# Proceedings and Transactions

*of*

# THE TEXAS ACADEMY OF SCIENCE

## 1941

VOLUME XXV

Austin, Texas
Published by the Academy
1942

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## FOREWORD

The Texas Academy of Science held its General Meeting with the American Association for the Advancement of Science and Associated Societies in Dallas, Dec. 29, 1941, at the Baker Hotel. One hundred and seventy-one papers prepared by Texas authors were presented at this meeting. The Publication Committee endeavored by mail to contact these authors to obtain abstracts and manuscripts. Some of the authors had sent their papers to appropriate Journals, and their manuscripts were not available for the Proceedings and Transactions. A few responded that they were continuing their research and were not ready for publication. The Committee judged many other papers to be more suitable for technical scientific Journals than for our publication.

Two important changes in policies have been adopted: First, *Proceedings* and *Transactions* are to be one publication. Second, the list of members is to be issued every third year by the Treasurer and is not to be included in the *Proceedings*.

We wish to thank all who have cooperated and aided us in our work.

*Chairman, Publication Committee.*

October 1, 1942.

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### BIOLOGICAL SCIENCES—Continued



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## OFFICERS AND ELECTED COMMITTEES FOR 1942

### OFFICERS

*President*, Elmer P. Cheatum, S. M. U.
*Executive Vice-President*, Frederick A. Burt, A. & M.
*Vice-President, Section I*, W. M. Craig, T. T. C.
*Vice-President, Section II*, W. G. Hewatt, T. C. U.
*Vice-President, Section III*, T. H. Etheridge, S. H. S. T. C.
*Vice-President, Section IV*, L. W. Blau, Houston.
*Vice-President, Section V*, Gordon Gunter, Texas Game, Fish and Oyster Commission, Rockport.
*Secretary*, Leo T. Murray, Baylor University.
*Assistant Secretary*, G. E. Potter, A. & M.
*Editor*, Frank J. O'Hara, St. Edward's University.
*Treasurer*, Otto Watts, Hardin-Simmons University.
*Representative to the A. A. A. S.*, S. W. Bilsing, A. & M.
*Chairman Collegiate Division*, J. C. Godbey, Southwestern University.
*Chairman Junior Academy*, Greta Oppe, Galveston.
*Immediate Past President*, O. A. Ullrich, Southwestern University.

### BOARDS (Chairman named first)

*Directors*, E. P. Cheatum, L. P. Murray, O. O. Watts, O. A. Ullrich, Clyde Reed (life), W. T. Gooch, '43, W. A. Price, '44, J. C. Godbey, '42.

*Constitution and Judiciary*, E. P. Cheatum, '47, O. A. Ullrich, '46, W. T. Gooch, '44, F. B. Isley, '43, Don O. Baird, '42, J. C. Godbey, '42, F. A. Burt, '46, L. T. Murray, '47.

### STANDING COMMITTEES

*Program*, G. E. Potter, W. M. Craig, W. G. Hewatt, T. H. Etheridge, L. W. Blau, Gordon Gunter, Greta Oppe, J. C. Godbey.

*Publications*, F. J. O'Hara, W. P. Taylor, S. W. Geiser, W. T. Gooch, Claude C. Albritton, Jr., T. S. Painter, S. B. McAlister.

*Auditing*, Luther Jones, F. M. Getzendaner, J. K. Silvey, Paul C. Witt, Spurgeon Smith.

*Nominations*, B. C. Sharp, W. T. Gooch, O. A. Ullrich, S. W. Bilsing, W. M. Winton.

*Affiliations*, W. G. Hewatt, Don O. Baird, G. E. Potter, E. B. Walker.

*Junior Academy*, Greta Oppe, Addison Lee, Secretary; S. W. Hayes, Editor; R. W. Strandtmann, Contest Director; Adda Reid Templeton, Membership Chairman; Leo T. Murray, Senior Academy Secretary; Velma Wilson, Hoyt Williams, Helen Dumont, Willis Floyd.

*Finance*, Otto Watts, F. A. Burt, E. P. Cheatum, Leo T. Murray.

*Library,* S. W. Bilsing, G. E. Potter, Don O. Baird.

*Membership,* R. E. Hungate, Don O. Baird, E. E. Deevey, W. T. Gooch, J. N. Michie.

*Regional Meetings,* O. A. Ullrich, E. P. Cheatum, Leo T. Murray.

*Research Grants,* T. S. Painter, W. W. Floyd, R. A. Studhalter, O. E. Sperry.

*Collegiate Division,* J. C. Godbey, C. C. Doak, G. E. Potter, F. J. O'Hara.

## SPECIAL COMMITTEES

*Publicity,* George E. Potter, Mayne Longnecker, Victor Gerlach, Ellen Schultz Quillen, Greta Oppe, Addison Lee.

*New Fellows,* J. C. Godbey, George E. Potter, Gordon Gunter, Willis Hewatt.

*Necrology,* Clifton C. Doak, Don O. Baird, E. N. Jones, John A. Yarbrough.

*Handbook Science,* W. Armstrong Price, B. C. Tharp, F. B. Isley, S. W. Bilsing.

*Oberholser Bird Book,* O. A. Ullrich, S. W. Geiser, Ellen Schultz Quillen, Walter P. Taylor.

## SOCIETIES AFFILIATED WITH THE ACADEMY

Central Texas Section, American Chemical Society
Dallas Astronomical Society
Dallas Nature Study Club
Dallas Ornithological Society
El Paso Archaeological Society
Houston Museum and Scientific Society
North Texas Biological Society
San Antonio Science Club
Texas Archaeological and Paleontological Society
Texas Association of Science Teachers
Texas Entomological Society
The Texas Folk-Lore Society
Texas Nature Federation
University Science Club
The Texas Society of College Teachers of Education
West Texas Historical and Scientific Society

## RESUME OF MINUTES OF BUSINESS SESSION

The Texas Academy of Science met in a final business session of the year at the Baker Hotel in Dallas, 9:15 a. m., Wednesday, December 31, 1941, President O. A. Ullrich presiding.

Officers and committee representatives reported as follows:

**Secretary.** Frederick A. Burt submitted his report in book form and presented orally the following summary of the work of the Academy during the year 1941:

The Academy has held four regular meetings during the course of the year, the annual meeting at San Antonio, November 7-9, inclusive, and the

Regional meetings at Commerce and Edinburg, April 25-26, and at Lubbock April 28 to May 1.

