.

From the measured resistivity change of a sample subjected to an annealing treatment at lower temperatures, ordering was at first suspected for the 50 atomic per cent composition. The observed drop in resistivity for this alloy may be equally well explained by the existence of a two phase region that is slow to attain equilibrium at the low temperature (500° C). The latter explanation is probably the more correct.

The titanium-vanadium system shows a maximum hardness and tensile strength in the high titanium region, and another small maximum towards the center of the beta solid solution region. A hardness maximum was also observed for an alloy containing 2.5 per cent vanadium. The hardness of this latter alloy decreases as it is quenched from successively lower temperatures.

The air oxidation rates of all titanium-vanadium alloys treated in air at both 775° C and 600° C, were considerably greater than that of titanium alone. At both temperatures, a peak in the oxidation rate occurs at about the 30 per cent vanadium composition. For the 775° C tests, alloys containing more than 70 per cent vanadium oxidize very rapidly, exhibiting a liquid oxide film over the sample.

Representative titanium-vanadium alloys covering the entire system showed excellent corrosion resistance in 315° C steam for the duration of a 125 hour test.

Differential dissolving potentials of the titanium-vanadium alloys against titanium
were roughly reproducibly constant for each alloy when quenched from a given temperature. The magnitude of the voltage difference is an approximate measure of the relative rates of solution of two specimens in a given solvent. A marked change in the potential, on passing from the single phase beta to the two phase alpha plus beta region, was not observed for this alloy system. The maximum rate of solution in hydrofluoric acid was shown by the hardest alloy of a 750°C quench, i.e., the 10.7 per cent vanadium alloy, which is two phase at that temperature.

RESOLUTION OF GLUTAMIC ACID WITH 2-AMINOBUTAN-1-OL

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The specific problem of this study was to investigate a simple resolution of DL-glutamic acid. D-glutamic acid is usually prepared as needed in most laboratories by methods of resolution which are time-consuming and involve many steps. Synthetic glutamic acid may soon be able to compete with that from natural sources. Since the monosodium salt of L-glutamic acid is used as a condiment, a resolution of the synthetic DL-glutamic acid would be necessary.

The exact role of the atypical D-glutamic acid in natural processes has aroused considerable interest since reports were published that D-glutamic acid appears in tumor tissue. Literature concerning this controversial metabolic problem expressed the additional need for preparative methodology to aid in the clarification of the normal and abnormal physiological function of D-glutamic acid.

The resolution of 2-aminobutan-1-ol was accomplished by reacting equimolar amounts of 2-aminobutan-1-ol with (+) tartaric acid to form (-) 2-aminobutan-1-ol (+) hydrogen tartrate which precipitated while the diastereomer did not. The salt yielded (-) 2-aminobutan-1-ol upon adjustment of the pH to 10.6 with calcium hydroxide. The over-all yield was 56 per cent.

The resolution of DL-glutamic acid with (-) 2-aminobutan-1-ol was brought under control. The reaction of equimolar quantities of (-) 2-aminobutan-1-ol and DL-glutamic acid resulted in a crop of (-) 2-aminobutan-1-ol-D-glutamate in a yield of 68 per cent, m.p. 146-147°C. (-) 2-aminobutan-1-ol-D-glutamate was decomposed by adjusting the pH to 10.6, the isoelectric point of glutamic acid. Then two or more volumes of ethanol were added to precipitate a 96 per cent yield of optically active glutamic acid. The over-all yield was 65 per cent of D-glutamic acid and 35 per cent of L-glutamic acid.

There was no significant difference in the approximate solubilities of (-) 2-aminobutan-1-ol-D-glutamate, 1.2 g. per 100 ml. of 83 per cent ethanol by volume, and (-) 2-aminobutan-1-ol-L-glutamate, 1.1 g. per 100 ml. of 83 per cent ethanol by volume. There was no significant difference in the approximate solubility over a range of alcohol-water solutions from 61 to 95 per cent ethanol by volume. However, 16 g. per 100 ml. of 83 per cent ethanol of D-glutamate brought 13 g. per 100 ml. of L-glutamate brought 31 g. per 100 ml. of D-glutamate into solution. Therefore, the diastereomers had a solubilizing effect on each other.

The resolution of 2-aminobutan-1-ol with L-glutamic acid was successfully carried out. The reaction of equimolar amounts of 2-aminobutan-1-ol and L-glutamic acid yielded 64 per cent of (+) 2-aminobutan-1-ol-L-glutamate, m.p. 146-147°C, [α]D = +3.6°, and 63 per cent of (-) 2-aminobutan-1-ol-L-glutamate. The former salt was decomposed with HCl to give an alcohol solution of (+) 2-aminobutan-1-ol hydrochloride. The recovery of L-glutamic acid from the salt was 97 per cent. The (+) 2-aminobutan-1-ol hydrochloride was decomposed by adjusting the pH to 10.6 with NaOH or Ca(OH)2 and NH4OH to give a 61 per cent yield of (+) 2-aminobutan-1-ol.

D-glutamic acid reacted with 2-aminobutan-1-ol to yield 78 per cent of (-) 2-aminobutan-1-ol-D-glutamate. A 24 per cent yield of (+) 2-aminobutan-1-ol-D-glutamate was recovered during this sep-
Fertility and combining ability for seedling vigor was determined by intersection of open-pollination seed material for study. All selections originated in the southern varieties; Fischer, Lincoln, and Achenbach. Combining ability for seedling vigor in terms of the regression of progeny means on parents was 25.65 per cent. The corresponding "b" and "r" values were not statistically significant. The correlation between weights of tops and roots and plant height of topcross progenies in the greenhouse were 0.91 and 0.67 (n = 43), respectively. The degree of association between the greenhouse and field test was low (r = 0.25; n = 43), probably because of unsatisfactory control of environmental variation in the greenhouse.

VARIATION AND INHERITANCE OF SEED FERTILITY AND SEEDLING VIGOR IN BROMUS INERMIS LEYSS.

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Twenty S0 clones of brome grass and S1 segregates from each were studied to obtain information on the extent of variation and inheritance of open-pollination seed fertility and combining ability for seedling vigor, the relationship between and the effect of inbreeding on these two attributes, and the possibilities of using greenhouse tests for evaluating seedling vigor. A replicated, space-planted topcross nursery containing the 20 S0 clones and 10 S1 segregates from each together with a common pollinator variety, Fischer, provided the material for study. All selections originated in the southern varieties; Fischer, Lincoln, and Achenbach. Combining ability for seedling vigor was determined by using topcross progenies grown in split-plot arrangements in the greenhouse and field. Four clonal families were tested in the greenhouse and 18 families in the field. The latter experiment also contained 22 additional topcross progenies and commercial strains. Seed fertility of all 20 S0 clones was investigated for two years and of eight selected S1 families for one year. It was evaluated by determining the number of florets per panicle, number of seedlings per panicle and proportion of seed-setting florets, termed fertility percentage or fertility.

Statistically significant differences in seedling vigor among clonal families were obtained under field conditions and gave evidence of segregation for combining ability within seven families. S1 topcross progenies averaged about 75 per cent of their parental performance when harvested at two months of age in the greenhouse and about 96 per cent when harvested at the end of three months in the field. This indicated a transitory inbreeding depression attributed to maternal influence on seed size. Heritability for seedling vigor in terms of the regression of progeny means on parents x 100 was 25.65 per cent. The corresponding "b" and "r" values were not statistically significant. The correlations between weights of tops and roots and plant height of topcross progenies in the greenhouse were 0.91 and 0.67 (n = 43), respectively. The degree of association between the greenhouse and field test was low (r = 0.25; n = 43), probably because of unsatisfactory control of environmental variation in the greenhouse.

Of three fertility attributes studied, fertility itself was given primary attention since it was postulated that a proportion rather than an absolute number of fertilized female gametes was the inherent plant characteristic. In 1951, mean fertility, number of florets, and number of seedlings per panicle of the S0 clones exhibited a range from 23.80 to 73.40 per cent, 206 to 398, and 67 to 223, respectively, with corresponding grand means of 51.60 per cent, 275, and 142. Repitition of the test in 1952 gave an interannual correlation of 0.68 (n = 58) for fertility, but the interaction between clones and years was statistically significant. All attributes appeared to be primarily under internal control, more so for fertility than for florets. Genetic and environmental path coefficients in 1951 were 0.982 and 0.189, respectively, for florets.

On the basis of 1951 fertility, three high-, two medium-, and three low-fertility S0 clones were chosen for study of their
S₁ progenies. Parent-progeny correlations for fertility and florets were 0.68 and 0.84, respectively, and the corresponding heritabilities 49.40 and 38.34 per cent (n = 8). Most families exhibited wide segregation for both characters, the range for fertility extending from 0.70 to 75.80 per cent and for florets from 140 to 418. Six S₁ families were about 60 per cent as fertile as their S₀ parents, while the other two were 96 and 131 per cent as fertile, respectively. Relative to florets, the four high S₀ clones exhibited about 20 per cent inbreeding depression in their S₁ progenies, while the other four S₁ means showed 8 per cent improvement over their S₀ parents.

On the average, fertility appeared largely independent of the number of florets but highly associated with number of seedlings. Weight of seed per weight of panicle and fertility gave a "r" value of 0.94 (n = 20). Negligible degree of association was found between fertility and certain other agronomic characters such as yield, seedling vigor, and panicles per unit area.

Based on the results of these experiments it was concluded: (a) that clones differ in general combining ability for seedling vigor, though this character appeared subject to a high degree of environmental influences and was low in heritability. It would appear that selection both among and within families may lead to strains that are superior to the present standards in this regard. However, more rigid environmental control would be necessary if seedlings were to be evaluated effectively in the greenhouse. (b) Number of florets were considered to be primarily under control of a large number of loci with additive effects. Fertility was considered to be determined both by meiotic behavior and by genes affecting the level of general fertility. A tendency of fertility to decrease as a consequence of inbreeding may warrant further study of fertility in cross-pollination progenies derived from selfed lines. Number of seeds was considered a function of the two other attributes, though its expression may be affected by the consequences of inbreeding depression in lowering plant vigor. (c) The relationship of fertility to other agronomic characters indicated that it would be feasible to select and recombine strains with high fertility and vegetative vigor.

RESPIRATION OF MAIZE ¹

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The development of government storage of maize during recent years has emphasized the need for more knowledge of the behavior of this grain. The present study was undertaken to determine the effects of moisture content of grain, temperature, O₂ depletion accompanied by CO₂ accumulation, dormancy, and the presence or absence of micro-organisms on the respiration of corn grain under controlled laboratory conditions. It is assumed that data obtained will be of value in the solution of practical storage problems as well as indicative of the physiological responses of this plant material.

Moistened grain, with 15-23 per cent moisture, was used in studies of temperature, moisture, and seed disinfection effects. Freshly harvested corn ears, with 17-42 per cent moisture, were used to study effect of dormancy on respiration. Incubators at 8.0°, 21.0°, and 30.0°C. were used for the study of temperature effects in each level of moisture. Ceresan-M was used to obtain near-sterile grain.

A modification of Kostychev's respiration flask was used in the experiments. A mercury-glass seal insures against leakage of CO₂. The gas analyses were made with a haldane-type gas analyzer. Respiration rates (R) were calculated as ml CO₂/kg dry grain/day. Since R decreased with depletion of O₂ and accumulation of CO₂ in the flasks, an average rate for the first 10 per cent of CO₂(R₁₀) was used in most comparisons.

Experimental Results. With moistened grain, respiration increased exponentially with moisture at all temperatures. When log R₁₀ was plotted against moisture percentages, a comparable logarithmic increase of respiration with moisture was obtained which was independent of temperature. An equation of the type: y = aeᵇˣ, described the exponential increase of respiration with moisture. The increase was
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CAUSES OF VARIATION IN CALVING INTERVAL OF HOLSTEIN-FRIESIAN COWS

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The main purpose of this investigation was to describe the length of calving interval and its variation, and to determine if it has a genetic basis. Also of interest were the phenotypic and genetic relationships between length of calving interval and the production of milk and fat.

The data were taken from the herds of the Iowa State College Holstein herd and the Iowa State Board of Control Holstein herds at Mount Pleasant and Cherokee, Iowa, and covered a period of approximately eleven years, 1940 to 1951.

The frequency distribution of the 1663 calving intervals used in this study deviated markedly from a normal distribution. The modal class was 360-380 days with a mean of 413 days or 13.6 months and an overall standard deviation of 78 days. The calving intervals ranged in length from 277 to 884 days.

Age at first calving had practically no influence on length of calving interval. The linear correlations between age at first calving and length of the first, sec-

greater at lower moistures, however, with the breaks of the curves varying from 20 per cent moisture at 8.0°C to 17 per cent at 30°C, and two similar equations were required to describe the complete response. The curves at the lower moisture percentages showed approximately the same values of b with different values of a and x. Immature grain had always a much lower respiration rate (R10) than moistened grain with a corresponding moisture percentage. The log curves showed the same relationship as moistened grain with the exception that the break in the log curve came at 24.5 per cent moisture and the slopes, or b, values, were definitely lower. Germination percentages for 16.7 to 31.2 per cent moisture were from 74 to 100, while the values for the less mature ears containing 32.8 to 41.7 per cent moisture were between 12 and 64. Even when high germination was obtained the germination rate was less, indicating some dormancy.

In the temperature studies, the averages and most of the individual Q10's were those expected of enzymatically controlled, chemical reactions with values near 3, and they emphasize the effect of low temperature in reducing respiration rates in moist grain.

With the method used, respiration occurred in an atmosphere which was continuously decreasing in O2 and increasing in CO2 percentages. The individual R values calculated for each sampling interval were, therefore, indications of the combined effects of O2 and CO2 on the respiration of corn. With moistened grain, respiration rates dropped rapidly and exponentially with time in all experiments. Relative decreases were no less in the drier samples with their lower respiration rates. Results with immature grain showed the same relationship except that the rates were lower. At 40 and 30 per cent moisture respiration decreased about two-thirds as O2 was exhausted instead of about one-half (in moistened, mature grain), suggesting more sensitivity to the effect of O2 and CO2.

Soaking the grain for 15 minutes in a 1 to 10,000 solution of Ceresan-M eliminated all molds and many samples proved to be sterile when germinated on nutrient agar. Others showed an occasional colony of a very slow growing bacterium, presumably a spore-former. More severe treatments gave complete sterility but injured the corn and were discarded. Data on the respiration of seven control samples of corn and seven Ceresan-M treated samples showed average germination at the end of the experiments was 91 per cent for the controls and 86 for the treated samples. When the respiration of the non-sterile and near-sterile lots were plotted against moisture percentages, the data points gave a satisfactory fit to a single curve, indicating no differences in respiration due to the elimination of all molds and most bacteria. The results indicated satisfactorily that maize grain has a respiration of its own which may increase in an exponential manner with increasing moisture content.

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ond and third calving intervals were 0.034, 0.030 and -0.010, respectively.

Differences in age of cow at time of calving accounted for 10.3 per cent of the total variance and 11.7 per cent of the intra-herd, intra-year variance of individual calving intervals. The intra-herd, intra-year correlation of age of cow at time of calving and the length of the ensuing calving interval was 0.029, which indicates that most of the association of age with length of calving interval is not linear.

The records of 222 cows from the Iowa State College Holstein herd were used in studying the influence of management on the length of calving interval. An average interval of 26 days elapsed from the time of first estrus until first breeding, indicating that the length of calving interval is influenced by intentional delay in breeding. On the average, an interval of 55 days elapsed from time of parturition until the occurrence of first estrus.

Yearly environmental differences accounted for 4.8 per cent of the total variance and 5.1 per cent of the intra-herd variance in individual calving intervals. The intra-herd correlation between calving intervals of the same cow was 0.184 after year effects were eliminated. When yearly environmental differences were ignored the repeatability estimate reduced to 0.175.