The Academy is organized by being divided scientifically into five sections, regionally into three branches, and scholastically into three divisions. The five sections are: I, Physical Sciences; II, Biological Sciences; III, Social Sciences; IV, Geological Sciences; and V, Conservation. The branches of the Academy comprise the South Texas, the West Texas, and the East Texas branches named in the order of their organization. The Scholastic Divisions are the Senior Academy, the Collegiate Division, which is composed of Chapters of College Science clubs, and the Junior Division, consisting of Chapters of High School Science clubs.

At the annual meeting held in San Antonio, the Senior Division of the Academy held eleven scientific sessions, in which seventy-nine papers were presented. There were also two business sessions, two social sessions, and one field trip.

At the same meeting, the Collegiate Division held two scientific sessions, at which fourteen papers were presented. One business session and one social session were also held.

The Junior Academy Division held two scientific sessions during the annual meeting, at which nineteen papers were presented. One social and one business session were held.

The business matters of the Academy are conducted by three boards and by various committees. The Board of Directors have held two meetings, both at Dallas. The Executive Council has held six meetings, two at Dallas, two at Waco, and two at San Antonio. The Constitution Board has held one meeting at Dallas.

Various committees have held many meetings, detail records of which will be found in the unabridged report of the Secretary, together with the unabridged minutes of the Board meetings above referred to.

At the present time the Academy has a paid-up membership of 679, exclusive of the local members of the Collegiate and Junior Academy chapters. There are fourteen Collegiate chapters and thirty-two Junior chapters. The Senior Academy has no organized local chapters.

**Treasurer.** Dr. Otto O. Watts stated that his books were in the hands of the auditor; hence, he could not make a detailed report at this meeting.[1] He said, however, that all officers and committees had used less than their budget allowances. The Academy now has funds on hand to clear all its outstanding indebtedness.

**Report of the Auditing Committee.** Luther G. Jones, Chairman of the Auditing Committee, reported that the committee had placed the books in the hands of Thomas W. Leland, certified public accountant, for auditing. This work had not been completed. It was moved and adopted that the Executive Council be empowered to receive the Auditor's report when it was completed.

[1]This report was made at the meeting of the Executive Council, February 21, 1942, and is included in the minutes of that meeting, page 11.

**Publication Committee.** Chairman H. H. Fletcher reported for his committee that it had used $710.17 of a budget of $800.00. Sixteen hundred copies of the *Transactions of The Texas Academy of Science* and the same number of the *Proceedings of the Texas Academy of Science* had been printed.

**Junior Academy of Science Committee.** Miss Velma Wilson, a member of this committee, reported that there were thirty-five chapters members of the Junior Academy at this time. All had participated in carefully planned meetings. The committee was sponsoring a publication, *TexSciana*, for members of the Junior Academy.

**Collegiate Division Committee.** J. C. Godbey, Chairman of the committee, reported that one new charter had been granted during the year, bringing the number of chapters up to thirteen. An excellent program had been prepared and rendered at the annual meeting held at Southern Methodist University.

**Handbook of Science Committee.** W. Armstrong Price, Chairman of the committee, submitted the following report, which was read by Frederick A. Burt:

The policy of the Committee and Anson Jones Press adopted June 10, 1939, has resulted in the publication of two of the thirty-five manuscripts of the *Handbook* series as brochures, namely, *Vegetation* by Tharp, and *Marine Life* by Reed.

The lapse of two years between 1939 and 1941 was due to much more work being done on the unfinished Reed manuscript than was contemplated by publisher or committee chairman. The committee advised the publisher, however, that the date of completion of this manuscript was indeterminate. He chose it nevertheless, alleging that it was the most salable of the list.

It is considered that the plan of publishing brochures has not been a success and Anson Jones Press now agrees to amend the contract so as to proceed at once to publish Volume One, the committee to select the manuscripts for it.

The Chairman has reported these and other attendant details to the Board of Directors and has been requested to proceed as above outlined. He has offered to pass the job of Editor of the *Handbook* on to someone who can push its publication more actively, but has been urged by the Board to continue to serve due to the loss of time required for a successor to familiarize himself with the manuscripts.

**Oberholser Book Committee.** This committee reported that it was working on plans to finance the Oberholser book on the birds of Texas but had nothing definite to record at this time.

**Necrology.** E. N. Jones, Chairman, reported the following list of our membership who have passed away during the year:

Dr. James R. Bailey, Organic Chemist.
Major John B. Hawley, Consulting Engineer.
Dr. Robert T. Hill, Geologist, Writer.
Dr. T. U. Taylor, Educator, Engineer.
Robert A. Thompson, Engineer.

Four of this list were Honorary Life Fellows in the Academy.

"In the name of the Texas Academy of Science, your committee extends to the relatives and friends of the deceased our sincere sympathy in their bereavement."

**New Business.** The following men were elected "Fellow" of the Texas Academy of Science: I. B. Boughton, Geo. T. Caldwell, J. W. Calhoun, T. N. Campbell, W. T. Chambers, W. M. Craig, Joseph Davies, R. C. Goodwin, Z. T. Huff, Forrest Kirkland, W. O. Milligan, W. C. McGavock, Arlo Smith, C. S. Smith, L. W. Storm, W. R. Woolrich, Arthur Young.

**Election of Members.** Don O. Baird, Chairman of the Membership Committee, proposed the names of thirty-three new members for election, and reported that this brought the total of new members for the year to 147. All of the candidates for membership were unanimously elected.

## EXECUTIVE COUNCIL MEETING

Dallas, December 31, 1941

Immediately following the adjournment of the final business session, the Executive Council held a short meeting in the Baker Hotel, President E. P. Cheatum, presiding.

Father Frank J. O'Hara asked to be relieved of his duties as Councilor of the Collegiate Division, since he had been elected Editor for the coming year. His request was granted and Dr. C. C. Doak was elected to the place of Councilor of the Collegiate Division.

J. C. Godbey was re-elected Chairman of the Collegiate Committee. Miss Greta Oppe was chosen Chairman of the Junior Academy Committee. Frederick A. Burt was approved as a member of the finance committee.