Heritability of differences in length of calving interval was estimated as 0.0311 by doubling the intra-sire regression of daughter on dam. The daughter-dam analysis included the records of 417 dams and 447 daughters. A heritability value of .148 was obtained by multiplying the paternal half-sister correlation by four. The 95 per cent fiducial limits on the daughter-dam estimate were +0.24 and -0.18. Because of the large sampling errors, little confidence can be placed in these estimates except that heritability probably is rather low.

Genetic correlations calculated from these data for the length of calving interval with milk and fat production were both over one. Because the sampling errors of such estimates are large they should probably be considered only as a slight indication that the true values of these correlations are probably positive and rather large.

The intra-herd and intra-year regressions of milk and fat production were such that for each increase of ten days in length of current calving an increase of 73.5 pounds of milk and 2.38 pounds of fat would be expected. The intra-herd regressions of milk and of fat production on length of the preceding calving interval indicate that an increase of 60.9 pounds of milk and 2.30 pounds of fat would be expected with each additional ten days in length of the preceding calving interval.

The heritability and repeatability estimates indicate that only a small portion of the variation in calving intervals is genetic. It may be concluded then, that selection would not be very effective in changing the length of calving interval.

ACHIEVEMENT IN CALCULUS ASSOCIATED WITH DIFFERENT METHODS OF MEETING PREREQUISITE MATHEMATICS

RALPH MARION ROBINSON
Department of Vocational Education

Higher education is continually challenged by the ever-increasing demand for highly trained professional people. The degree and amount of training necessary for any given professional person has been increased as our society becomes more and more complex. Engineering education has been affected in that the strong demand for engineers has stimulated careful study of engineering curriculum by leaders in the field. Several solutions have been suggested such as: (1) adding a year to the curriculum, (2) increasing the college entrance requirements, and (3) revision of engineering curricula. Exploratory courses have been tried in some institutions as one means of improving engineering education.

This study was concerned with three exploratory programs of fulfilling the mathematics prerequisite to calculus,
ABSTRACTS OF DOCTORAL THESES, 1952-53

for students in the Division of Engineering at the Iowa State College during the years 1948, 1949, and 1950. At this institution one and one-half Carnegie units of high school algebra and one unit of plane geometry are required for admission to college algebra. Many students who entered the Iowa State College had as much as four semesters of high school algebra, two semesters of plane geometry and one semester of plane trigonometry.

In the fall of 1948, students with credit in high school algebra and two semesters of plane geometry were enrolled in college algebra. On the basis of their high school grade average, pre-college entrance examinations, and a mark received on an achievement test, the students who had four semesters of high school algebra and one semester of plane geometry were placed in a special group who took college algebra and plane trigonometry successively in one quarter. Upon the completion of college algebra and plane trigonometry, students received 9 quarter hours of credit toward graduation in engineering.

In the fall of 1949, the entering high school students who had credit in four semesters of high school algebra, two semesters of plane geometry, and one semester of plane trigonometry were enrolled in analytic geometry. However, no credit toward graduation in engineering was given for the courses prerequisite to analytic geometry.

In the fall of 1950, the entering engineering students who had credit in four semesters of high school algebra, two semesters of plane geometry, and one semester of plane trigonometry were enrolled in college algebra and plane trigonometry concurrently. Students in this group met five times per week for five quarter hours of credit toward graduation in engineering. Students who had credit in but three semesters of high school algebra and two semesters of plane geometry took college algebra for five quarter hours and plane trigonometry for four quarter hours. However, they received but five quarter hours of credit toward graduation in engineering.

These three exploratory programs in mathematics were evaluated by contrasting them with each other and also with the usual sequence of mathematics taken during the freshman year. Samples were drawn, so that there were 50 students for each of the three years in the exploratory programs and 100 students for each of the three years in the regular programs.

The criterion by which the programs were evaluated consisted of the course marks received in first quarter calculus. These marks of A, B, C, D, and F were assigned values of 4, 3, 2, 1, and 0, respectively. In addition, any student who did not enroll in calculus was given a score of -1.

The pre-college measures available at the Iowa State College for the three years included in this study were the high school grade average, the scores on the American Council on Education Psychological Examination, and a score on the English placement test.

An analysis of variance without regard to individual differences was made by a two-way classification by year and type of mathematics program. An F-value was computed using the within mean square as the denominator and significance at the 5 per cent level was noted among years. Significance at the 1 per cent level was noted for type of course and for interaction. Another test ignoring student ability was made among the three exploratory courses. A highly significant difference was again noted. This analysis did not give much indication concerning the effectiveness of the program since the groups differed greatly in ability and achievement as indicated by (1) the high school average, (2) scores on the ACE examinations, and (3) the English placement test.

Before undertaking an analysis of covariance, an analysis of regression was made to determine which of the available variables should be used for control. A regression equation was developed for predicting calculus achievement from all four variables. Further analysis revealed no significant loss when two of these variables were eliminated. Thus, for purposes of control, only the ACE scores and the high school grade average were used in the covariance analysis.

The covariance analysis was made by multiple classification consisting of type of program, year, and interaction. When the mathematics programs were evaluated in the foregoing manner, the exploratory courses were superior, although no evidence was available from the interaction to justify a conclusion that any one exploratory program was superior to another.
The preparation of triphenyltin-lithium from stannous chloride and phenyllithium is a two step process, the first step being nucleophilic displacement of the chlorine atoms bonded to the tin atom as chloride ions by the phenyl anion of phenyllithium to form diphenyltin. The second step involves addition of the phenyl anion to the open octet of the tin atom in diphenyltin to form the complex, triphenyltinlithium.

The attraction of the phenyl anion for diphenyltin must indeed be strong as the complex does not appear to be involved in an equilibrium system with its component parts as is evidenced by reactions with gaseous carbon dioxide, Dry Ice, benzenephone and benzalacetophenone. If the complex does dissociate into its component parts, it would be expected that the phenyllithium would react with the aforementioned compounds to form benzoic acid, triphenylcarbinol and diphenyl-β-styrylcarbinol, respectively. In each reaction the compound formed was tetraphenyltin (ca. 10%), and in the last two reactions, good recoveries of the ketones were made.

The complex does not possess sufficient activity to add to the carbon-carbon double bond of trans-stilbene, but it does successfully attack the oxirane ring as is evidenced by the preparation of triphenyl-2,3-dihydroxyethyltin (45%) and triphenyl-2-hydroxy-3-chloropropyltin (27%) by reaction of ethylene oxide and epichlorohydrin, respectively, with the complex.

Triphenyltin-lithium was reacted with a series of organic halides to form the following organotin compounds: triphenyl-ethyltin (36%, m.p. 56-58°), triphenyl-benzyltin (20%, m.p. 89-91°), tetraphenyltin (82%, m.p. 227–229°), triphenylmesityltytin (39%, m.p. 155–157°), triphenyl-α-methoxyphenyltin (24%, m.p. 129–130°), triphenyl-2-methoxyphenyltin (30%, m.p. 151–152°), triphenyl-2-chlorophenylltin (20%, m.p. 136–139°), triphenyl-2,4-dimethoxyphenyltin (43%, m.p. 112–115°), triphenyl-2,5-dimethoxyphenyltin (43%, m.p. 97–99°), triphenyl-2,6-dimethylphenyltin (34%, m.p. 116–119°), triphenyl-o-tolyltin (25%, m.p. 163–165°), hexaphenylditin (53%, m.p. 229–231°), and triphenylsilyltriphenyltin (71%, m.p. 289–291°).

It was found that when o-substituted aryl iodides were reacted with triphenyltin-lithium a second reaction, along with that of the formation of the unsymmetrical compound, took place. This second reaction is thought to be a halogen-metal inconversion reaction between the complex and the aryl iodide. The products formed by this reaction would be triphenyltin iodide and an o-substituted phenyltin compound. The latter compound was indirectly identified by conversion to an o-substituted benzoic acid by means of the carbonation reaction, and the hexaphenylditin obtained in the same reaction is believed to arise by reaction of triphenyltinlithium with triphenyltin iodide, as formed.

Complexes other than triphenyltin-lithium may be prepared by substituting other organolithium compounds for phenyllithium. The preparation of symmetrical alky1 and aryl organotin compounds by this method appears to be promising as the yields of tetraethyltin, tetra-n-butyltin, tetra-p-tolyltin, and tetra-m-tolyltin were in excess of 70%. It was not possible to prepare tetra-o-tolyltin by treatment of tri-o-tolyltin-lithium with o-iodotoluene. The steric hindrance presented by the three o-methyl groups probably prevented a successful attack on the halide from taking place. A reaction between this complex and benzyl chloride prepared the desired unsymmetrical compound in only a 2.3 per cent yield.

Triphenyltin hydride (52%) was prepared by the reduction of triphenyltin iodide with lithium aluminum hydride in ether. The hydride was reacted with methylthi1ium to form triphenylmethy1tin (18%), lithium hydride and tetraphenyltin (25%). These results are at variance with those reported by Wittig and co-workers (1).

A reaction between triphenylbenzyltin and phenyllithium proved to be extremely interesting in that the benzyl group was preferentially cleaved by the organolithium compound. This result is an exact reversal of the reaction between triphenylbenzyltin and halogen acid, in which the phenyl group is preferentially removed (2).
reaction of triphenyl-\(p\)-dimethylamino-phenyltin with \(p\)-substituted benzenediazonium chlorides in a buffered solution proved to be a rather unsatisfactory method. It was found that azo tin compounds could be prepared directly and in good yields by reacting triphenyl-\(m\)-dimethylaminophenyltin with \(p\)-substituted benzenediazonium fluoroborates. The following azo tin dyes have been prepared:

- triphenyl-4-dimethylamino-3-(4'-nitrophenylazo)phenyltin (24\%, m.p. 187-189\°C),
- triphenyl-4-dimethylamino-3-(4'-bromo-phenylazo)phenyltin (5\%, m.p. 170-172\°C),
- triphenyl-4-dimethylamino-3-(4'-chlorophenylazo)phenyltin (7\%, m.p. 162-165\°C),
- triphenyl-3-dimethylamino-6-(4'-nitrophenylazo)phenyltin (67\%, m.p. 205\°C),
- triphenyl-3-dimethylamino-6-(4'-bromophenylazo)phenyltin (49\%, m.p. 199-200\°C),
- triphenyl-3-dimethylamino-6-(4'-carboxyphenylazo)phenyltin (48\%, dec. 358\°C) and sodium 4-(2'-triphenylstannyl-4'-dimethylamino)phenylazobenzoate (97\%).

Two of these compounds, triphenyl-3-dimethylamino-6-(4'-nitrophosphylazo)phenyltin and triphenyl-3-dimethylamino-6-(4'-bromophenylazo)phenyltin, were tested for their substantivity as dyes. Neither proved to have lasting substantivity.

REFERENCES

IN VITRO STUDY OF UNIDENTIFIED FACTOR(S) IN CATTLE FEEDS WHICH FAVORABLY INFLUENCES CELLULOSE DIGESTION BY RUMEN MICRO-ORGANISMS

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Department of Animal Husbandry

The purpose of the study was to demonstrate further the existence and some of the properties of this unidentified factor(s) in cattle feeds which favorably influences cellulose digestion by rumen micro-organisms.

In vitro techniques (artificial rumen) were employed throughout the study. The general procedure of this technique included the carrying out of a series of ten consecutive 24-hour fermentations in laboratory flasks under conditions resembling the conditions present in the rumen of cattle and sheep. The flasks were originally inoculated with rumen micro-organisms taken from a live animal. To these flasks was added daily a chemically defined basal medium, which contained all the nutrients known to be needed by these micro-organisms. Various feeds or fractions were tested by adding them to other flasks containing the basal medium and observing their stimulating effect upon cellulose digestion over that occurring where the test material was absent.

The results obtained indicated that there was an unidentified factor(s) in certain cattle feeds which favorably influenced cellulose digestion by rumen micro-organisms.

The distribution of this unidentified factor(s) in feeds appears to be fairly widespread. Protein-rich feeds and other concentrate feeds of plant origin as well as good-quality roughages were found to be potent sources. Also, other materials such as manure extract and yeast were found to be rich sources of this factor(s).

Of the protein feeds soybean oil meal, wheat bran, linseed oil meal, and distillers' dried solubles were the most helpful in supplementing the basal medium. Other feeds giving a smaller stimulating effect were yellow corn, distillers' dark grains, distillers' light grains, dried live yeast, grey shorts and cottonseed meal. Also, roughages such as alfalfa meal, corn cobs, and blue grass hay appeared to contain some of the unidentified factor(s). Feedstuffs showing little or no favorable influence were fish meal, skim milk powder, yeast feed, meat and bone scraps, and liver and glandular meal. With one exception, combinations of feedstuffs indicated that the stimulatory effect on cellulose digestion was not additive.

The identity of the factor(s) needed by rumen micro-organisms for efficient cellulose digestion is not known. However,
the following characteristics or properties were observed from fractionation studies:

1. Rumen micro-organisms do not produce this factors in sufficient quantities in vitro to meet their needs.
2. It is heat stable.
3. It is water soluble and soluble in low concentrations of ethanol.
4. It is adsorbed on Norite.
5. It is not adsorbed on Nalcite HCR and IRA 410 ion-exchange resins.
6. It is destroyed by ashing.
7. It is not removed from aqueous solution by acid and alkaline zinc sulfate precipitation.
8. It does not appear to be an amino acid.
9. It does not appear to be a B-complex vitamin.

FACTORS AFFECTING PASSIVE IMMUNITY IN BLOOD-INDUCED LOPHURAE MALARIA OF THE COMMON FOWL

THOMAS MICHAEL SCHWINK
Department of Zoology and Entomology

Agglutination and passive protection tests were conducted with plasmas and sera from normal chickens and from chickens immunized as follows: (1) against both Plasmodium lophurae and erythrocytes from other chickens; (2) against P. lophurae, but not against erythrocytes from other chickens; (3) against erythrocytes from other chickens, but not against P. lophurae.

New Hampshire Red chickens more than two months of age served as sources of the plasmas and sera. Only macroscopic agglutination was recorded in most of the agglutination tests, but the microscope was used in a few instances. In the passive protection tests, the plasmas were administered to chicks infected when nine to 19 days old by inoculation with chicken erythrocytes parasitized with P. lophurae. The results obtained and conclusions drawn are summarized below.

1. Isohemagglutinins were demonstrated in the plasmas or sera of 24 out of 32 chickens which had been immunized with nonparasitized or parasitized chicken erythrocytes, but were evident in the plasma of only one of 14 chickens which had recovered from P. lophurae infections induced with parasitized duck erythrocytes and had never been injected with chicken erythrocytes. Such antibodies were demonstrated also in plasma from one of seven normal chickens tested. The injected erythrocytes rather than the malaria infection itself are believed to induce the production of the anti-erythrocytic antibodies present in the plasmas of chickens originally infected and subsequently superinfected by inoculation with parasitized chicken erythrocytes.
2. Freezing and thawing markedly enhanced the agglutinating powers of 16 out of 18 isoagglutinating chicken plasmas tested and slightly enhanced the agglutinating power of one of the other two.
3. Supplements of previously frozen plasmas from other chickens enhanced agglutination by unfrozen chicken isoagglutinating plasmas in 19 out of 22 tests. Supplements of unfrozen plasmas enhanced such agglutination in only eight of 23 tests. Frozen supplements, then, were more effective.
4. Supplements of previously frozen plasmas from other chickens inhibited agglutination by previously frozen chicken isoagglutinating plasmas in 13 of 19 tests. Supplements of unfrozen plasmas similarly inhibited agglutination in 13 of 16 tests. Frozen and unfrozen supplements were equally effective.
5. Chicken isoagglutinating plasmas agglutinated both nonparasitized and parasitized erythrocytes. Absorption with nonparasitized erythrocytes rendered such plasmas incapable of agglutinating either parasitized or nonparasitized erythrocytes.
6. Passive protection against P. lophurae with plasma from chickens which had been immunized against erythrocytes from other chickens but had never been infected with malaria was effected in all four experiments in which such plasmas were tested. Such plasma was every bit as effective as plasma from chickens which had been immunized against both P. lophurae and erythrocytes from other chickens. Some protection was obtained with plasma from chickens immunized against P. loph-
urae but not against chicken erythrocytes, but it was of a lower magnitude than that conferred by plasmas containing anticythroidic antibodies. The evidence is believed to indicate that most of the passive protection conferred by plasmas from chickens originally infected and subsequently superinfected by inoculation with parasitized chicken erythrocytes is attributable to antibodies induced by the injected erythrocytes rather than by the malaria infection.  

7. Normal chicken plasma conferred significant passive protection in one of three experiments in which such plasma was tested.  

8. Passive protection was obtained when administration of plasma was begun two days after inoculation, as well as when plasma injections were begun prior to inoculation. No significant protection was evident when plasmas were administered for only two or three days. The protection obtained when plasmas are administered daily starting prior to inoculation is not due merely to removal of the infecting inoculum of parasitized erythrocytes.  

9. Comparable protection was afforded by unfrozen and previously frozen plasmas from chickens immunized against chicken erythrocytes but not against malaria. Unfrozen and frozen plasmas are both suitable for use in protection tests.

LYOPHILIZATION AND GERM TUBE DEVELOPMENT OF Puccinia Uredospores

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Department of Botany and Plant Pathology

A number of mixed and pure race collections of cereal rust uredospores were preserved up to three years with no significant loss in viability in storage and only about a 15 per cent loss during lyophilization. Spores in conventional suspending media did not survive but nonsuspended spores gave good survival. The best results were obtained when the lyophil tubes were held at room temperature during processing. Spores which were prefrozen and dried at a bath temperature of -10°C. or lower gave about 35 per cent loss in processing. Most of the lyophilized spores were stored at 5-10°C. but samples have been stored at room temperature for at least a year and at 35°C. for at least six months with no viability loss. Samples ranging in size from 10 to 500 mg. were successfully processed.

The lyophilized uredospores gave heavy infection on susceptible hosts after three years' storage and pure races maintained their physiological characteristics. Lyophilized spores gave similar infection ratings to nonlyophilized spores of the same germination value. A number of different inoculation methods were successfully used with lyophilized spores.

Lyophilized uredospores required a rehydration period of at least 24 hours in a saturated moist chamber for maximum germination and, in many cases, also required this rehydration period for maximum infection. The dried spores showed faster rates of rehydration than nonlyophilized spores under the same rehydration conditions, and the extent of water uptake was considerably greater. The processed spores were rehydrated for as long as 110 hours in a saturated moist chamber with no loss of viability.

Rate of drying, during lyophilization, was most rapid in the first 15 minutes. The smaller samples of 10-25 mg. reached constant weight in about 40 minutes while samples of 500 mg. required about 90 minutes. At constant weight, the spores contained about 2-3 per cent water, on a fresh weight basis.

The vacuum (10^-50 microns) had to be maintained for prolonged viability. Spores sealed under a water pump vacuum of 12 mm. lost viability within a few days.  

Uredospores processed by the modified Barratt-Tatum technic showed no significant loss in viability up to one year's storage when the desiccants were removed after three hours. When the desiccants were left in the lyophil tubes, viability declined rapidly.

As high as 40 per cent "vesicle formation", including appressoria, substomatal
vesicles and infection hyphae, was obtained with Puccinia coronata under the proper conditions. These structures formed on artificial media appeared identical to those which have been described in host tissue. At least three factors were shown to be involved in vesicle formation, pH, zinc, and a "gelatin factor". The latter could be extracted from gelatin by dialysis. The required pH range was 6.2 to 6.6 and the optimum zinc concentration for vesicle formation was 9-14 ppm. The same factors were required for a characteristic type of germ tube branching. Branching occurred under the same general conditions as vesicle formation but over a wider range of both pH and zinc concentration.

Zinc could not be replaced by any other metal and the gelatin factor could not be replaced with a number of amino acids, growth factors, and nucleic acid derivatives which were tested.

Preliminary tests on water agar with added zinc and silicon gave both branching and vesicle formation indicating that silicon may be the gelatin factor. Silicon stimulated vesicle formation and branching at low concentrations and inhibited the same processes at higher concentrations. There appeared to be a complex interaction between zinc and silicon.

GENETIC ASPECTS OF THE PRODUCTION REGISTRY PROGRAM OF THE UNITED Duroc RECORD ASSOCIATION,1

CHARLES EDWIN SHELBY,2
Departments of Animal Husbandry and Genetics

The main objectives of this study were to measure the relative influence of heredity and environment on the three measures of sow productivity stressed in the Production Registry program conducted by the swine breed associations, and to suggest any changes in the present program which might increase the accuracy of selection.

The data were obtained from the United Duroc Record Association, Peoria, Illinois. They consist of the records of 869 litters from 31 herds in 1949 and of 691 litters from 30 herds in 1950. These data were from the herds which completed all requirements in the Official Duroc Production Tested Herd Program in either or both years. They include complete records on all sows in these herds in 1949 and in 1950. The data for each year were analyzed separately.

Means and standard deviations were slightly higher in 1949 than in 1950. Coefficients of variation were almost identical in both years.

<table>
<thead>
<tr>
<th>S.V.</th>
<th>1949 Mean</th>
<th>1949 s</th>
<th>1949 C.V.</th>
<th>1950 Mean</th>
<th>1950 s</th>
<th>1950 C.V.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Number of pigs at birth</td>
<td>10.18</td>
<td>2.80</td>
<td>28</td>
<td>10.26</td>
<td>2.83</td>
<td>28</td>
</tr>
<tr>
<td>2. Number of pigs at weaning</td>
<td>7.18</td>
<td>2.30</td>
<td>32</td>
<td>7.61</td>
<td>2.50</td>
<td>33</td>
</tr>
<tr>
<td>3. Weight of the litter at weaning</td>
<td>237.5</td>
<td>100.3</td>
<td>42</td>
<td>255.7</td>
<td>103.8</td>
<td>41</td>
</tr>
</tbody>
</table>

1 Chairman of Committee, Jay L. Lush, Dept. of Animal Husbandry, and John W. Gowen, Dept. of Genetics.
3 a. B.S. University of Kentucky, Lexington, Ky., 1948.
4 a. Fellow, Agricultural Experiment Station.
Phenotypic correlations were similar in 1949 and 1950. Correlations between size and weight of the litter at weaning were largest.

Phenotypic Correlations in 1949 and in 1950

<table>
<thead>
<tr>
<th>Correlation</th>
<th>Year</th>
<th>1949</th>
<th>1950</th>
</tr>
</thead>
<tbody>
<tr>
<td>$r_{N_0N_56}$</td>
<td></td>
<td>0.49</td>
<td>0.55</td>
</tr>
<tr>
<td>$r_{N_0W_56}$</td>
<td></td>
<td>0.37</td>
<td>0.43</td>
</tr>
<tr>
<td>$r_{N_56W_56}$</td>
<td></td>
<td>0.81</td>
<td>0.79</td>
</tr>
</tbody>
</table>

Differences between herds were the most important of the three sources of environmental variance at weaning. They were statistically highly significant for all characters. Differences in age of dam were the most important source of variance at birth. They were statistically highly significant for litter size at birth and for litter weight at weaning. Differences between litters farrowed in the spring and in the fall were not important.

The standard deviation of weaning weight was less for litters from gilts than from older sows. The actual values increased almost but not quite in proportion to the mean. This suggests that the most perfect age correction factor should be partly additive and partly multiplicative.

Per Cent of the Total Variance Due to Environmental Influences in 1949 and in 1950

<table>
<thead>
<tr>
<th>Influence</th>
<th>Number of pigs at birth</th>
<th>Number of pigs at weaning</th>
<th>Weight of the litter at weaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>Herd</td>
<td></td>
<td></td>
<td>+17.9</td>
</tr>
<tr>
<td>Season</td>
<td>- 0.2</td>
<td>- 0.3</td>
<td>+ 0.4</td>
</tr>
<tr>
<td>Age of dam</td>
<td>+13.9</td>
<td>+ 6.6</td>
<td>+ 2.2</td>
</tr>
<tr>
<td>Total</td>
<td>+18.7</td>
<td>+12.4</td>
<td>+20.5</td>
</tr>
</tbody>
</table>

Means, Standard Deviations, and Coefficients of Variation of Weaning Weight at Three Ages in 1949 and in 1950

<table>
<thead>
<tr>
<th>Months</th>
<th>1949</th>
<th>1950</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>s</td>
</tr>
<tr>
<td>12</td>
<td>214.8</td>
<td>89.4</td>
</tr>
<tr>
<td>18</td>
<td>241.6</td>
<td>104.3</td>
</tr>
<tr>
<td>24 or over</td>
<td>259.9</td>
<td>103.0</td>
</tr>
<tr>
<td>Total</td>
<td>237.5</td>
<td>100.3</td>
</tr>
</tbody>
</table>

Heritability and Repeatability in 1949 and in 1950

<table>
<thead>
<tr>
<th></th>
<th>Heritability</th>
<th>Heritability</th>
<th>Repeatability</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Half sib</td>
<td>Full sib</td>
<td></td>
</tr>
<tr>
<td>1. Number of pigs at birth</td>
<td>.084</td>
<td>.254</td>
<td>.215</td>
</tr>
<tr>
<td>2. Number of pigs at weaning</td>
<td>.066</td>
<td>.003</td>
<td>.134</td>
</tr>
<tr>
<td>3. Weight of the litter at weaning</td>
<td>.150</td>
<td>.097</td>
<td>.137</td>
</tr>
</tbody>
</table>
Linear and quadratic regressions of litter size at birth on age of dam from 10 to 16 months were fitted in both 1949 and 1950. The regressions indicate that the increase in litter size at this age is curvilinear. The linear regression was 0.23 pig per month of age in 1949 and 0.12 in 1950.

Correction factors for age of dam were computed at one and two month intervals in the period from 10 to 20 months, and at 6 month intervals thereafter. The correction factors for 1949 and for 1950 were similar. They may be used to make comparable records from sows of different ages.

Intraherd heritability and repeatability were estimated for these characteristics. The estimates of heritability which were subject to large sampling errors differed greatly in the two years. The estimates for repeatability seemed more reliable. The size of these estimates indicate that improvement by means of simple mass selection will be slow.

The efficiency of selection in the Official Duroc Production Tested Herd Program can be increased:

a) by the use of repeated observations; (Genetic progress will be about 30 percent greater when selection of breeding stock is based on two litters instead of one.)

b) by using deviations from the herd average as a measure of individual merit;

c) by basing selection on records corrected for age of dam;

d) by considering the average performance of close relatives when individual merit is close.

SOME STUDIES ON THE DIFFUSION OF SODIUM IN SODIUM TUNGSTEN BRONZE

JOHN FRANCIS SMITH

Department of Chemistry

This investigation was undertaken to study the process of sodium diffusion in single crystals of the metallic sodium tungsten bronze. Concentration gradients were established by effusion of sodium from single crystals into a vacuum. The concentration gradients were measured by means of an x-ray determination of a precision lattice constant, subsequently making use of the Vegard's law relationship to evaluate the sodium concentration. Advantage was taken of the high absorption of copper x-radiation in the sodium tungsten bronze in order to measure the lattice parameter of an exposed crystal surface.

The diffusivity was evaluated by a method which to the author's knowledge has not been previously suggested or used. This method was based upon Fick's first law rather than his second. The data obtained from a series of crystals held at constant temperature for varying times gave a family of curves showing the concentration as a function of depth with time as a parameter. From these curves the mass of sodium transferred through a plane parallel to the surface and at any particular depth was plotted as a function of time. The slope of this curve divided by the concentration gradient, both evaluated at the same time and depth, was the diffusivity for the corresponding concentration.

Three such series of crystals were run: one each at 664°C., 752°C., and 832°C. Diffusivities were evaluated for a bronze formula of Na0.78WO3. The evaluated diffusivities were fit to an Arrhenius type equation:

\[ D = D_0 \exp \left( - \frac{\Delta H}{RT} \right) \]  
\[ D_0 = 0.87 \text{ cm}^2/\text{sec} \]  
\[ \Delta H = 51.8 \text{ kcal/mol} \]  

In conjunction with the diffusion studies it was necessary to determine the coefficients of linear expansion. For Na0.8WO3 the following expansion formula is valid:

\[ L = L_0 \left( 1 + 8.8 \times 10^{-6} T - 1.92 \times 10^{-9} T^2 \right) \]  

In this equation L is any linear length and T is the temperature in °C.
ROLE OF ADENINE THIOMETHYLРИBOSIDE IN YEAST METABOLISM

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Although the sulfur-containing nucleoside, adenine thiomethylriboside, was isolated from yeast 40 years ago, its physiological function has remained obscure. The present investigation has been a study of the anabolism of the compound and its significance to the cell.

The first requirement for such an investigation was the development of a suitable method of analysis. A colorimetric test with nitroprusside similar to that used for methionine assay was developed which permitted the determination of the nucleoside in the absence of methionine. To separate the nucleoside from the amino acid, the former was precipitated as the phosphotungstate while the methionine remained in solution. The time-consuming and inefficient method formerly in use for the isolation of adenine thiomethylriboside from yeast has been greatly simplified. Much better yields can now be obtained with a relatively short time.

The biosynthesis of adenine thiomethylriboside by either Saccharomyces cerevisiae or Torulopsis utilis was discovered to be dependent on the presence of methionine in the growth medium of the yeast. An excess of this amino acid did not affect the growth of the microorganisms although it was essential for the accumulation of the riboside. Furthermore, a direct correlation was shown between the amount of adenine thiomethylriboside produced by yeasts and the quantities of methionine present in the medium. The optimal level of methionine in the growth medium was found to be 0.05 per cent. This concentration of methionine caused the concentration of the nucleoside to be as high as 0.6 per cent of the dry weight of the cell.

Methionine in this case is not fulfilling a non-specific function such as serving as a source of sulfur since other sulfur compounds, both organic and inorganic, are unable to replace methionine. More conclusive proof came from experiments with radioactive sulfur which had been administered as methionine and was recovered in the nucleoside with no decrease in its specific activity.

Studies with C\textsuperscript{14}-labeled methionine demonstrated that its alpha, beta, and gamma carbons are not transposed to the adenine thiomethylriboside. This indicates that the fragment transposed cannot be larger than -SCH\textsubscript{3}; however, mercaptan does not serve as a precursor. Therefore, it was proposed that methionine and adenosine are condensed to form a sulfonium compound which is the actual transmethylating form of methionine. Splitting of this compound leads to the formation of adenine thiomethylriboside.

An investigation of the adenine thiomethylriboside content of microorganisms showed that the compound is found in other yeasts, bacteria, and molds. Failure to detect the nucleoside in a particular species does not exclude the possibility that the organism makes use of the proposed transmethylation route, but does not accumulate adenine thiomethylriboside in sufficient amounts for detection. The thietin-like structure of the intermediary methionyladenosine suggests an ubiquitous cellular function.
The cause of corn root necrosis has been investigated for many years, but there is little information about the effects of crop rotation on its abundance or on types and distributions of soil fungi associated with corn roots.

Sterilized oat straws were buried next to and 18 to 20 inches away from hills of corn in the field at planting time. These straws were buried in two experimental corn-oats, corn-oats-meadow, corn-oats-meadow-meadow and corn-corn-oats-meadow rotations; one located on the Soil Conservation Experimental Farm, Clarinda, Iowa, and the other on the Howard County Experimental Farm, Cresco, Iowa.