## EXECUTIVE COUNCIL MEETING

A. & M. College, February 21, 1942

The Executive Council of the Texas Academy of Science met in a called session, February 21, 1942, at A. & M. College, President E. P. Cheatum presided.

After a thorough discussion it was decided to hold the 1942 annual meeting at A. & M. College, November 12-14, if possible. The present emergency may necessitate a change in either time or place.

The report of the Treasurer for the year 1941 was presented and approved as follows:

**Report of the Treasurer on the 1942 Budget, and the Financial Condition of the Academy on Feb. 21, 1942**

| | | |
|---|---|---|
| Note Retirement | | $300.00 |
| Interest on Notes | | 6.00 |
| Outstanding Bills: | | |
| Membership Committee | $56.35 | |
| Collegiate Division | 18.50 | |
| Anson Jones Press | 9.00 | |
| F. A. Burt | 1.40 | |
| Total Outstanding Bills | | 85.25 |
| President | | 75.00 |

| | | |
|---|---|---|
| Secretary | 75.00 | |
| Treasurer | 75.00 | |
| Const. Jud. Board | 35.00 | |
| Collegiate Division | 25.00 | |
| Junior Division | 60.00 | |
| Membership Committee | 50.00 | |
| Auditing Committee | 25.00 | |
| Publication Committee | 800.00 | |
| Contingency | 50.00 | |
| Annual Meeting | 25.00 | |
| Total Budget | | $1,686.25 |

*Receipts for Year*

| | | | |
|---|---|---|---|
| Balance at Beginning of Year | | $267.72 | |
| Dues Collected | | 267.00 | |
| Other Collections: | | | |
| E. S. Quillen, Cactus Books | $289.10 | | |
| E. S. Quillen, Refund | 6.80 | | |
| S. W. Bilsing, Transactions | 1.50 | | |
| Total Other Collections | | $297.40 | |
| Total Receipts | | $832.12 | |

*Paid Out of the Budget*

| | | | |
|---|---|---|---|
| Note Retirement | $300.00 | | |
| Interest on Notes | 6.00 | | |
| Outstanding Bills | 85.25 | | |
| Treasurer | 5.00 | | |
| Total Expenditures | | $396.25 | |
| Balance on Hand | | | $ 435.87 |

OTTO O. WATTS, *Treasurer.*

## JUNIOR ACADEMY DIVISION

### OFFICERS 1941-1942

*General Chairman,* GRETA OPPE, Ball High School, Galveston.

*Secretary-Treasurer,* ADDISON LEE, Austin High School, Austin.

*Editor,* S. W. HAYES, Austin High School, Austin.

*Contest Director,* R. W. STRANDTMANN, East Texas State Teachers College, Commerce.

*Membership,* ADDA REID TEMPLETON, Longview High School, Longview.

### REGIONAL DIRECTORS

Velma Wilson, South Texas; Helen Dumont, Central Texas; Willie Floyd, West Texas; Mrs. Edna Miner, East Texas.

### ANNUAL FALL REPORT

The Secretary submitted his report regarding expansion of the Junior Division and included the following program:

1. Increased active understanding and effort by the Senior Division of the Academy.

2. Additional publicity through articles for magazines, newspapers, and journals by chapter sponsors and members of the Academy Committee.

3. Effort to secure active support of high school principals and superintendents in order to make membership more permanent.

4. Effort to secure active support of college teachers (both science and education teachers) who teach prospective high school teachers.

5. Effort to secure membership of more large city school clubs.

6. Endorsement and recommendation of the State Department of Education.

The project of writing service booklets was submitted to the sponsors who approved the plan for the series.

The sponsors were notified of the approval given by the Executive Council of the Senior Academy last spring to furnish each chapter with one copy of the *Proceedings* and *Transactions* of the Academy.

A design for a bronze membership pin which could be purchased by all chapter members was submitted. This pin will be about ⅝″ across and in the shape of the State of Texas with a star in the center and having the raised letters T. J. A. S. around the star. This design was officially adopted and authorization was made for the Junior Academy Committee to make a short-term contract with a suitable company for the manufacture of these pins.

Representatives from the Austin High School invited the Central Texas Division of the Junior Academy to have their regional meeting for the coming spring in Austin. The Central Texas represented sponsors approved.

The sponsors approved the Junior Academy exhibit and recommended continuation of this activity for future meetings.

The final results of the Chicago Apparatus Company Contest were as follows:

1st Place: Mike Ramsey, Abilene High School, Abilene, Texas.
2nd Place: Marjorie Holcomb, Austin High School, Austin, Texas.
3rd Place: John D. Byous, Commerce High School, Commerce, Texas.

The A. A. A. S. honorary memberships were awarded to Mathis Blackstock, Austin, and Mary Adele Robert, Commerce. Honorable mention for this honor was given to John Byous, Commerce, and Patsy Tucker, Austin.

## PUBLICATION REPORT

I. **Texas Junior Academy of Science 1942 Bulletin of Information.** This is a 44-page mimeographed bulletin which contains the purpose, history, organization, rule, and regulation, constitution, membership, activities and awards, and a list of projects, demonstrations, and scientific papers for the Junior Academy. It also contains a chapter with suggestions on the organization and maintenance of a science club.

II. **Service Bulletins.** Three of the series of service bulletins have been written and accepted. They are (1) *Science in Verse;* Y. T. S. Botanical Society, Austin High School, Austin, Texas; (2) *Free and Inexpensive Science Teaching Aid,* William A. Betts, Austin High School, Austin, Texas; and (3) *An Insect Guide for High School Students,* Lillian H.

Gantt, Paschal High School, Fort Worth, Texas. Mrs. Gantt has already presented the Academy with copies of the Service Bulletin No. 3, and these are available by writing to the Junior Academy Secretary. The other service bulletin will be made available just as soon as possible.

III. **The TexSciana.** Recent improvements in the publication of the *TexSciana,* which is the official news publication of the Junior Division, include (1) specific dates for publication, (2) pictures and diagrams, (3) exchange column, (4) listings of science opportunities in various Texas Colleges.

| Town | Club | Sponsor |
|---|---|---|
| Commerce | East Texas Ornithology Club | Mr. R. W. Strandtmann |
| Brownsville | Science Club | Mrs. Ruth Wright |
| Austin | Raymond Ditmars Scientific Soc. | Mr. S. W. Hayes |
| Austin | Y. T. S. Botanical Society | Mr. Addison Lee |
| Fort Worth | Science Club | Mrs. Lillian Gantt |
| Corpus Christi | Texas Order of Science | Mr. B. E. Schulze |
| Denton | Denton Science Club | Miss Genelia Lewis |
| Galveston | Science Club | Miss Greta Oppe |
| Commerce | Star Gazers' Club | Mr. R. E. Alexander |
| Waco | Waco Chapter T. J. A. S. | Miss H. Dumont |
| Mt. Pleasant | Phi-bi-chem Club | Mr. Frank Stinson |
| Sour Lake | The Big Thicket Science Club | Miss A. Barnes |
| Commerce | Chemphybiogens | Mr. H. Williams |
| Abilene | Julius Olsen Club | Miss Willie Floyd |
| Houston | Lamar Chapter T. J. A. S. | Mrs. Edna Miner |
| Conroe | Travis Club | Mr. Jack Oney |
| Longview | Lithium Chapter T. J. A. S. | Miss A. R. Templeton |
| Pilot Point | Chem-bigens | Mr. James Wheeler |

## COLLEGIATE DIVISION

### OFFICERS FOR 1942

*President,* JAMES ALLEN, Southwestern University.
*First Vice-President,* NANCY BOWER, Mary Hardin-Baylor College.
*Second Vice-President,* MALCOLM MALEY, Hardin-Simmons University.
*Secretary,* CONSTANCE JONES, Incarnate Word College.
*Counselor,* DR. C. C. DOAK, A. & M. College.
*Committee,* J. C. GODBEY, C. C. DOAK, GEORGE E. POTTER, FATHER FRANK J. O'HARA.

### PROGRAM OF ANNUAL MEETING

December 29, 1941

1. "The Photelometric Method for the Determination of Cholesterol," Constance Jones, Incarnate Word College.
2. "Some Common Fossils of Bell County," Lucille Adair, Mary Hardin-Baylor College.
3. "Perfumes and Flavors," Elma Jean Fowler, Mary Hardin-Baylor College.
4. "Plastics," Clara Ng, Our Lady of the Lake College.

5. "Effects of Three Dusts in Control of the Turnip Aphid," D. C. Thurman, A. & M. College.

6. "The Quantitative Study of the Effect of Five Common Mouth Washes on the Oral Flora," Mary Lundeen and Olivette Rheiner, Incarnate Word College.

7. "Copper from Chili," Nancy Bower, Mary Hardin-Baylor College.

8. "Fluorescence Phenomena and Their Demonstration," William Henry, University of San Antonio.

9. "Chemiluminescence," Marche Burt, Mary Hardin-Baylor College.

## PROGRAM OF EASTERN REGIONAL MEETING

May 9, 1942

1. "Preliminary Notes on Chermid Leaf Galls Affecting Yaupon," Albert W. Jackson, A. & M. College.

2. "Desiccated Blood Plasma: A New Life Line," George Willeford, A. & M. College.

3. "Fall and Winter Activities of the Mole in East Texas," James S. Durell, A. & M. College.

4. "Nomenclature and Synonymy of the Female Sex Hormones," Helen T. Pratt, University of Houston.

5. "Natural Color Photomicrography," George Rose, University of Houston.

## COLLEGIATE CONTEST

The Texas Academy of Science, through the generosity of a close friend who prefers that his name be omitted, offered $25.00 in cash to the members of the Collegiate Division who produced the best papers at our annual meeting. The following were winners in the contest: 1st, Constance Jones, Incarnate Word College; 2nd, Marche Burt, Mary Hardin-Baylor College; 3rd, D. C. Thurman, A. & M. College.

## MINUTES OF COLLEGE DIVISION COMMITTEE

The Collegiate Division Committee of the Texas Academy of Science met at College Station, February 21, 1942, at which all members were present. The following decisions were made: 1st, The Collegiate Division will participate in all Regional meetings; 2nd, The President was encouraged to write to all the member clubs and collect interesting data to be put into a bulletin to be mimeographed and distributed to the membership; 3rd, An attempt will be made to increase the amount devoted to prizes at the annual meeting and to divide these prizes into two classifications, namely, papers of the essay type and papers of the research type and to give awards in both fields; 4th, It was deemed expedient to present the work of the Collegiate Division to other colleges and universities in the State in an effort to encourage them to join with us in the enlargement of the Collegiate Division.

## CLUBS AND SPONSORS

Abilene Christian College Science Club, Paul C. Witt.
A. & M. United Science Clubs, Dr. C. C. Doak.
Beta Beta Beta (Baylor University), Dr. Leo T. Murray.

Curie Science Club (Our Lady of the Lake College), Sister Mary Clarence.
Hardin-Simmons University Science Club, Dr. O. O. Watts.
Mary Hardin-Baylor College Science Club, Dr. Amy Levesconte.
North Texas State Teachers College Science Club, Dr. L. P. Floyd.
Phi Sigma Kappa (Incarnate Word College), Sister Michael Edwards.
St. Edward's Academy of Science, Father Frank J. O'Hara.
Sam Houston State Teachers College Science Club, Dr. S. R. Warner.
Sigma Delta Chi (East Texas State Teachers College), Dr. Elsie Bodeman, Mrs. Emily Barry Walker.
Southwestern University Science Society, Dr. J. C. Godbey.
Stephen F. Austin State Teachers College Science Club, Dr. Hal B. Parks, Dr. Roy H. Adams.
University of San Antonio Science Club, Dr. William C. McGavock.

## Photelometer and Cholesterol*

CONSTANCE JONES, Incarnate Word College, San Antonio

The Photelometer is a photoelectric instrument applicable to accurate analytical work. It is comparatively new and is used industrially for the determination of molybdenum, manganese, and copper in steel; and in chemical and clinical laboratories for determining creatinine,[13] hemoglobin,[12] bilirubin,[6,11] non-protein nitrogen, urea, sulfanilimide, and many other substances. One of the very effective applications of the Photelometer, when specially constituted for the purpose, is the measurement of particle size and specific area of finely divided materials.[14]

The theoretical aspects of this instrument were explained in a paper given last year by Miss June Pike.