Corn root systems were removed, thoroughly washed and examined on the thirtieth day of June, July, August, and September at Clarinda and on the fourteenth day of July, August, September, and October at Cresco. Observations revealed the least amount of root necrosis on the corn roots grown in the corn-oats-meadow rotations, followed closely by those in the corn-oats-meadow-meadow rotations; there was somewhat more root necrosis in the corn-corn-oats-meadow rotations, with most in the corn-oats rotations. In general, root necrosis increased in abundance as the season advanced.

At each time of corn root removal, some buried oat straws were also taken. The fungus-colonized straws and necrotic portions and healthy portions of corn roots, when plated on agar, revealed fifty-five genera of fungi; generically unidentified representatives of Actinomycetes, Basidiomycetes, and Myxobacteriales, plus a great number of nematodes and a number of bacteria which were not recorded.

Fusarium spp., Sporotrichum sp., Pyrrochaopta sp., sphaerosporangiate Pythium spp. and Phytophthora spp., Trichoderma spp. and Alternaria spp. were the six most prevalent genera of fungi at both locations. In addition to the first six genera of fungi, a nematosporangiate Pythium sp., Phoma sp., Myrothecium sp., a black sclerotium-producing fungus, Curvularia spp., Penicillium spp., and Fusarium moniliforme, which were cultured primarily or solely from roots in 1952, had not been cultured from straws in the previous experiment.

Fusarium spp. and Penicillium spp. were recovered with approximately equal frequencies in the four rotations, while Stemphylium sp. appeared more abundantly in the corn-oats-meadow than in the other rotations at both locations. Twelve additional genera and types of fungi exhibited similar colonization patterns in the four rotations at the two locations. Nematosporangiate Pythium spp., Trichoderma spp., Pythium acanthicum and Curvularia spp. exhibited somewhat different colonization patterns with respect to rotations at the two locations.

In general, the effects on the amount of corn root necrosis attributable to the corn-oats-meadow, corn-oats, meadow-meadow, corn-corn-oats-meadow and corn-oats rotations were not observed to be associated with the abundance or lack of occurrence of individual genera or types of fungi.

The pathogenicity of 478 isolates of various cultured fungi was determined against corn seedlings and corn seedling roots. All the isolates of nematosporangiate Pythium sp., Phytophthora sp. (strain "A") and Phytophthora sp. (strain "B") proved to be pathogenic to corn roots. A limited number of sphaerosporangiate Pythium
spp. were pathogenic to corn roots. A.
fee isolates of Pyrenochaeta sp., Peri-
conia sp., Fusarium sp., and orange
sclerotium-producing fungi, Alternaria
 spp., Trichoderma spp. and Myxotrichella
 sp. caused observable necrosis on corn
roots. Other isolates causing observable
necrosis, i.e., Cephalosporium sp., Cir-
cinella sp., Curvularia spp., were con-
sidered of minor importance in respect to
their occurrence.
It is of interest to note that Diplodia zea,
a suspected corn root pathogen, and Phia-
llophora radicicola, a known corn root
pathogen, were neither seen on nor isolated
from corn roots or oat straws. A nemato-
sporangiate Pythium sp. and Pyrenochaeta
 sp., both pathogenic to roots, were found
to colonize primarily corn roots, rarely
straws. For the first time Phytophthora
 spp. and Periconia sp. were observed to
be pathogenic to roots of corn; the latter
fungus was cultured solely from roots.
This investigation suggests that Pythium
paroecandrum, P. debaryanum, Phytoph-
thora spp. (strains "A" and "B"), Pyreno-
chaeta sp. or Periconia sp. in addition to
or rather than a nematosporangiate Pyth-
ium sp. may be the initial cause of corn
root necrosis.

A THEORY OF SAMPLING FINITE UNIVERSES WITH ARBITRARY PROBABILITIES

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Among the decisions involved in design-
ing many surveys is that of specifying the
method by which the sample is to be se-
tected and the estimation to be carried out.
From N units, n are to be selected, deter-
minations are to be made on the n units,
and inferences are to be drawn about char-
acteristics of the N units. In the early ap-
plications of probability sampling in sur-
vey work, equal probability of including
each of the N units in the sample was spe-
cified. In recent years, however, it has
been recognized that unequal probabilities
of selection for the N units, under certain
circumstances, could materially improve
the precision of results.
A theory of sampling systems (including
both the method of selection and the meth-
od of estimation) is developed in this dis-
sertation for the case of sampling a finite
universe without replacement. The prin-
cipal characteristic of this theory is that
the estimators and the moments of their
sampling distributions are expressed in
terms of the probability of inclusion in the
sample of k-tuplets of the universe units.
The theory as developed includes many of
the known results for the equal probability
selection method as special cases.

The successful employment of the sam-
pling systems set forth depends upon the
availability of prior quantitative informa-
tion on the units comprising the universe
of investigation. In many situations this
information can be used advantageously in
a variety of ways in designing the sampling
investigation. As a basis for comparing
the use of auxiliary information to vary
the inclusion probabilities with alternative
uses, an extensive review of the literature
relating to these alternative techniques
was undertaken under the headings, (1)
restrictions on the selection of the sample,
(2) definition of the sampling units, (3)
methods of estimation, and (4) variable
selection probabilities. This presentation
emphasized the distinctions among the
four types of uses.
The theoretical portion of the disserta-
tion develops, from first principles, a
general class of estimators. The elements
of this class are linear functions of the
variate under estimate with coefficients
depending upon the universe units included
in the sample. These coefficients can be
determined by imposing the condition of
unbiasedness on the estimator. The sim-
plest case considered yields an estimator
of a total for some characteristic x of the
form
\[
\hat{X} = \sum_{i=1}^{n} x_i / P_i
\]
where P_i is the a priori probability of in-
cluding the i-th universe unit (i=1, 2, ..., N)
in a sample of size n and z_i is the value of
the characteristic x for the i-th unit selec-
ted for the sample. This estimator is un-
biased. Its variance and estimated vari-
ance are given and depend only on the $x_{i1}$, $P_1$, and $P_{ij}$, where $P_{ij}$ is the a priori probability of including both the units $u_i$ and $u_j$ ($i, j = 1, 2, \ldots, N; i \neq j$) in a sample of size $n$.

The preceding case is extended to two stages of sampling with unequal probabilities of selection for the sampling units at both stages. The comparable unbiased estimator for this situation is of the form

$$\hat{X} = \sum_{i=1}^{m} \left( \sum_{j=1}^{n_i} x_{ij} / P'_i P'_{/j} \right)$$

Here $P'_i$ is the inclusion probability for the $i$-th first-stage sampling unit ($i = 1, 2, \ldots, M$) and $P'_{/j}$ is the a priori probability that the $j$-th second-stage unit ($j = 1, 2, \ldots, N_j$) will be included in a sample of $n_i$ such units given that the $i$-th first-stage unit is selected at the first stage. The variance of this estimator is derived, and unbiased estimates of the contributions to the variance attributable to each stage of the sampling are presented. Several well known results for both equal and unequal probability selection are obtained as special cases of this formulation. Biased estimators and their mean-square errors are also considered.

Methods of selecting samples with probability proportionate to a measure of size of each of the sampling units have been in use for a number of years. Several of these methods were examined and were found to be unsatisfactory for use in applications of the theory of this work. Several new methods of selecting samples with probability proportionate to an arbitrary measure were proposed. These methods were shown to give each pair of the universe units an a priori nonzero probability of inclusion in the sample. This property is required of any sampling plan permitting unbiased estimation of sampling variance. The methods developed do not require unduly arduous calculation, and they are proposed as particularly suitable for the selection of two first-stage units per stratum in a stratified multi-stage sampling design.

An examination was made of the conditions under which unequal inclusion probabilities for first-stage units, assigned on the basis of an auxiliary variate in a stratified two-stage plan, could lead to gains in efficiency over equal probability selection. Possible gains were shown to depend upon the existence of an average within stratum positive correlation between the variate under measurement and the square of the auxiliary variate.

When a sampling investigation is designed to provide estimates of means or totals of one (or a few related) characteristics, the use of the sampling systems of the type developed in this work may prove to be of particular importance. When the auxiliary information is highly positively correlated with the variate under measurement, sampling two or more units with probability proportionate to the auxiliary variates at each stage, in a stratified multi-stage design, makes full use of the auxiliary information. It further provides estimation procedures which are measurable in the sense that unbiased estimates of sampling variance can be made without resorting to additional assumptions. In multi-variate investigations the use of the auxiliary information through stratification, sampling unit equalization and ratio or regression methods of estimation, with equal probability selection, seems preferable. These devices incorporate the auxiliary information in both the design and analysis, and, in general, they lead to computationally simpler methods of estimation and subsequent analysis, an important consideration in multi-variate investigations.

In situations where unequal inclusion probabilities for the individual units arise naturally through the selection process, and in examination of related problems (such as those occasioned by the failure of designated respondents to be "at home" when called upon by an interviewer), the basic approach of the theoretical portions of this investigation is of particular interest and may be expected to lead to new results.
Homozygous diploid lines of corn produced by the monoploid method were evaluated for combining ability. This evaluation was necessary to provide a preliminary appraisal of the monoploid method, a new technique in corn breeding. The monoploid method, developed by Dr. S. S. Chase, is a procedure by which spontaneously occurring monoploid plants are identified in the seedling stage with the aid of a genetic marker system. Many of the monoploid plants are able to live to maturity and produce normal pollen and eggs. The successful self pollination of these monoploids gives homozygous diploid progeny. The objective of this research was to evaluate the combining ability of homozygous diploids and to determine if the ability to live in the monoploid state had any relation to the combining ability of the derived lines.

Homozygous diploids were evaluated from two populations, Golden Cross Bantam and Stiff Stalk Synthetic. All items tested, including the sweet corn material were top crosses with the dent single cross tester, L289 x 1205.

In the Golden Cross Bantam population 23 homozygous diploids were compared with 37 random $S_1$ lines in 1950. Comparative mean yields were 61.8 and 62.2 bushels per acre, respectively. These yields were not significantly different. Graphs of the frequency distributions of the two groups were very similar.

In the Stiff Stalk Synthetic populations 31 homozygous diploids were compared with 35 unselected $S_5$ lines and with five selected lines in 1951. Mean yields were 58.4, 58.1, and 60.1 bushels per acre, respectively. Most of the same lines plus several additional ones were tested in 1952. Then, 43 homozygous diploids were compared with 38 unselected $S_5$ lines and with five selected lines. Mean yields were 103.8, 103.8, and 99.5 bushels per acre, respectively. Differences each year between the homozygous diploids and unselected inbreds were not significant, nor were the differences between the selected inbreds and the other two groups significantly different either year.

Graphs of the frequency distributions of the homozygous diploids and unselected inbreds were very similar in each of the two years.

From the one year’s data from Golden Cross Bantam and the two years' data from the Stiff Stalk Synthetic population, it was concluded that the combining ability of a random group of homozygous diploids was little, if any, different from the combining ability of a random group of unselected inbred lines, at least for the populations studied. This indicated that monoploid livability had little if any influence on the combining ability of the resulting homozygous diploid progeny. It was pointed out that similar studies on other populations were necessary to validate the above conclusions.

In the 1950 yield trial several single crosses of monoploid plants crossed to the tester were included. These single crosses gave significantly greater yields than the homozygous diploids from the same population, Golden Cross Bantam. A yield test the following year, using remnant seed of these items, gave similar results. Since a biological explanation of this relationship was not evident, it was concluded that this significance was probably due to the chance of sampling.

Two comparisons were made in the 1950 test comparing the yields of inbreds with the yields of homozygous diploids extracted from those inbred lines. The inbred P51 yielded 59.4 bushels per acre, whereas the homozygous diploids from P51 yielded 61.6 bushels per acre. The inbred W22 and the homozygous diploid from W22 gave yields of 84.0 and 87.2 bushels per acre, respectively. These results were not unexpected. From the various theoretical aspects considered, it was concluded that a group of homozygous diploids would have the same gametic distribution as a zygotic population; therefore, a top cross test of homozygous diploids and open pollinated plants would give similar results. Homozygous diploids would be expected to be free of lethals; however, in the limits of inbreeding an inbred population would be expected to be free of lethals also.
Consideration was also given comparative frequencies of zygotes and gametes of a given yield potential. Means and variances of zygotic and homozygous diploid distributions were also calculated. From the theoretical aspects considered, no advantages were apparent for the yielding ability of a group of homozygous diploids.

**SERUM PROTEINS, LEUKOCYTES, AND MORTALITY OF SEVEN INBRED MOUSE STRAINS DURING CORTISONE ADMINISTRATION AND INFECTION WITH SALMONELLA TYPHIMURIUM**

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The purpose of this investigation was to determine the relationship between the serum proteins and natural resistance to mouse typhoid. The seven inbred mouse strains used in this study were chosen for their wide range in natural resistance to Salmonella typhimurium. Electrophoretic analyses were made of the sera of both normal and infected mice to determine whether strain differences in the serum protein composition were correlated with resistance. Additional data on plasma volume, body weight, spleen weight, and number of circulating leukocytes were utilized to evaluate the physiological significance of the serum protein changes.

Certain observations suggested that adrenal hormones might contribute to the pathological alterations and might even be a basis for natural resistance. In a study of these same mouse strains, other investigators established that resistance to Salmonella typhimurium was associated with high leukocyte counts. Increased excretions of 17-ketosteroids, depletion of adrenal ascorbic acid, hyperglycemia, lymphopenia, eosinopenia and neutrophilia are all known to be characteristic of both glucocorticoid administration and Salmonella infections. For this reason, the investigation was designed to compare the responses of resistant and susceptible mice both to cortisone and to mouse typhoid. The data warranted the following conclusions:

1. Certain characteristics of mouse typhoid infection which had been described in earlier investigations were confirmed in this study. In the first week of infection, the circulating neutrophils increased, the erythrocytes and lymphocytes decreased, and the eosinophils disappeared from the blood. The spleen tripled in weight. By the second week of the infection, agglutinins specific for S. typhimurium were present in the blood.

2. A study was made of certain pathological changes which had not been previously described. The blood volume often increased; the relative erythrocyte volume decreased during the infection. As a result, the plasma volume increased up to 20 per cent in some strains. Plasma fibrinogen and the alpha and beta globulins increased in concentration while the albumin decreased. Due to the increased plasma volume, these relationships were valid whether the proteins were expressed as grams per cent of serum or as grams in total plasma. Because the urine protein tests were negative and because the plasma fibrinogen increased, it was concluded that the decline in serum albumin could not be attributed to either liver or kidney damage.

3. Significant time relationships were established. The increase in the alpha and beta globulins was maximum at the time of the greatest dissolution of lymphatic tissue, as estimated by the decrease in the circulating lymphocytes.

4. The gamma globulins did not increase until the second week of infection. Electrophoretic analyses of sera before and after their incubation with the cellular antigen indicated that the gamma globulins consisted, for the most part, of specific agglutinins to S. typhimurium.

5. Strain differences were observed in the electrophoretic patterns and total protein concentrations of normal serum, in the normal body weights and packed erythrocyte volumes of whole blood, and in both the initial weights of the spleen and the
rates of spleen enlargement in infection. None of these differences were associated with innate resistance to S. typhimurium.

6. Other strain differences in response to infection were found to be correlated with natural resistance. Anemia, lymphopenia, loss of body weight, decrease in serum albumin, and increase in the alpha and beta globulins were most extreme in the susceptible mice. In respect to all these traits, the seven strains were almost identically ranked in resistance and in the magnitude of the response.

7. The responses of the neutrophils, agglutinins and gamma globulins were also found to be greater in susceptible mice. Because these three responses are known to be protective mechanisms, it is possible that all the traits listed above were correlated with resistance because they were the results, not the causes, of innate immunity.

8. The most significant clue to the basis for natural resistance was the correlation of low lymphocyte count with low innate resistance in uninfected mice - a relationship which had previously been established in these strains by other workers. This correlation was confirmed in the present study although the method of bleeding was designed to put a minimum of stress upon the mice. This fact damages the hypothesis that low lymphocyte counts (and low natural resistance) were a result of increased adrenal secretion.

9. Although there was insufficient evidence to implicate the adrenals as a basis for the differential resistance of these seven strains, there was evidence that the adrenals had an expression in mouse typhoid pathology: (1) Cortisone administration altered the protein composition of serum. It accentuated the strain differences in electrophoretic patterns which appeared during mouse typhoid. (2) Cortisone lowered the resistance of all mice to S. typhimurium. It was effective in dosages which were neither unphysiological nor toxic. Massive doses of two other steroid hormones, progesterone and desoxycorticosterone, did not decrease natural resistance. It was concluded that the harmful action of cortisone could not be attributed to the general effects of hormone over-dosage. (3) The cortisone dose which caused the most resistant mice to have the mortality curve characteristic of susceptible mice also caused them to have a similar serum protein composition and lymphocyte count during mouse typhoid.

10. Pretreatment with cortisone was most effective in lowering natural resistance when administered two days before the typhoid inoculation. It was established that when mice were pretreated in this way, their leukocyte pictures were characterized by lymphopenia and neutrophilia. It was concluded that the lymphocyte was of greater importance in establishing natural immunity than was the neutrophil.

11. Cortisone had a differential effect on the survival of immune and normal mice which were infected by identical bacterial inoculations. A hormone dose which reduced the survival of normal resistant mice from 100 per cent to 0 per cent had no significant effect on immune mice.

12. Cortisone increased the concentration of total protein in serum. Because hematocrit values were not significantly altered, it was concluded that this hyperproteinemia could not have been the result of hemoconcentration.
This study was undertaken to determine if an efficient means could be developed for detecting susceptible plants in a potato progeny segregating for immunity to the latent mosaic (virus X).

Susceptible seedling potatoes, when inoculated with a suitable strain of potato virus X, expressed local necrotic symptoms within four days. Most susceptible potato plants, vegetatively propagated, expressed necrotic symptoms five to fifteen days after inoculation with virus X.

The optimum temperature for symptom expression of virus X in potatoes was found to be about 16°C, but symptoms were expressed over a range of 10° to 24°C when suitable isolates were used.

The number of susceptible potato seedlings that expressed symptoms after being inoculated with virus X was increased when the light intensity under normal winter greenhouse conditions was decreased approximately 300 foot candles.

Mass inoculation of potato seedlings was effectively carried out using a paint spray gun with 12 g. of 400 mesh carborundum suspended in 100 ml. of inoculum. Application at 15 lb./in.² pressure with a plant to nozzle distance of one cm. caused no apparent mechanical injury. Less than six per cent of the susceptible plants in a segregating progeny escaped infection when this technique was used.

Ten isolates of virus X varying from mild to severe in their reactions on several hosts were separated using Gomphrena globosa L. as the local lesion host. These isolates were compared in effectiveness of inciting symptoms in susceptible potato plants. X 5 isolated from a potato selection grown in Maine incited local and systemic symptoms in the greatest number of plants and over the greatest temperature range. Local symptoms were incited equally well by isolate X RS obtained from the University of Wisconsin. However, the number of susceptible plants that expressed systemic symptoms was significantly less than with isolate X 5. Another, isolate X 8, obtained from a Green Mountain potato grown at North Dakota was the mildest in reaction on potatoes. Following inoculation, isolate X 8 was demonstrated present in Datura stramonium L., Nicotiana glutinosa L., N. rustica L. and N. tabacum L. at 16° and 24°C., but no symptoms developed. Isolate X 8 readily incited local symptoms when inoculated to G. globosa.

Mechanical inoculation using a suitable isolate of virus X was compared with the conventional graft test for immunity and was found to be equally reliable. All susceptible X-free potato plants tested, whether they were from susceptible parents or from immune parents, expressed necrotic symptoms after being inoculated with a severe isolate of virus X.

A virtually virus X immune seedling crop of potatoes was obtained by mass inoculation of seedling plants before transplanting to the greenhouse bench and by a second hand inoculation after the plants had become established.
A number of vic-dioximes have been used as reagents in the quantitative analysis of nickel and palladium, including α-benzildioxime, 2,3-butanedioinedioxime (dimethylglyoxime), 1,2-cycloheptanedioxime, 1,2-cyclohexanedionedioxime, and α-furildioxime. None of these can be regarded as the completely satisfactory reagent for this purpose. Differences in physical properties exist, also, between the nickel(II) complexes of the several vic-dioximes; these differences are somewhat surprising since the reactions in which the complexes are formed have been considered to be identical.

Studies of the fundamental character of the vic-dioximes and their nickel complexes are indicated in order to find explanations for the physical differences, and also to provide information useful for possible future improvement of these reagents.

Magnetic susceptibility measurements are often of value in the study of complex compounds of the elements of the first transition series, since they allow the determination of the number of unpaired electrons present. In order that such measurements might be made on the nickel(II) complexes of the vic-dioximes and that such equipment would be available for other investigations of a similar nature, an apparatus suitable for obtaining these data was assembled.

The Gouy method of susceptibility determination was employed as the basis for the design and operation of the equipment, this technique being simpler, more versatile and more accurate than other methods that were considered. The construction, calibration and operation of the apparatus are described in detail. An electromagnet, its power supply, a semimicro balance, a sample tube suspension, and a current-measuring device comprise the major units of the equipment. The calibration scheme and method of operation adopted are believed to allow susceptibility measurements on liquid samples to be made with a precision of 0.1 per cent or better and an accuracy of the same order of magnitude.

The water-insoluble nickel(II) complexes of α-benzildioxime, 2,3-butanedioinedioxime, α-furildioxime, 1,2-cycloheptanedionedioxime and 1,2-cyclohexanedionedioxime were prepared in fairly large amounts by adaption of the analytical procedures in which these reagents are usually used. To facilitate working with the nickel compounds, they were all recrystallized from organic solvents, being transformed in this process from amorphous powders to more easily handled needlelike crystals.

The magnetic susceptibilities of the crystalline complexes were measured. They were found, without exception, to be diamagnetic, and thus are to be considered as normal nickel(II) complexes of the square coplanar type, at least in the solid state. The susceptibility data obtained for the nickel compounds of the first two of the reagents named above correspond fairly well to figures previously reported in the literature for the same compounds.

Magnetic and allied spectrophotometric studies were carried out on solutions of the same five nickel(II) complexes, in both reactive and nonreactive solvents. The complexes dissolved unchanged in chloroform and o-dichlorobenzene. When they were dissolved in pyridine or n-butylamine, however, greater or lesser amounts of reaction took place with the solvents, depending on the particular complex observed. The reaction resulted in the production of a paramagnetic species of nickel complex and also served to diminish the height of an absorption band usually attributed to the diamagnetic square type of compound; it therefore could be followed magnetically or spectrophotometrically.

These studies established definitely the fact that 1,2-bis(α-furildioximo-N,N')nickel(II) is the least stable of these compounds toward reaction with pyridine or n-butylamine to form an unknown paramagnetic complex. The results of the observations on pyridine and n-butylamine solutions of the other four compounds are not entirely in agreement, but they indicate that 1,2-bis(α-benzildioximo-N,N')nickel(II) is the next least stable.

Some tentative suggestions are made as...
to the nature of the reactions of 1,2-bis (2-furildioximo-N,N')nickel(II) with pyridine and n-butylamine, on the basis of magnetic susceptibility and conductance measurements made on solutions of the complex in these two solvents. The addition of two molecules of the basic solvent to the original square complex to form an octahedral paramagnetic configuration, followed by more or less ionization, is regarded as the most probable course for these reactions to take.

EFFECT OF PROTEIN MATERIALS UPON THE GROWTH PROMOTING ACTIVITY OF VITAMIN B₁₂ FOR LACTOBACILLUS LEICHMANNII

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In the microbiological assay of vitamin B₁₂ with Lactobacillus leichmannii two factors complicate the results. First, vitamin B₁₂ is not a specific nutrient for L. leichmannii. Secondly, vitamin B₁₂ occurring in tissues is bound to proteins which must be heated, subjected to proteolysis, or treated with cyanide to make vitamin B₁₂ available for use by this organism. In these processes, however, growth promoting substances, purine and pyrimidine derivatives and peptides which substitute for vitamin B₁₂ are released. Inhibition of vitamin B₁₂ by protein binding and the presence of growth factors in the test materials cause opposing effects. A special case of vitamin B₁₂-inhibition occurs with extracts of gastric mucosa which contain a substance that prevents the absorption of vitamin B₁₂ by bacteria thus inhibiting their growth. It was the purpose of this investigation to study the effects of several protein materials upon the growth of L. leichmannii in order to determine the nature of the vitamin B₁₂-binding substances and to fractionate and concentrate the vitamin B₁₂-inhibitory substances from proteins.

For testing inhibition L. leichmannii was grown on a standard assay medium containing amino acids, salts, vitamins, glucose, and other nutrients. The medium was heated with vitamin B₁₂ by autoclaving for five minutes at 15 pounds pressure. Test samples were then added and the tubes inoculated, incubated for 22 hours, and turbidity read in a photometer.

A commercial preparation of desiccated hog gastric mucosa (Ventriculin) was extracted with water and treated with protein precipitants to obtain fractions containing the vitamin B₁₂-inhibitory principle. Ammonium sulfate, ethanol, or a combination of the two methods at different pH values were used as precipitating agents. A zinc-ethanol method was found to be satisfactory also. All of these methods gave concentrates of inhibitory principle separated from a portion of the inactive material. However, these concentrates contained growth factors which replaced vitamin B₁₂ for L. leichmannii. Although these substances complicated the assay of the inhibitory principle, they could be diluted out in high concentrations of the latter.

A great deal of effort was expended in trying to separate the growth factors from the vitamin B₁₂-inhibitory principle. No precipitating agent not any of the conditions used gave a concentrate of vitamin B₁₂-inhibitor free of growth substances. Dialysis removed a portion of the growth substances but not enough to prevent interference in the assay.

The use of chromatography and ion exchange as purification processes was investigated. By using ascending chromatography on paper with concentrated sodium citrate as developing agent, inactive substances, colored by ninhydrin, moved up the filter paper, whereas the inhibitory principle remained at the point of application. A filter paper pile could be used to purify larger quantities of the inhibitory material. Cellulose columns were not satisfactory because both factors ran through the column without being separated. Ion exchange has not received enough study for definite conclusions to be drawn as to its possibilities as a concentration method. However, the experiments tried did not separate the growth and inhibitory factors.

The vitamin B₁₂-inhibitory principle was found to be very stable; it will withstand
freezing and drying and can be kept for weeks in a refrigerator without loss of activity. In dilute solutions of neutral and acid pH it will withstand boiling, but it is readily destroyed by alkali. No change in the absorption spectrum of vitamin B\textsubscript{12} was observed in the presence of mucosal extracts at pH 7.0. Ventriculin extracts, treated with trypsin, still retained vitamin B\textsubscript{12}-inhibitory activity.

The inhibitory action of Ventriculin extracts was destroyed when they were heated with the basal medium. From the differences observed by heating the inhibitory principle alone and in the basal medium, it appeared that heat was not the destructive agent but that other substances were responsible for the inactivation when the mixture was heated. The constituents of the basal medium were investigated in order to determine the nature of the agents causing destruction of the inhibitory action. Among the substances tested only L-histidine in the presence of iron(II) or manganese(II) caused inactivation of the vitamin B\textsubscript{12}-inhibitor when heated. The similarity of these structures to benzimidazole and cobalt(II) which form a part of the vitamin B\textsubscript{12} molecule led to the testing of the latter substances, and they also were found to be effective in destroying the inhibitory activity.

Blood is known to contain small amounts of vitamin B\textsubscript{12}, which are not available to bacteria until the blood is heated or subjected to enzyme action. Blood was fractionated, but this did not aid in locating the vitamin B\textsubscript{12}-binding substance in the experiments performed. Several pure protein fractions from blood were tested for vitamin B\textsubscript{12}-inhibitory activity but were found to be less active than the mucosal extracts. β\textsubscript{1}-metal-combining protein showed a definite inhibition of growth of L. leichmannii. This protein may have caused only an indirect inhibition of growth by removing metal ions from the medium. Acid glycoprotein contained growth factors which were released upon heating. Other blood proteins tested had no significant effect.

### PROTEOLYTIC ENZYME SYSTEM OF STREPTOCOCCUS LACTIS

**WILHELMUS CARL VAN DER ZANT**

Department of Dairy Industry

Streptococcus lactis is a common dairy organism and long has been recognized primarily as being saccharolytic. However, various investigations have shown that many strains are capable of causing some protein degradation when grown in milk. It is thought that the enzymes of this organism may contribute to the hydrolysis of protein in cheese and cultured milks. The purpose of this investigation was to study the factors involved in the production of the proteinases of S. lactis and some of the characteristics of this enzyme system in regard to the breakdown of milk proteins.

Proteolysis by three strains of S. lactis grown in skim milk at 32°C was determined by the increase in acid-soluble nitrogen as determined by the Kjeldahl procedure and also by the increase in tyrosine and tryptophan in protein-free filtrates of these cultures. Tyrosine and tryptophan were determined colorimetrically with Folin-Ciocalteau reagent using essentially Hull's method. S. lactis grown in milk caused a rapid increase in both soluble nitrogen and tyrosine and tryptophan during the first 24 hours, followed by a smaller but gradual increase during the rest of the experiment (70 to 90 hours). The increase in acid-soluble nitrogen during the first 12 hours were very slight but definite increases in tyrosine and tryptophan were found within 4 hours. Considerably more soluble nitrogen and tyrosine and tryptophan were found when the pH of the milk was maintained at values ranging from 6.0 to 7.5 than at higher or lower pH levels or in comparable samples without maintained pH. Addition of calcium carbonate to milk cultures of S. lactis permitted greater proteolysis than without calcium carbonate. The lactic acid produced by S. lactis did not cause proteolysis of milk protein. Culture media of various types from which the bacteria had been removed after growth,
failed to show proteolytic activity. In subsequent experiments, cell-free extracts prepared by sonic vibration from S. lactis grown in either milk or broth were tested for proteolytic activity on milk, casein, and lactalbumin as substrates by determining colorimetrically with Folin-Ciocalteau reagent the amount of tyrosine and tryptophan liberated from the substrate after incubation with cell-free extract. Production of protease activity appeared to be partially adaptive, since replacement of whole protein in the growth medium with breakdown products of protein decreased the protease activity. Omission of individual vitamins from vitamin-test casein medium A affected the organism growth; omission of nicotinic acid decreased the protease activity more than the growth. Maximum protease activity against milk and casein was found at pH 7.0; optimum pH on lactalbumin was at pH 6.5. α-Casein was digested somewhat more rapidly than β- and γ-casein. When milk was used as growth medium, some indication of a second optimum against milk and casein as substrate was found at pH 5.5; this optimum, however, was not found when the cells were grown in vitamin-test casein medium. Maximum protease activity, within the temperature limits studied, was found at 45°C. Reducing agents activated the protease activity slightly, while metallic ions either had no effect or were slightly inhibitory. The effect of heating at 50, 55 and 61.7°C. for different lengths of time was tested at various pH levels of the cell-free extract. Maximum stability of the protease activity was found at pH 7.0. Heating at 61.7°C. for only 2 minutes inactivated the preparation. The extract was inactivated quite rapidly at pH's 5.0 and 9.0, even at the lower temperatures. The protease activity was quite stable between pH 5.0 and 9.0 during 4 days of storage at 2°C.; considerable destruction took place at pH's 5.0 and 9.0 after 36 hours. Evidence was presented for the presence of the protease activity more than the growth. Omission of one vitamin at a time from vitamin-test casein medium A either had no effect or slightly decreased the activity of the cell-free extract against glycyl-L-leucine and DL-alanylglycine; maximum activity against these two peptides, within the temperature limits studied, was at 45°C. Cell-free extract could withstand heating at 61.7°C. (pH 7.0) for 10 minutes without serious loss of activity against glycyl-L-leucine and DL-alanylglycine; maximum stability was at pH 7.0. Considerable destruction of activities against both peptides occurred during heating for more than 3 minutes at pH's 5.0 and 9.0. The activities against glycyl-L-leucine and DL-alanylglycine were quite stable between pH's 6.0 and 9.0 during 4 days of storage at 2°C. Considerable inactivation occurred after 4 days at 2°C. and pH 5.0. Holding at pH 4.0 for 12 hours destroyed the peptidase activities completely. Hydrolysis of glycyl-L-leucine at pH 8.0 was activated by Mn++, Cu++, Zn++, and Ni++ were inhibitory; Mg++, Co++, and cysteine had essentially no effect. In the case of DL-alanylglycine, Co++ activated the hydrolysis at pH 8.0, Mg++ in 0.01 M concentration gave some activation, Cu++, Zn++ and Ni++ were inhibitory and Mn++ and cysteine were inactive.