The operation of the Photelometer is exceedingly simple and rapid. The test solution is put into the absorption cell and the pure solvent into a similar one. With the pure solvent the instrument is quickly adjusted to read 100 on the millimeter. The test solution is then moved into position and the meter reading noted. This reading is quickly translated into concentration from a chart or calibration curve. The instrument is extremely sensitive to even the slightest changes in concentration and it is especially reliable in that it eliminates errors due to fatigue or after-images, such as occur in visual colorimetry. The Photelometer requires no comparison standards at the time of making the measurement. A single calibration of the instrument with solutions of known concentration provides the "comparison standard" for an indefinitely long period.

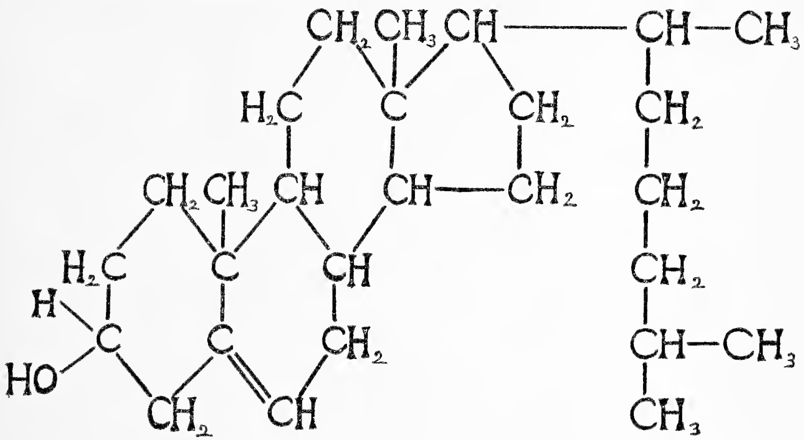
One peculiarity of the Photelometer is that each instrument must be calibrated individually, but a single calibration holds indefinitely; hence the calibration must be done with the greatest accuracy.

The Photelometer used in our laboratory has been calibrated for hemoglobin determinations by Sanford, Sheard, and Osterberg at the Mayo Clinic. Last year Miss June Pike calibrated it for blood sugar. And now that cholesterol has come into prominence as a very important factor in health, the calibration of the Photelometer for this substance was undertaken.

*Prize winning paper of Collegiate division.

Cholesterol is an essential constituent of all living animal cells.[3] The fact that there is a gradually increasing amount from 0.5% in the fetal to almost 2% in the adult brain may be an index to its importance.[16] The dependence of cholesterol metabolism on thyroid function is indicated by the marked increase in blood cholesterol (hypercholesterolemia) in conditions of hypo-thyroidism and the tendency to low values in hyperthyroidism. Hypercholesterolemia occurs also in diabetes, chronic hemorrhagic nephritis, and especially in the so-called nephrosis.[4] The structural formula as given by Windaus shows clearly that cholesterol is a mono-basic, secondary alcohol.[3] (Table 1.)

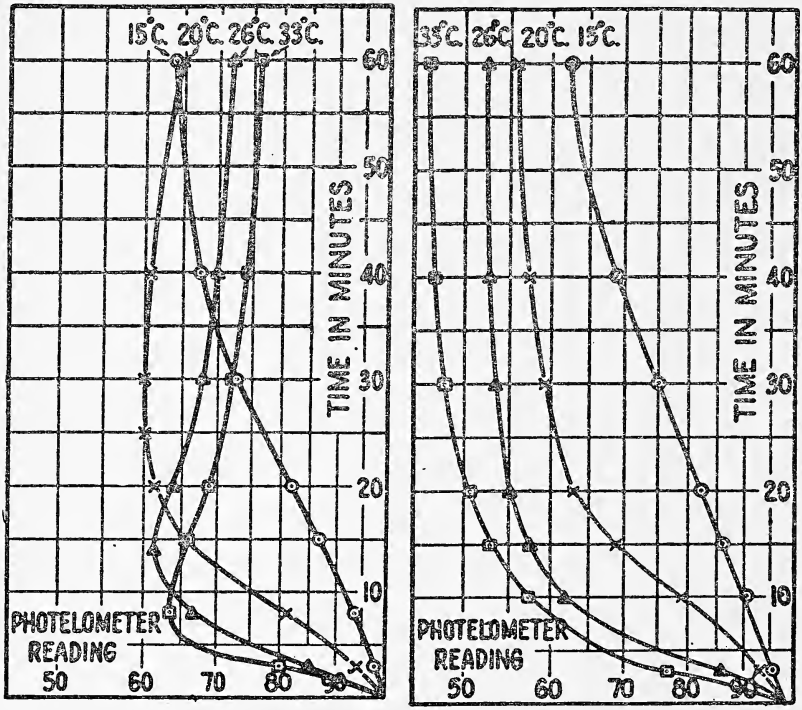
Table 1. WINDAUS FORMULA OF CHOLESTEROL.



It will be recalled that in her experiment for the determination of blood sugar, Miss Pike used a blue filter in the photoelectric cell, since the absorption bands of the blood sugar were in the region of the blue. For the determination of cholesterol, either a blue or an orange filter may be used, but the latter is preferable since the reading can be made at maximal value after a short time, as is evident from the curves of Table 2. Besides, colored impurities in the reagents give little blank with an orange filter. Since the time of reading can be fixed more readily than the temperature, it is best to make the readings with the orange filter in exactly ten minutes, at a temperature of 26° C. or slightly above, for at this time, and at this temperature range, change of temperature effect is at a minimum. This can be readily seen by referring to Table 2.

The points for the calibration curve were obtained by determining the readings on the Photelometer for known concentrations of cholesterol. Many trials were made before a satisfactory curve was obtained. To obtain the various solutions of known concentrations, a stock solution was made by transferring exactly forty milligrams of cholesterol to a 250 cc. volumetric flask and making it up to the mark with chloroform. Then 0, 1, 2, 3, and 4 cc. of this solution were diluted to 5 cc. with chloroform, making solutions representing blood serum containing respectively 0, 80, 100, 240, and 320 mg. of cholesterol per 100 cc. Accuracy in this work is all important. The dilutions are best made in a precision-grade glass-stoppered cylinder. However, they can also be made by measuring the chloroform in the same size pipette as that used for the cholesterol stock solution.

Table 2

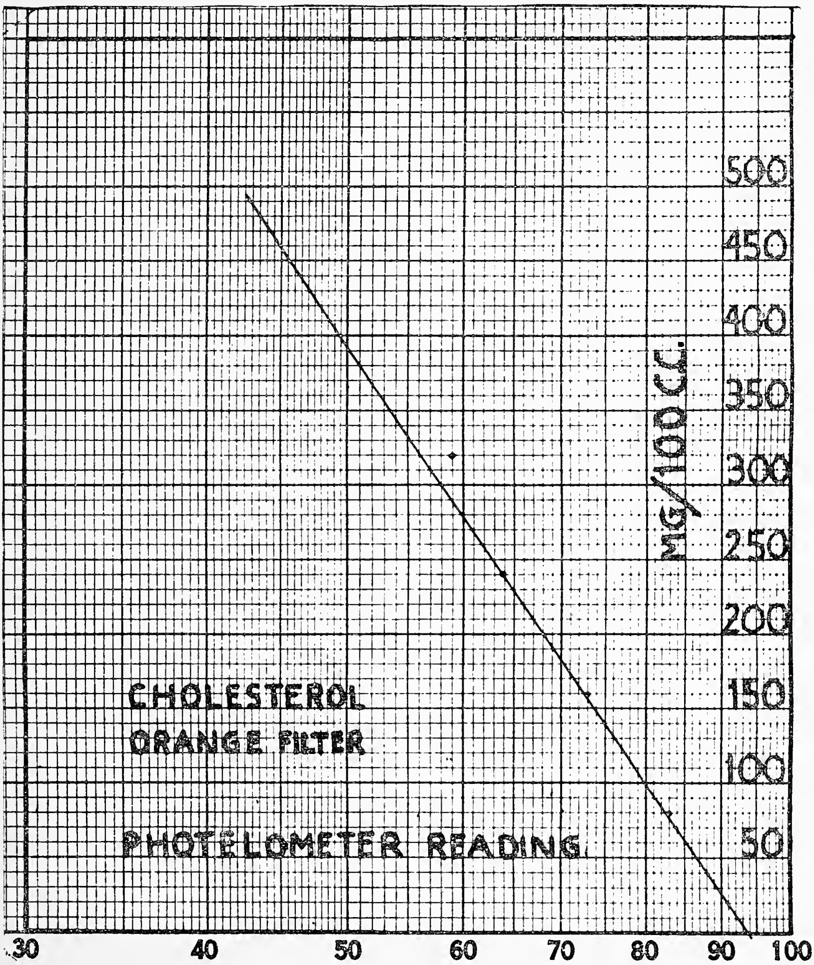



**The relationship between light-absorption and time of the development of the color in the Liebermann-Burchard reaction, at various temperatures, (left) with orange filter, (right) with blue filter.**

To each of the various solutions of known concentrations 5 cc. of acetic anhydride-sulfuric acid reagent were added. (15 cc. acetic anhydride, 1 cc. sulfuric acid, 24 cc. chloroform.) Then the mixture was put in a water bath at 26° C. and allowed to stand for 9 minutes. Finally the solution was transferred to the absorption cells and the Photelometer reading for the solution taken one minute after the removal from the water bath.[7] The most obvious error is the fact that, according to the curve at the zero concentration of the cholesterol, the millimeter does not read 100 (Table 3). This was due to the fact that the 40 mg. of cholesterol was weighed on an ordinary analytical balance which was not accurate enough for the work. The weights had not been calibrated for some time and had evidently gained weight. For the next stock solution, a very sensitive chainomatic balance was used, and this error was corrected (Table 4). The points on this curve also demonstrate another of the various sources of error. The first three points are in a straight line, while the fourth is far out of line

(Table 3). This was perhaps due to the fact that a one cc. pipette was used for the first three, while a graduated pipette was used for the last. This error was corrected by using the same pipette throughout the entire process of calibration.

Table 3



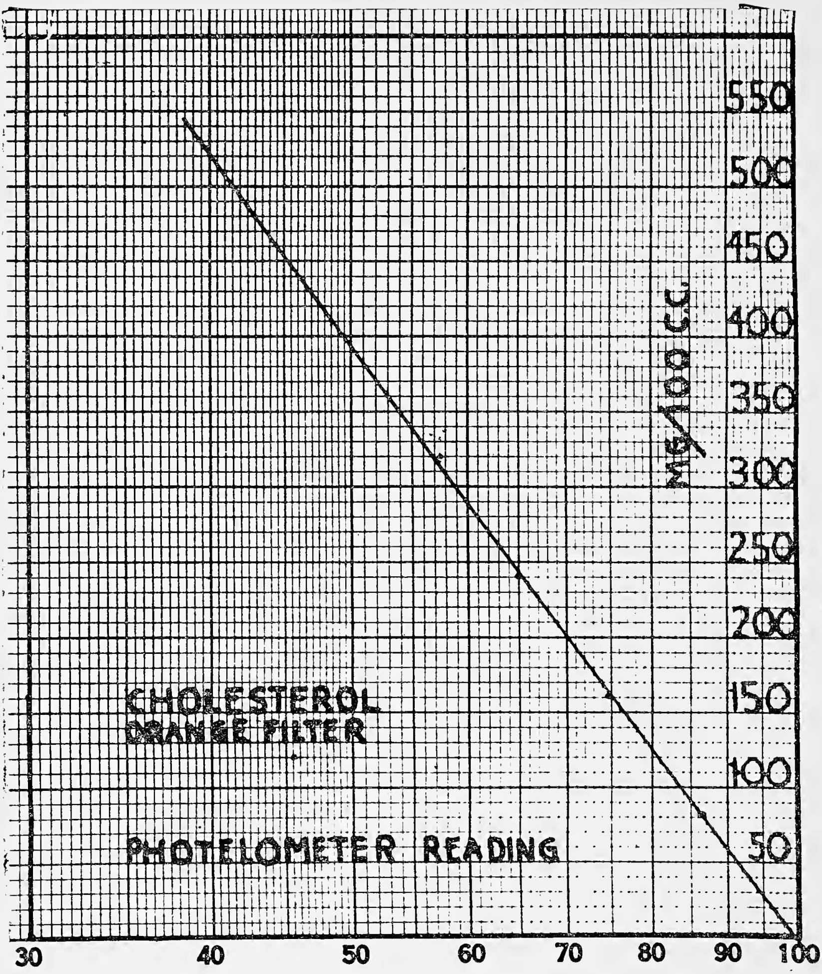

(Two errors made in the several trials.)