Both the protease activity and the peptidase activities against glycyl-L-leucine and DL-alanylglycine were precipitated from a cell-free extract of S. lactis with (NH₄)₂SO₄ in the range between 40 and 75 per cent saturation and also by absolute ethanol between 40 and 60 volume per cent at 7.0. Examination of the protein-free fraction of milk cultures of S. lactis for amino acids in the free- and peptide-form by paper chromatography after incubation for 24 and 96 hours revealed increases in the amino acids which already were present at 0 hour incubation; some amino acids not present at 0 hour appeared in the protein-free filtrate after incubation for 24 and 96 hours. Evidence was presented for the presence in the protein-free filtrate of three peptides at 0 hour, five peptides after 24 hours of incubation and six peptides after 96 hours.
The purpose of this investigation was to determine theoretically the injection period in a betatron or a betatron-started synchrotron. The elementary consideration of momentum-matching will give the time at which injection should take place. However, it is reasonable to assume that injection can take place over a finite period of time rather than for an infinitesimally short period. It is this interval which is of interest, primarily from the point of view that if the dependence of the interval upon the parameters of injection is known, it may be possible to enlarge the interval with corresponding increases in machine output.

The conditions allowing suitable injection processes have been investigated with the aid of a radial electric potential function. This radial potential is of such a nature that it provides a force on the electron which is exactly equal at all times to the magnetic and inertial forces which are actually present. The shape and position of the assumed potential function can then be investigated for varying parameters of injection in order to determine what ranges will give injection.

Two general cases have been considered. The first is that of constant voltage or constant momentum injection, the problem being to determine the time interval over which the mono-energetic electrons can be accepted by the magnetic field. In terms of the assumed potential, this becomes a determination of the period during which suitable potential functions exist. The following equation results from this analysis.

\[
\Delta t = \frac{P_f(r)}{K_1e^2r_1[A'_{\theta}(r_1)]^2}
\]  

where \(\Delta t\) is the period of acceptance, \(P_f\) is the momentum of injection, \(K_1\) is the time slope of the magnetic field in the region of injection, \(e\) is the electronic charge, \(r_1\) is the radius of injection, \(A'_{\theta}(r_1)\) is an increasing function of the radius of injection, the form of the function being \(f_1(r)\) dependent upon the field shape and is a function of the field shape.

For a given machine Eq. (1) states that the acceptance period is directly proportional to the momentum of injection, is inversely proportional to the slope of the magnetic field and will decrease with an increase in the radius of injection.

The second case that has been considered is that where the injection momentum is being changed during the acceptance period. A momentum function composed of a linear rise and a linear drop has been used as an approximation to the injection pulse. For injection in the region of the linearly rising momentum,

\[
\Delta t = \frac{\gamma \Delta P'(r)}{K_1r_1\left[\alpha/K_1 + eA'_{\theta}(r_1)\right]^2}
\]  

and for a linearly decreasing momentum,

\[
\Delta t = \frac{P \Delta P''(r)}{K_1r_1\left[\alpha/K_1 + eA'_{\theta}(r_1)\right]^2}
\]

In Eqs. (2) and (3) \(\alpha\) is the time slope of the momentum function while \(\gamma\) and \(\rho\) are intercepts. The term \(\Delta P'\) is again a function of the radial field configuration and is a constant for a given machine.

Possibilities for a form of momentum matching and large acceptance times are shown by the negative sign in the denominator of Eq. (2).

An attempt was also made to determine the duration and location of the acceptance periods in the Iowa State College synchrotron by the use of a pulse perturbation technique. The only place an acceptance time could be definitely located was at the peak of the injection pulse. For normal operating conditions the acceptance time was measured as 1.4-1.5 microseconds.
The main objective of this study was to determine the relationships between agriculture and federal antitrust activity. Historical analysis of events from 1850 to the present was employed.

The years 1850-1890 were ones of great change in the American economy, with a transformed agriculture finding itself in a new industrial age. As prices of agricultural products fell after the Civil War, the farmer accused those having dealings with agriculture of using their monopoly positions to his disadvantage. Farmers' groups sprang up to meet the "menace of monopoly". These organizations established associations to attack "monopolists" through the device of cooperative purchasing, marketing and manufacturing and also took important antimonopoly action on the political front.

"Granger" legislation was passed in the states, and federal regulation of the railroads was established by the Interstate Commerce Act of 1887. After 1876, margins of victory in national elections were very narrow. The fact that many farmers supported reformist third parties caused the major parties, especially the Republican party, to sponsor measures calculated to regain the vote of the Western Farmer.

In order to placate the Western wing of their party, the Republicans put the Sherman Antitrust Act of 1890 on the statute books. This piece of legislation, along with others, passed with similar intent the same year, failed to achieve its purpose, with the Republicans being defeated in the elections of 1890 and 1892.

Early administration of the antitrust legislation was ineffective, even half-hearted, and afforded little relief to agriculture. From 1890-1896, the agrarian revolt reached its peak, with the People's party giving political expression to the anti-monopoly sentiments of the farmer.

With the defeat of the Populists in the election of 1896, returning prosperity and some apparently favorable court decisions under the Sherman Act, agricultural pressure for antitrust legislation declined. After federal courts in 1908 and 1910 held that farmers and their organizations came under the antitrust laws, there was agitation for exemption of agricultural producers. A wave of combination swept over the nation at the turn of the century, and there was a general increase in antitrust sentiment for new regulatory legislation. The movements resulted in some exemption for agriculture from the antitrust laws and the Clayton and Federal Trade Commission Acts of 1914.

The new legislation was not satisfactory to agriculture—although use was made of the F. T. C.—and the twenties saw a new approach taken to solving the problem of "monopoly". The Capper-Volstead Act gave the first effective exemption to agricultural organizations from the antitrust laws. "Trusts" were dealt with directly through the passage of the Packers and Stockyards Act and the Grain Futures Act.

The antimonopoly legislation of the twenties was not achieved as the result of Republican fears of a farmer-supported third party, but rather through the operations of a bipartisan "farm bloc". An attempt by Senator Robert LaFollette to establish a successful antimonopoly third party with agrarian support was short-lived and was not as effective as the farm bloc in influencing federal and antitrust activity.

After 1925, and especially during the early thirties, there grew among agricultural groups the realization that antimonopoly legislation would not serve to restore the relative position of agriculture. The Agricultural Adjustment Act of 1933 permitted, in its section concerning marketing agreements, greater latitude to cooperative associations in combining with processors and handlers than the Capper-Volstead Act provided. There also was agricultural support for the relaxation of the antitrust laws under the National Industrial Recovery Act, although some agrarian Senators objected vigorously.

When the depression did not come to a speedy end, and especially after the recession of 1937-1938, there was increased agrarian sentiment for a revival of the antitrust laws. New legislation was introduced by agrarians in Congress, Senators from farm states were placed on the Temporary National Economic Committee and general farm organizations urged the passage of new legislation and the vigorous pursuit of new regulatory legislation.
prosecution of existing antitrust laws.

The increased federal antitrust activity was brought to a halt by the entrance of the United States into the war and what results there were gave small comfort to agriculture. The war brought prosperity to the farmer and there were notable shifts in the views of some of the major general farm organizations. With cooperative associations secure in their exemption from prosecution, and with a prosperity-born conservatism, there was a tendency to take a more tolerant view of industrial combination and to express more concern over "labor monopoly" and "government monopoly".

Among major general farm organizations, only the Farmers' Union, a direct descendent of Populism, is still concerned with industrial monopoly. With the change in attitudes of the larger farm organizations, and with the disappearance from the Senate of agrarian antimonopolists, there is little immediate prospect of agriculture's being in the forefront of any new drive against industrial monopoly.

THE EMBRYOLOGY OF THERMOBIA DOMESTICA PACKARD 1

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Cleavage in Thermobia domestica is superficial, the centrally located zygotic nucleus dividing repeatedly to give rise to daughter nuclei which migrate to the peripheral region of the egg. By 18-19 hours, these nuclei together with their cytoplasm, have formed a thin epithelium surrounding the yolk. The cells in this primary epithelium soon become more numerous at the posterior end of the egg, and by 25 hours a small germ disc may be seen at this end. Within a short time this disc elongates to form a germ band. The remainder of the primary epithelium becomes the serosa.

Beginning at about 40 hours, cells from the germ band begin to migrate inward toward the yolk. They form a deeply staining layer, the cells of which are flattened in a direction vertical to the cells of the germ band. The formation of this layer follows no regular pattern. Instead, cells migrate inward, apparently at random, from any part of the germ band. The outer, original germ band is ectoderm, while the newly formed inner layer is mesoderm.

As the germ band develops, it sinks into the yolk only very slightly. As it sinks inward, its edges give rise to a thin membrane connecting the edges of the germ band and the serosa. This new membrane is the amnion. The amnion never closes, so that the embryo is never completely covered by this membrane.

At 44-45 hours a slight invagination may be seen near the posterior end of the germ band. This is the beginning of a deep abdominal loop, which remains until eclosion. It is the point at which the embryo will be doubled back on itself when the embryo becomes longer than the egg. A little later the stomodeal and proctodeal invaginations become evident.

By the forty-sixth hour the head becomes distinguishable from the rest of the body by a transverse groove, and by 48-49 hours the mandibular, maxillary, and labial segments may be distinguished. The appearance of these segments is followed shortly by the appearance of the thoracic and abdominal segments. A pair of small evaginations, the appendage primordia, may be distinguished on each segment soon after the segment becomes apparent. The appendage primordia of the abdominal segments disappear within a short time, except for the pleuropodia on the first segment, which persist until just after blastokinesis. Coelomic sacs develop in each segment. Six segments appear in the head, three in the thorax, and eleven in the abdomen. Four pairs of coelomic sacs develop in the head, three in the thorax, and ten in the abdomen.

During the fourth day the serosa contracts at the anterior end of the egg, the cells at that point sinking into the yolk and disintegrating to form a secondary dorsal organ. As the serosa contracts, it pulls the amnion toward the anterior end of the egg. This membrane in turn pulls the embryo, head first, around to the ventral side of the egg. At no time during this process of blastokinesis does the embryo lose contact with the periphery of the egg.

2 a. B.S., Iowa State College, Ames, Iowa 1944.
   M.A., University of Kansas, Lawrence, Kansas, 1948.
As the embryo grows laterally upwards around the yolk, the cardioblasts appear at the junction of the splanchnic and somatic mesoderm. When the two sides meet, the cardioblasts form the tubular heart.

Spiracular invaginations form on the sixth day. A total of ten pairs develops, one pair on each of the first two thoracic segments, and one pair on each of the first eight abdominal segments. These ectodermal invaginations extend only a short distance into the body before they become indistinguishable from the mesoderm. As with the reproductive system, the tracheal system undergoes most of its growth after eclosion.

Germ cells were not seen in early stages of Thermobia. No oosome develops. The germ cells in the embryo are distinguishable later principally by their position ventromedial to the coelomic sacs. Reproductive organs are not apparent in the embryo. The fore-gut and hind-gut develop from ectodermal invaginations near the anterior and posterior ends of the body. They are very clearly ectodermal, as are the four Malphigian tubes which begin as evaginations from the hind-gut near its junction with the mid-gut.

The mid-gut epithelium develops later than the rest of the alimentary canal. At the time of hatching it is not complete. The cells present in this epithelium at eclosion arise from two sources: (1) proliferations from the ectoderm of proctodeum and stomodeum, and (2) cells migrating peripherally from the yolk. More of the cells have their origin from the latter source.

The nervous system develops in a manner common to most insects. Neuroblasts at each side of a neural groove give rise to ganglionic cells. Seventeen pairs of ganglia, exclusive of the brain, develop in Thermobia. One pair develops in each of the three gnathal segments, one pair in each of the three thoracic segments, and one pair in each of the eleven abdominal segments. Later the ganglia of abdominal segments nine, ten, and eleven fuse with the ganglia of abdominal segment eight.

The brain arises in a manner similar to that of the ventral ganglionic chain. The optic lobes, however, do not form from neuroblasts, but instead by delamination from the ectoderm of the eye region. Later, the eye plate forms in the ectoderm in the same region as that which gave rise to the optic lobes.

COMPARISON OF COSTS OF SERVICE AND SELF-SERVICE METHODS OF SELLING MEAT IN RETAIL FOOD STORES

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The question of the difference in cost between service and self-service methods of selling meat in retail food stores has been of interest to the retail food industry for a number of years. The major purpose of this study was to compare the costs of selling meat self-service with the service methods in various sizes of stores. A second major purpose was to determine how the cost varied as the size of the store increased.

Data for the study were collected in forty-nine meat departments in various size retail food stores. Twenty-six of these were service and twenty-three were self-service. A stratified random sample was used for service stores. This procedure was not strictly adhered to for self-service stores because of insufficient numbers over a desired volume range. The basis for stratification was dollar volume of meat department sales. The meat departments varied in size from $500 to $1,100 sales per week. Dollar volume of sales was used as a measure of size. Four cost factors were studied; these were labor, paper supplies, square feet of floor space and equipment investment. Generally, physical data were collected and converted to costs in dollar terms. It is believed these costs make up from 80 to 85 per cent of the cost of selling meat in retail food stores. It is also believed that the remaining costs, shared with the stores' other operations, would not alter the results. Comparisons between service and self-service methods were made in terms of both physical factors and dollar costs.

1 a. Chairman of Committee, Geoffrey Shepherd, Dept. of Economics and Sociology.
2 a. B.S. Southwestern Louisiana Institute, Lafayette, La., 1941.
b. M.S. Louisiana State University, Baton Rouge, La., 1950.
2 b. Research Associate, Agricultural Experiment Station.
Regressions of labor cost, floor space, equipment investment, paper supplies and a combination of these, in terms of combined cost, on meat department sales volume were computed for both service and self-service methods of selling meat. The significance of differences between the coefficients of regression for each method and between selected regression values was tested by means of students' 't' test at the one and five per cent levels of probability. The results of the study may be summarized as follows:

1. Physical hours of labor averaged lower under self-service than service methods from $500 to about $2000 sales per week. From $2000 to $7000 sales per week, self-service required more physical hours of labor.

2. When the physical hours of labor were converted to dollar costs, taking account of differences in job classifications and thus wage scales, the self-service method cost less throughout the range in size from $500 to $7000 sales per week.

3. Investment in equipment averaged from $400 higher in self-service meat departments at $500 sales per week to $3000 higher than service markets at $7000 sales per week.

4. There was no difference between the two methods in the average amount of floor space used by the meat department. Thus there would be no difference in the rental charge between the two methods of selling meat.

5. Cost of paper supplies averaged about 1.6 per cent of sales in self-service markets and about 1.2 per cent of sales in service markets.