From Table 5 it is possible to tell at a glance the concentration of the cholesterol from the Photelometer reading.

In order to demonstrate the rapidity and simplicity of Photelometric determinations in comparison with other methods a number of experiments were conducted in the laboratory. Cholesterol was extracted from sheep brains, gallstones, and human blood.

For the extraction of cholesterol from sheep brains, the method includes the dehydration of the brain with plaster of Paris and the subsequent

Table 4




Final calibration curve for cholesterol for the Photelometer in our laboratory.

percolation of the material with hot acetone. The acetone-soluble material consists principally of cholesterol with other lipids from the brain. The extracts were concentrated under reduced pressure and the mixture was allowed to cool over night in the refrigerator. Cholesterol crystals were filtered off, dissolved in alcohol, decolorized with Norit, filtered, allowed to crystallize and then to recrytallize from hot absolute ethyl alcohol. They were then dried at 100°C. The melting pt. was 146°C. which checked closely with critical tables. The specific rotation of the crystals in chloroform is —36.11° at 15°C. The results obtained corresponded within two per cent.[10]

Gallstones were obtained from several local hospitals in San Antonio and submitted to the following procedure in order to obtain cholesterol: The material was crushed and extracted with a mixture of equal volumes of alcohol and ether. The residue was removed on a dry filter and the filtrate was evaporated almost to dryness on a warm water bath. The precipitate was put in a flask and enough five per cent solution of potassium hydroxide was added to yield 10 cc. for each gram and the resulting solution was allowed to reflux for two hours. The cholesterol was precipitated by pouring it into several volumes of water. It was extracted several times with ether, washed with water, then dried over anhydrous sodium sulfate. The ether layer was filtered off, and the cholesterol crystals were obtained and checked.

Table 5. CALIBRATION CHART FOR CHOLESTEROL
(Obtained from Table 4)

| *Phl. | *Cho. | Phl. | Cho. | Phl. | Cho. | Phl. | Cho. | Phl. | Cho. |
|---|---|---|---|---|---|---|---|---|---|
| 100.0 | 0 | 82.0 | 109 | 71.5 | 185 | 61.0 | 272 | 50.5 | 377 |
| 99.0 | 5 | 81.5 | 112 | 71.0 | 189 | 60.5 | 277 | 50.0 | 382 |
| 98.0 | 11 | 81.0 | 116 | 70.5 | 193 | 60.0 | 281 | 49.5 | 389 |
| 97.0 | 16 | 80.5 | 119 | 70.0 | 198 | 59.5 | 286 | 49.0 | 394 |
| 96.0 | 21 | 80.0 | 122 | 69.5 | 200 | 59.0 | 291 | 48.5 | 400 |
| 95.0 | 27 | 79.5 | 125 | 69.0 | 204 | 58.5 | 295 | 48.0 | 406 |
| 94.0 | 34 | 79.0 | 129 | 68.5 | 209 | 58.0 | 300 | 47.5 | 411 |
| 93.0 | 40 | 78.5 | 133 | 68.0 | 212 | 57.5 | 305 | 47.0 | 417 |
| 92.0 | 45 | 78.0 | 137 | 67.5 | 216 | 57.0 | 310 | 46.5 | 422 |
| 91.0 | 51 | 77.5 | 140 | 67.0 | 221 | 56.5 | 315 | 46.0 | 428 |
| 90.0 | 58 | 77.0 | 143 | 66.5 | 225 | 56.0 | 320 | 45.5 | 434 |
| 89.0 | 63 | 76.5 | 147 | 66.0 | 230 | 55.5 | 325 | 45.0 | 440 |
| 88.0 | 70 | 76.0 | 150 | 65.5 | 234 | 55.0 | 330 | 44.5 | 447 |
| 87.0 | 75 | 75.5 | 155 | 65.0 | 240 | 54.5 | 335 | 44.0 | 451 |
| 86.0 | 80 | 75.0 | 158 | 64.5 | 244 | 54.0 | 340 | 43.5 | 459 |
| 85.0 | 88 | 74.5 | 161 | 64.0 | 248 | 53.5 | 345 | 43.0 | 466 |
| 84.5 | 93 | 74.0 | 165 | 63.5 | 251 | 53.0 | 350 | 42.5 | 471 |
| 84.0 | 94 | 73.5 | 169 | 63.0 | 254 | 52.5 | 355 | 42.0 | 479 |
| 83.5 | 99 | 73.0 | 172 | 62.5 | 260 | 52.0 | 360 | 41.5 | 485 |
| 83.0 | 100 | 72.5 | 178 | 62.0 | 263 | 51.5 | 365 | 41.0 | 491 |
| 82.5 | 105 | 72.0 | 180 | 61.5 | 268 | 51.0 | 371 | 40.5 | 499 |
| | | | | | | | | 40.0 | 506 |

*Phl.—"Photelometer" Reading
*Cho.—Number Grams of Cholesterol per 100 cc. Blood

Blood was obtained from the local hospitals and also from students in the college laboratory. It was submitted to the following procedure in order to determine the quantitative estimation of cholesterol in blood. 0.2 cc. of serum were allowed to dry on a filter paper disc and then extracted with approximately 4 cc. of boiling chloroform for 60 minutes in a Leiboff extraction tube. The resulting solution was made up to 5 cc. with chloroform and then treated in a manner similar to those for calibration.

Table 6 shows the comparison between the determination of cholesterol by the Colorimeter and the Photelometer. There is a slight variation in the two determinations and it seems that the Photelometer would be more accurate due to the constancy of the Photronic cell.[7]

Table 6

COMPARISON OF THE AMOUNT OF CHOLESTEROL IN BLOOD SERUM BY THE USE OF THE COLORIMETER AND THE PHOTELOMETER

**Colorimeter**

| Patient No. | Standard | Unknown | Mg./100 cc. |
|---|---|---|---|
| 1. | 20 | 16.4 | 244 |
| 2. | 20 | 15.8 | 256 |
| 3. | 20 | 16.4 | 244 |
| 4. | 20 | 16.8 | 238 |
| 5. | 20 | 15.2 | 263 |

**Photelometer**

| Patient No. | Phl. | Mg/100 cc. |
|---|---|---|
| 1. | 64 | 248 |
| 2. | 63 | 254 |
| 3. | 64.5 | 244 |
| 4. | 65.5 | 234 |
| 5. | 62 | 263 |

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# TRANSACTIONS

## PHYSICAL SCIENCES

Chairman: G. R. TATUM, Baylor University

Professor W. M. Craig, Texas Technological College, was elected chairman of the Section for 1942.