6. When the dollar costs of labor, equipment, floor space (rent) and paper supplies were combined into one cost, no significant difference in cost could be observed between service and self-service methods of selling meat. The differences in the individual costs, noted above, apparently cancel when these costs are combined. Thus, at any given volume of sales (in the range $500 to $7000 per week) the average costs under service and self-service operation are apparently not sufficiently different to be considered of practical importance.

7. The average cost curves under both methods of selling show that the cost of retailing meat decreases considerably as the size (volume of sales) of the market increases. The cost decreases most as markets increase in size from $500 to about $3000 sales per week.

Several interesting conclusions may be drawn from the above results and from the general aspects of the study. They are briefly stated below:

1. Most stores that have converted to self-service have experienced an increase in sales volume. Thus, upon conversion, such stores would move along the average cost curve toward the right, and cost per pound would fall as sales increase.

2. Both service and self-service markets, at any given volume, can decrease their costs if they increase their volume. If the market is in a volume range less than $3000 sales per week, the decline in costs as sales volume increases is much greater than at sales volumes above $3000 sales per week.

3. Self-service meats will likely encourage the trend toward larger type food stores. The trend in new construction is toward larger stores and a change from service to self-service generally involves modernization and new construction.

4. Self-service methods may eventually lead to centralized pre-packaging. This might likely be done by firms set up for this function, by the packers, or by chains for their own stores. A number of instances of success in this field can be cited already and research is continuing. However, technological problems will likely delay this development for quite a few years.

5. Self-service has been an excellent solution to the "rush hour" problem. Consumer acceptance is no longer considered a major problem. Self-service meats ease the problem of skilled labor, increase the percentage that meat sales are of the total sales, promote rapid turnover thus decreasing inventory and are "in tune" with modern merchandising. It is most likely that self-service methods will in a few years account for the greatest proportion of meat sales.

6. Self-service methods have generally helped to move the economy cuts, often at higher prices. This is most likely a reflection of "real" consumers' preference which has not been given the opportunity to show up in service markets. Part of this study may also be due to impulse buying.

7. There is some reason to believe that self-service methods may be affecting the demand for meat, presumably increasing it. The determination of a change in demand is a complicated problem, however. The answer to the problem of a real change in demand will probably be delayed for a while until a sufficient number of self-service markets have been in operation for some time so that quantitative data can be made available for research purposes.
ACTION PATTERNS OF STARCH ENZYMES

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The actions of several enzymes on starch and starch degradation products were investigated by paper chromatographic studies. These enzymes included the phosphorylases of potatoes, of broad beans and of several other plants, salivary amylase, beta amylase of sweet potatoes and of soybeans, Q-enzyme from broad beans and from potato and R-enzyme from broad beans.

The limit dextrins from waxy maize starch were prepared with sweet potato beta amylase, potato phosphorylase and salivary amylase. Glycogen beta amylase limit dextrin was prepared with soybean beta amylase. The above limit dextrins are high molecular weight products, except for the salivary amylase limit dextrin.

The action of saliva proceeds in several phases. An initial rapid breakdown of amylopectin to maltose (G2), amyloctrose (G3), and amylotetraose (G4), and dextrins containing one to several branches per molecule is followed by a slower hydrolysis of G4 to G3. At a still slower rate, G3 is hydrolyzed to G2 and glucose and a series of four relatively stable branched dextrins ranging from 4 to 7 glucose units are formed. A second series ranging from 8 to about 13 glucose units contains two branches per molecule. Other higher compounds were formed. At an extremely slow rate, saliva caused the hydrolysis of maltose to glucose, with an accompanying weak transglycosidase activity. This was shown by the detection of small amounts of branched trisaccharide (B3) and G3 in the maltose digests. The action of a soybean beta amylase preparation on maltose and on G3 was shown to be very similar to that of saliva.

R-enzyme was definitely demonstrated to hydrolyze alpha-1,6 linkages by its conversion of isomaltose to glucose and of panose to glucose. The action of R-enzyme was tried on the above limit dextrins.

From the products obtained, it was concluded that the branches in phosphorylase limit dextrins were 3 and 4 glucose units long; the branches in the beta amylase limit dextrins were 2 and 3 glucose units long with some branches of 1 glucose unit. With extended beta amylase action, the 3 glucose unit branches are no doubt shortened by one maltose unit by beta amylase. Light acid hydrolysis studies gave similar results.

The branched limit dextrins from salivary amylase action on waxy maize starch were separated and isolated by paper chromatography. The action of R-enzyme was investigated on each. R-enzyme had only a slow action on the branched tetraccharide (B3) with the production of a small amount of glucose. About 50 per cent of the B3 fraction was readily hydrolyzed to G2 and G3. Approximately 75 per cent of the B4 component was hydrolyzed to G2 and G4. Substantially all of the B7 was hydrolyzed to G3 and G4. The results from acid hydrolysis studies of B4 and B7 and of their aldonic acids indicated that the B4 structure was either O-O-O- or O-O-O-O, and that B7 was either O-O-O-O- or O-O-O-O-O. (O-O-O-O indicates a maltose linkage; O-O indicates an isomaltose linkage).

Potato phosphorylase was used as a detecting reagent on the paper chromatograms. A chromatogram sprayed with a solution containing phosphorylase and glucose-1-phosphate and incubated in a moist chamber gave areas, after spraying with iodine, where starch synthesis was primed by certain sugars. Amyloctrose was a weak primer; amyloctetraose and higher linear sugars were very good primers. This reagent was much more sensitive in detecting priming sugars than the alkaline copper-phosphomolybdic acid sprays used for reducing sugars. The impure phosphorylases of broad beans, peas, jack beans, and lima beans had like priming needs which differed from those of potato and corn. Sugars containing one less glucose unit were effective as primers with these phosphorylases. Maltose was a weak primer for these phosphorylases.

Q-enzyme was shown to act on substrates of low molecular weight includ-
ing maltose, \(G_3\), \(G_4\), \(G_7\), isomaltose, panose and sucrose. From the results of experiments on these sugars it was concluded that \(Q\)-enzyme exhibited reversible transglucosidase action on 1,4 bonds and on 1,6 bonds in addition to its transfer of 1,4 and 1,4 bonds. \(Q\)-enzyme catalyzed the transfer of the glucose unit of sucrose to form 1,4 and 1,6 bonds.

**EFFECT OF MILK PRODUCTS RECONSTITUTED WITH DIFFERENT FATS ON GROWTH AND BLOOD CONSTITUENTS OF DAIRY CALVES**

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This study (divided into four experiments) was designed to study the effects of restricted milk diets containing various types and amounts of fat and other constituents upon certain physiological responses of the dairy calf. The criteria were body weights; incidence of diarrhea; vitamin A, carotenoids, fat, calcium, and inorganic phosphate levels of blood plasma; hemoglobin and reducing sugar levels of blood; vitamin A storage; and apparent digestibility of fat.

In experiment I, thirty-five calves were randomized into 8 groups and fed reconstituted milks at the rate of 10 pounds per 100 pounds of body weight daily. Supplemental vitamin A was administered in capsules. Rations with 84 per cent water contained the following solids, respectively: (a) 16 per cent non-fat dry milk solids, (b) 11 per cent non-fat dry milk solids and 5 per cent dried whey product, (c) 9 per cent non-fat dry milk solids and 7 per cent dired whey product, (d) 8 per cent non-fat dry milk solids and 8 per cent dried whey product, (e) 10 per cent non-fat dry milk solids and 8 per cent hydrogenated soybean oil, (f) 5 per cent non-fat dry milk solids and 5 per cent butter oil, (g) 10 per cent non-fat dry milk solids and 3 per cent hydrogenated soybean oil, (h) 10 per cent non-fat dry milk solids and 3 per cent hydrogenated soybean oil, (i) 10 per cent non-fat dry milk solids and 3 per cent hydrogenated soybean oil, (j) 10 per cent non-fat dry milk solids and 3 per cent hydrogenated soybean oil. Rations containing 87 per cent water included, respectively: (a) 13 per cent non-fat dry milk solids, (b) 10 per cent non-fat dry milk solids, (c) 13 per cent non-fat dry milk solids, (d) 13 per cent non-fat dry milk solids, (e) 13 per cent non-fat dry milk solids, (f) 13 per cent non-fat dry milk solids, (g) 13 per cent non-fat dry milk solids, (h) 13 per cent non-fat dry milk solids, (i) 13 per cent non-fat dry milk solids, (j) 13 per cent non-fat dry milk solids.

Scouring was less frequent on rations containing fat than on milks of approximately equal caloric value composed only of reconstituted milk solids - not - fat. Moreover, it was observed that inclusion of dried whey product resulted in more scouring both in low-fat groups and in groups fed hydrogenated soybean oil. It was further observed that approximately 1.6 pounds of milk solids -not-fat per 100 pounds of body weight daily were required in low-fat diets for support of satisfactory growth. When lesser amounts of milk solids -not-fat were fed, growth was markedly sub-normal. These data served as guides in formulating rations for further study.

In experiment II, milks containing 87 per cent water included the following solids, respectively: (a) 10 per cent non-fat dry milk solids and 3 per cent hydrogenated soybean oil, (b) 5 per cent non-fat dry milk solids, 5 per cent dried whey product and 3 per cent hydrogenated soybean oil, (c) 10 per cent non-fat dry milk solids and 3 per cent butter oil, (d) 5 per cent non-fat dry milk solids, 5 per cent dried whey product, and 3 per cent butter oil. Rations containing 82 per cent water included, respectively: (a) 18 per cent non-fat dry milk solids, (b) 13 per cent non-fat dry milk solids and 5 per cent butter oil, (c) 10 per cent non-fat dry milk solids and 3 per cent hydrogenated soybean oil, (d) 10 per cent non-fat dry milk solids and 3 per cent hydrogenated soybean oil. Whole milk (3 per cent fat) was fed to animals in a control group. All milks other than whole milk were homogenized. Feeding rate was 10 pounds of milk and 12,000 International Units vitamin A per 100 pounds body weight daily. Seven calves were allotted at 4 days of age to each ration and the experiment continued to sixty days of age.

Plasma vitamin A levels were similar and initially averaged 16.5 micrograms per cent for whole milk and butter oil groups. The final mean for all calves fed milk fat was 15.2 micrograms per cent. Average values for low-fat and hydrogenated soybean oil groups decreased from 18.4 to 10.8 micrograms per cent during the same period. Blood plasma carotenoid data were similar for calves.
in the whole milk and the butter oil groups. The initial mean value for calves fed milk fat was 21.6 and the terminal level was 13.6 micrograms per cent. For calves in the other groups (low-fat and hydrogenated soybean oil) the mean initial carotenoid value was 20.4 and the final level was 1.3 micrograms per cent. These differences were due at least in part to differences in the amounts of vitamin A and carotenoids ingested.

Mean plasma fat concentrations were highest for calves in the whole milk group, initially averaging 127 and increasing to 165 mg. per cent when calves were 60 days of age. Butter oil groups were next highest, initially averaging 120 and decreasing to 152 mg. per cent. Hydrogenated soybean oil groups had an initial average of 118 and a final mean of 78 mg. per cent. Values for low-fat groups decreased from an initial mean of 125 to a final average of 30 mg. per cent. There were no apparent adverse physiological effects resulting from low blood plasma fat levels.

Since there were no apparent differences among the various dietary groups in the other blood constituents investigated, the group mean values were combined to establish average trends for calves in the restricted dietary regimes employed in this study. The mean values at 4 and at 60 days, respectively, were reducing sugar, 86 and 64 mg. per 100 ml. blood; hemoglobin, 12.2 and 10.2 grams per 100 ml. blood; calcium, 12.0 and 10.1 mg. per 100 ml. blood plasma; and inorganic phosphate, 6.7 and 5.9 mg. per 100 ml. blood plasma.

One or more calves from each of the various dietary regimes in experiment II were depleted of vitamin A reserves to measure vitamin A storage (experiment III). Calves removed from whole milk were not depleted in eight weeks. Animals from the butter oil groups reached depletion in a minimum of six to eight weeks. Hydrogenated soybean oil and low-fat groups were depleted in one to four, and three to six weeks, respectively.

Limited digestion balance trials (4-day preliminary periods and twenty-four hour collection periods) were used to investigate the digestibility of hydrogenated soybean oil. Results indicated that the apparent digestibility of this oil is approximately 92 per cent which is similar to that of butter fat.

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GENETIC COVARIATION OF EGG PRODUCTION AND OTHER ECONOMIC TRAITS IN POULTRY

ANDY JACK WYATT

Departments of Poultry Husbandry and Genetics

The primary purpose of this investigation was to estimate heritabilities and genetic correlations involving certain performance traits in chickens.

Data from nine breeds, which included 38 distinct lines of breeding, were studied. These data involved 1960 pullets from 609 dams and 159 sires and covered a five-year period. Traits studied were egg weight, egg production rate for three periods, and body weight at eight weeks, at housing, and in March. Housing weights were corrected to a constant age.

Preliminary analyses indicated that date of hatch had little influence on the traits studied. Interactions of lines with hatches were found to be negligible.

Genetic analyses were based on intra-line and year variances and covariances. Heritabilities and genetic correlations were calculated from regressions of daughter on dam.

Estimates of heritability, adjusted for an average inbreeding of 19 per cent, were as follows: egg weight, 0.52; production rate (December 1 to March 1), 0.11; production rate (March 2 to May 31), 0.0; production rate (first egg to May 31), 0.0; body weight at eight weeks, 0.39; housing weight, 0.18; March body weight, 0.52. These estimates are biased to the extent that epistasis is important.

Negative genetic correlations of -0.43 between winter rate and egg weight and -0.31 between winter rate and March body weight were found. Even though these cor-
relations are subject to large sampling errors, they indicate that selection for increased winter rate will be accompanied by a decrease in both egg size and March body weight. These antagonistic genetic relationships, together with the low heritability found for egg production, may be responsible for the slow progress in breeding for egg production in recent years. Estimates of genetic correlation among the body weights were all positive and high. In addition, the genetic correlation between egg weight and March body weight was 0.30. Hence, selection for March body weight would appear to improve body weight at other ages as well as egg weight but would decrease winter rate.

Presence of negative genetic correlations between desirable traits, such as those found in this study, limits the genetic progress possible by selection. Selection based on production rate alone would soon need to be interrupted to give attention to the decrease in egg weight and March body weight which would result.

INTERACTION BETWEEN PROTEINS AND SURFACE ACTIVE IONS

JEN-TSI YANG
Department of Chemistry

In recent years numerous investigations have been published on the protein-ion interaction. Of particular interest are the surface active ions which exhibit markedly strong affinity for proteins as compared with other organic ions and thus produce many diverse effects on proteins and biological systems. This field of interest is, however, not yet fully exploited and, consequently, controversy with regard to the nature of binding between proteins and surface active ions still exists. Therefore, in this thesis it was attempted to further investigate such binding affinity, to clarify at least part of the foregoing controversy, and to correlate the protein-ion interaction with the structural changes of the protein.

I. Competitive Interaction between Proteins and Surface Active Anions.

Three proteins, ovalbumin, bovine albumin and zein, and a surface active anion, sodium dodecylbenzenesulfonate (SDBS), were studied electrophoretically. Stable complexes of albumin-SDBS were prepared by two methods: (1) prolonged dialysis of mixtures of protein and excess SDBS against distilled water, or (2) acid precipitation of albumin-SDBS complexes, followed by redispersion in alkaline solution. Zein-SDBS complex was prepared by extracting the protein in excess with SDBS solution.

Definite interaction between Zein-SDBS and ovalbumin was observed with the appearance of an ovalbumin-SDBS component at the expense of the native ovalbumin. No displacement reaction occurred with mixtures of Zein-SDBS and bovine albumin. Likewise, ovalbumin removed the bound anion from bovine albumin-SDBS complex, but no interaction was detected for mixtures of ovalbumin-SDBS and bovine albumin. It was postulated that competitive interaction is closely related to the different binding affinities of the proteins for the anions.

II. Interaction between Proteins and Surface Active Cations.

Electrophoretic analyses of mixtures of albumins and zephiran, a surface active cation, revealed strikingly different behavior between the two proteins studied. In the case of ovalbumin an "all-or-none" reaction took place, whereas for bovine albumin the cation was only loosely adsorbed.

Preparation of protein-zephiran complexes failed. Mixtures of ovalbumin and zephiran yielded gels on prolonged dialysis, mixtures of bovine albumin and zephiran yielded regenerated protein. This again indicated the difference in binding affinity between the proteins and close relation between interaction and denaturation.
III. Quantitative Study of Interaction between Protein and Surface Active Anion.

The combination of bovine albumin and ovalbumin with SDBS was studied by a combination of equilibrium-dialysis and electrophoresis. SDBS could be determined in the dialyzates by ultraviolet absorption ($\lambda_{\text{max}} = 223 \text{ m\text{	extmu}}$) at concentrations as low as $10^{-5} \text{ M}$. The binding curve covered a wide range of SDBS concentration, the protein concentration being kept constant. Electrophoretic analyses revealed three regions in the binding curve for bovine albumin. In the first stage (region A) interaction was statistical with a limit of about ten ions per molecule. In the second stage (region B) the reaction was "all-or-none", giving rise to a complex containing about fifty ions, which corresponded to about one-half of the basic groups of the protein. In the third stage (region C) statistical combination again occurred, no upper limit being attained even in saturated SDBS solution under the conditions employed (in phosphate-NaCl buffer of pH $= 7.6$ and ionic strength $= 0.20$, at 1-3°C.).

Kinetic study at constant SDBS activity indicated that the reaction in region B was of the first order with respect to the protein. Complete reversal of the second and third stages was not achieved, indicating the strong binding affinity between the protein and surface active anion. The binding curve was also concentration-dependent to some extent. Quantitative studies were somewhat complicated by the inhomogeneity of the surface active compounds employed.

Similar experiments were conducted for the binding of SDBS of ovalbumin. The first statistical stage was found to be absent, whereas the second "all-or-none"

stage appeared with binding of about forty ions per molecule of the protein, which was equivalent to one ion per basic group of the protein.

A hypothesis was suggested for the binding process. The first stage was postulated as a fast reversible reaction, involving no structural change of the protein. Probably only virtual equilibrium was attained in region B, due to the irreversible and the slow characteristics of the "all-or-none" step. This step was presumed to involve denaturation of the protein. In region C the protein molecule was further disrupted by the penetration of surface active ions in a statistical manner. Controversy on the binding process as raised in the literature was thus at least partly clarified. The absence of the initial region A in the case of ovalbumin suggested that this protein was more labile than bovine albumin and was denatured by the first ions bound. This was in good agreement with the conclusion obtained in Parts I and II.

IV. Some Flow Birefringence Studies of Protein-Surface Active Anion Complexes.

Denaturation of protein-SDBS complexes was briefly investigated with flow birefringence measurements. Both ovalbumin-SDBS and bovine albumin-SDBS complexes (prepared by acid precipitation method) exhibited strong anisotropy of flow, indicating the unfolding of the protein molecule. The interpretation of the results, however, was complicated by the state of aggregation. Future methods of approach were outlined. It was pointed out that correlation of protein denaturation with the nature of binding would offer one of the most promising sources of information on protein structure.
TOXICITY AND TRANSLOCATION OF HERBICIDES

DALE W. YOUNG

Department of Botany and Plant Pathology

The effectiveness of a herbicidal mixture depends upon its acute or chronic toxicity, combined with the ability of the plant to translocate a lethal amount into the roots and growing regions. Some herbicides exhibit maximum acute toxicity, destroy foliage on contact, and may be described as chemical mowers. Contact herbicides are effective on annuals but have limited value on perennial plants.

Herbicides exhibiting chronic toxicity may be divided into those that are absorbed by the roots and translocated to the above ground tissues, and those absorbed by leaves and translocated to the below ground tissues. In general, translocated herbicides exhibit low initial toxicity. Injury to the plant is cumulative and chronic toxicity may be manifest first in the meristematic regions, then throughout the plant.

The purpose of this study was to measure the relative toxicity of various herbicides, with special emphasis on synergistic effects of herbicidal combinations, and to determine the factors affecting translocations of herbicides.

Toxicity

Toxicity was studied by treating vegetation on field and ballast areas with various chemicals and combinations of chemicals at all seasons of the year, at varying rates and concentrations per acre.

Fifty pounds of TCA sodium salt and 80 pounds of sodium chlorate per acre have given generally good control of quack grass, smooth brome grass and miscellaneous weeds. This mixture is definitely synergistic, and results with it have been as good as with 400 pounds of sodium chlorate used alone and better than 100 pounds of TCA alone. TCA-chlorate was the least expensive of the treatments and was not significantly poorer than the best.

CMU was tested extensively. Rates of 20 pounds per acre have given excellent control of quack grass and smooth brome grass. Ten pounds of CMU in combination with 80 pounds of sodium chlorate per acre has given an effective control as 20 pounds of CMU used alone on most plants in Iowa. The addition of two pounds per acre of 2, 4-D, DNC or 10 gallons of oil to a CMU spray has not increased the toxicity.

Early applications of herbicides, just as the perennial grasses appear in the spring, have given better results than late spring, and mid-summer or later applications may give poor control. The CMU-chlorate spray applied in April or May held the areas free from weeds during the season, but allowed reinfestation with annual weeds the next year. TCA-chlorate sprays were nearly as effective on perennial plants, but reinfestation with annuals was more rapid. At present, follow-up treatments with toxic oils could be used at a total cost below that of CMU-chlorate.

Oil with an aromatic content above 50 per cent and a boiling range between 500 and 700° F. may be an effective contact herbicide. At least two sprays of the high aromatic, high cycle oils at rates of 60 gallons per acre were necessary. The oils can be applied for approximately the same price as burning, with the advantage of no fire damage and some preservative value for ties and rails. The special value of oils probably lies in re-treatments after perennials have been removed by other chemicals.

Translocation

Translocation studies were conducted in field areas with mesquite, using the shield method, and in the greenhouse with soybeans, using a leaf immersion technique. Results are reported as the amount of branch kill or inhibition of the trifoliate leaves. 2,4,5-T and 2,4-D esters or amines with wetting agents were translocated equally well in mesquite, while in soybeans high concentrations of some esters were not translocated as readily as amines. Oil emulsions of 2,4-D salts were more effective than aqueous solutions. The action of the oil is not known. It has been thought to facilitate penetration, possibly by keeping the herbicide in moist contact with the plant tissue longer than water solutions. These experiments have shown that it is the emulsifying or wetting agent that increases the effectiveness of the herbicides, and the oil is of limited value.

Translocation was slowed or stopped
Translocation of herbicides was not significantly reduced when plants were under stress for moisture. However, when plants were under stress for moisture, growth was reduced, differentiation accelerated and absorption of chemicals was slower. In mesquite there was no correlation between accumulated rainfall before treatment and translocation of herbicides.

Toxic materials combined with 2,4-D reduced translocation by injuring the translocated tissues. In soybeans, 0.5 per cent toxic wetting agent prevented translocation of 2,4-D at concentrations above 500 ppm., while, with a similar concentration of nontoxic wetting agent, translocation of 2,4-D increased with the concentration up to 10,000 ppm. A toxic wetting agent, however, permitted translocation of lower concentrations of 2,4-D than a nontoxic wetting agent.
**MASTERS' THESSES**

Accepted July 1, 1952 - June 30, 1953*

**SUMMARY AND INDEX**

The following summaries and indices may prove helpful to those interested in tabulations and to those who may wish to examine theses in the same or related fields.

Index to Masters' theses by departments. The departments are arranged alphabetically. Under each department are listed alphabetically the names of the authors.

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* A list of Masters' theses accepted July 1, 1951 - June 30, 1952 is included in No. 2, Vol. 27 of the Iowa State College Journal of Science.
The titles of theses are arranged in alphabetical order by names of authors. Each listing includes the name of the author, the title of the thesis, and the department.

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Cohen, Robert Mortimer. Performance of a pulse extraction column. Chemical Engineering.

Cleveland, Iola Zoe. Certain factors related to the use of time by home economics students in one high school. Vocational Education.


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Snell, Absalom West. Settlement of terraces constructed on two Iowa soils. Agricultural Engineering.


Stone, James Albert. Effect of wavelength contrast on discrimination thresholds under mesopic vision. Psychology.


Suhr, Virtus William. Relationship of personality traits and certain psycho-sociological factors to driving performance of commercial drivers. Vocational Education.


Swift, Fred Calvin. Effects of indane seed treatments on germination and early growth of field corn. Zoology and Entomology.


Thomas, Walter Ivan. Heritability and interrelation of popping volume and some agronomic characteristics in popcorn. Agronomy.

Thompson, William Walter. Localized applications of DDT to the corn plant and their effects on corn borer mortality (Pyrausta nubilalis Hubner). Zoology and Entomology.

Thornburg, Margaret Ann Cochran. Effect of insecticides on the rate of pulsatile organs in the legs of Myzus persicae Sulzer. Zoology and Entomology.

Tracy, George Abner. Magnesium-uranium alloy system. Chemistry.


Vavra, Lewis Robert. Sex differences in certain factors of space judgment under conditions of mesopic vision. Psychology.

Vilo, Wesley Michael. Industrial arts general metalwork for secondary schools. Vocational Education.

Vil, Edner. Influence of dietary fat on...
susceptibility of Dermestes maculatus De Geer to selected insecticides.
Zoology and Entomology.


Willard, Charles Osborn. Prior achievement, aptitudes and interests associated with the election of senior high school sciences. Vocational Education.

Williams, Elsie Kimbrell. Effectiveness of television as a teaching medium for clothing construction. Vocational Education.

Williams, Wayne Watson. Fundamental properties of five Iowa sands. Geology.


Woolverton, Charlene Lee. Differences in opinions of mothers and daughters about suitable content for eighth grade home economics courses. Vocational Education.


Young, Donald Fredrick. Flow of aqueous suspensions of rounded glass particles. Theoretical and Applied Mechanics.


PUBLICATIONS OF MEMBERS OF THE STAFF
OF THE IOWA STATE COLLEGE FOR
THE ACADEMIC YEAR 1952-53

Certain summaries and indices are of interest in a survey of the publications of members of the staff of an educational and research institution such as the Iowa State College. The publications are listed in alphabetic order under the names of the senior authors. Junior authors are also listed alphabetically with cross reference to senior author.

**SUMMARY**

- Number of individuals listed: 532
- Number of publications: 538
- Number of publications with joint authorship: 313
- Number of publications with single author: 225
- Number of departments or fields represented in publications: 42
- Number of individuals who serve as editors or on the editorial staff of one or more scientific or technical periodicals: 23

The individuals thus serving are: Bartley, Benbrook, Brosier, Burroughs, Carlander, Douglas, Gaskill, Gilman, Gowen, Heady, Heath, Heer, Hooker, Johnson, Kirkham, Loomis, Murphy, Nelson, Parks, Pierre, Tintner, Underkofler, Weber.

**INDEX TO PUBLICATIONS BY DEPARTMENTS OR FIELDS**

The numbers which follow the names of the departments refer to the index number of the alphabetic list by authors.

**Agricultural Engineering:** Total 12 - Numbers 50, 114, 125, 138, 160, 174, 175, 176, 345, 346, 512, 513.


**Animal Husbandry:** Total 24 - Numbers 7, 78, 79, 80, 86, 87, 88, 89, 90, 107, 149, 293, 302, 321, 353, 362, 376, 404, 405, 407, 408, 413, 414, 538.

**Bacteriology:** Total 7 - Numbers 154, 322, 388, 412, 413, 414, 437.


**Chemical Engineering:** Total 8 - Numbers 12, 13, 30, 77, 134, 216, 449, 480.


**Child Development:** Total 4 - Numbers 244, 245, 246, 406.

**Civil Engineering:** Total 12 - Numbers 29, 36, 37, 98, 109, 110, 115, 131, 318, 330, 355, 463.


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Electrical Engineering: Total 8 - Numbers 55, 56, 57, 220, 283, 284, 378, 515.
Engineering Administration: Total 1 - Number 267.
Engineering Extension: Total 2 - Numbers 68, 69.
English and Speech: Total 4 - Numbers 47, 339, 340, 520.
Foods and Nutrition: Total 7 - Numbers 85, 394, 420, 421, 451, 452, 479.
Food Technology: Total 10 - Numbers 2, 27, 150, 304, 381, 474, 475, 476, 504, 505.
Forestry: Total 3 - Numbers 68, 81, 127.
Genetics: Total 3 - Numbers 207, 218, 272.
History and Government: Total 9 - Numbers 4, 5, 6, 208, 209, 210, 211, 212, 390.
Home Economics Education: Total 3 - Numbers 341, 395, 396.
Horticulture: Total 8 - Numbers 73, 74, 103, 120, 327, 328, 398, 485.
Household Equipment: Total 1 - Number 351.
Institution Management: Total 1 - Number 20.
Landscape Architecture: Total 1 - Number 484.
Library: Total 4 - Numbers 70, 242, 383, 384.
Mathematics: Total 7 - Numbers 54, 96, 97, 488, 489, 490, 491.
Mechanical Engineering: Total 2 - Numbers 303, 304.
Modern Language: Total 2 - Numbers 121, 146.
Physical Education for Men: Total 1 - Number 347.
Physics: Total 21 - Numbers 8, 9, 11, 31, 32, 33, 76, 135, 170, 294, 301, 331, 343, 344, 361, 363, 364, 472, 478, 524, 525.
Psychology: Total 1 - Number 168.
Statistics: Total 7 - Numbers 10, 278, 305, 312, 313, 348, 522.
Science Administration: Total 1 - Number 173.
Textiles and Clothing: Total 1 - Number 436.
Theoretical and Applied Mechanics: Total 2 - Numbers 177, 271.
Vocational Education: Total 8 - Numbers 75, 111, 112, 126, 307, 386, 430, 526.
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10. Andersen, D. joint author. See under Fassel.


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36. ---, joint author. See under Bivens.
37. Barnes, K.K., joint author. See under Prevert.

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Benkeser, R.A., joint author. See under Gilman.
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229. The old and new at Storm Lake State Park. Iowa Conservationist. 12:105, 111. 1953.
Hansen, R. D., joint author. See under Hansen, R. S.


245. Hawk, V. B., joint author. See under Wilkie.


253. Use and estimation of input-output relationships or productivity coefficients. Jour. Farm Econ. 34:775-786. 1952.


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275. Humphrey, J. E., joint author. See under Fritz.


300. What the census shows about Iowa farms and farm families. Iowa Farm Sci. 1:161-162. 1953.


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313. _____, and O.B. Tandon. The estimation of heritability by regression of offspring on parent.  
   Biometrics. 9:90-100. 1953.
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315. . Studies in avian neoplasia. II. The estimation of Rous virus-neutralizing antibodies in sera collected from flocks experiencing losses due to lymphomatosis.  
316. . Studies in avian neoplasia, III. Incidence of Rous virus-neutralizing antibodies and lymphomatosis in chickens inoculated with neoplastic and normal tissue suspensions.  
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Kitts, W.D., joint author. See under Underkofler.
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Koerner, J.F., joint author. See under Sinsheimer.
Koning, A.L., joint author. See under Hamilton.
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356. Miller, C. F., joint author. See under Spedding.


358. Mills, B., joint author. See under Walker.


365. Morton, J. W., Jr., joint author. See under Gilman.


380. ___ , joint author. See under Dumenil.


387. Overland, R. N., joint author. See under Smith.


394. Park, O. W., joint author: See under Rothenbuhler.


396. Park, O. W.; joint author: See under Rothenbuhler.


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398. L. E. Peterson. See under Hooker.

399. J. L. Pflasterer. See under Banks.

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424. Ryser, F.C., joint author. See under Deane.


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