### ABSTRACTS

**Certain tests for randomness applied to data grouped into small sets,** EDWARD L. DODD, University of Texas.—Randomness may be illustrated by the throws of a die, such as 2, 5, 3, 6, 6, 1, 3, 4, 2, 3, 6, 4, . . . In a long series, it is expected that each of the six numbers, 1, 2, 3, 4, 5, and 6 will occur with about equal frequency,—each "about one-sixth of the time." However, it is the *irregularity* in the *order* of their appearance that is of importance for *randomness*.

Sampling based upon numbers involving too much regularity may lead to fallacious results. For example, if we wish to estimate the average cost of residences in a city and take as the sample only those residences with a number ending in 01, like 701 or 2301, we would get a very poor sample. The houses would be corner houses, presumably more expensive on the average than those in the city at large. Such numbers have insufficient irregularity.

In 1927, L. H. C. Tippett published Random Sampling Numbers, Tracts for Computers No. XV, Cambridge University Press, edited by Karl Pearson. In the main, these numbers were taken from census reports by methods which were thought to introduce the same irregularity in their order of appearance as might be expected if ten balls numbered 0, 1, 2, 3, 4, 5, 6, 7, 8, and 9 were placed in a box, and drawn singly, with replacement and shaking after each drawing. The Tippett Table covers 26 pages with 1600 digits on each page, making 41,600 digits in all. These Tippett numbers have been used extensively by statisticians. Most writers have regarded the order of these numbers as adequately irregular. But G. Udny Yule expressed a doubt.

It is conceivable that any series of numbers, however regular, might result from a pure chance process, such as drawing numbers from a bag or numbered cards from a pack. But chance usually introduces the irregularity desired for sampling problems.

Based upon the theory of probability, certain tests have been devised to determine whether the expected irregularity in a series of numbers is actually present. Kendall and Smith in a paper in the Journal of the Royal Statistical Society, 1938, present four such tests. Professor Dodd suggests four tests. One is a modification of the Kendall-Smith "*poker test*" for two of a kind, etc., the other modification securing classes with more uniform expected frequencies. One test examines the *range* of a fixed set of numbers, say four numbers in sequence, the range being the difference between the greatest and the least number in the set. Two tests are based upon the *order* of numbers in a set; and in one of these *maxima* and *minima* are considered. All the tests contemplate the use of *chi-square* procedures. In tabular form, some algebraic results are presented to assist in carrying out the tests. The paper is to appear in *Econometrica*.

**Contributions to the knowledge of codehydrogenase I**, FRITZ SCHLENK, Department of Preventive Medicine and Public Health, University of Texas, School of Medicine, Galveston, Texas.—Since the preparation of Codehydrogenase I (nicotinamide containing coenzyme) in a pure state was first described in 1936 a number of other methods for its preparation have been published which frequently do not give sufficient evidence that the products obtained are pure.

The use of proper reference standards for coenzyme determinations in tissues and other materials is an important condition for obtaining uniform results. Wide discrepancies in results have caused confusion in this field.

Therefore, attempts were made to extend the previously elaborated methods of testing the purity of codehydrogenase I, especially by preparing some characteristic derivatives of it. The methods are to be described and a critical review of the test reactions will be given.

**Utilization of petroleum products by the chemical industry**, LEWIS F. HATCH, University of Texas.—During a period of national emergency the spectacular and vital part an industry plays in supplying essential war materials often overshadows the long term trends in the industry. These influences, however, are present and being manifest in spite of the temporary dislocation of emphasis. The present effect which the petroleum industry has at this time and will have in the future on the chemical industry is a case in point.

Almost without exception, the important chemical producers are those whose operations are based upon the utilization of the cheap and plentiful raw materials—air, coal and water. When we set up the conversion of cheap and plentiful raw materials to be the criterion for the establishment and expansion of profitable chemical operations, petroleum appears to be a basic material of vast possibilities to the industry. Petroleum as a source of raw material has the advantages of abundance, low cost, wide distribution, ease of transportation, and a composition receptive to an ever-widening variety of reactions.

The first individual compound to be manufactured on a large commercial scale from a raw material supplied by a petroleum refinery was isopropyl alcohol made from propylene. This development marked the entry of the synthetic organic chemical industry into a new and profitable period—a period marked by the ever increasing use of refinery and natural gas as a raw material. Today a number of different reactions are used to change these saturated and unsaturated hydrocarbons into more useful compounds. The sulfuric acid absorption of olefins followed by hydrolysis and other reactions is still the most important means of producing a variety of alcohols, ketones, ethers and other products. Chlorination is used in the preparation of amyl alcohol and its derivatives from pentane. By the chlorohydrination or oxidation of ethylene, followed by other reactions, ethylene glycol and its derivatives are prepared. Recently an oil company has announced a process for making glycerol from propylene employing a new high temperature chlorination technique developed by them. Another company is nitrating low molecular weight paraffin hydrocarbons to produce nitroparaffins.

The wide variety of compounds thus produced from petroleum appears in many industries. The largest users are the manufacturers of coating agents and allied products, synthetic resins, plastics and fibers and in printing inks, cosmetics, and medicinal preparations. They are also used in dewaxing of mineral oils and extraction of vegetable and animal materials. Methyl and isopropyl alcohols are used extensively as a component of anti-freeze solutions. Ethylene glycol is used extensively as the heat exchange medium in liquid cooled airplane and tank engines. The alcohols and ketones furnish chemical raw material for the synthesis of a great many types of compounds including esters, chlorides, xanthates, fruit essences, perfumes, dyestuffs and wetting agents.

All of these uses are essentially those of a world at peace. A number of chemicals such as butadiene, toluene, and ethyl alcohol are now being furnished by the petroleum industry for use to further our war effort. These same war chemicals have great potential peace time utilization, and the expanded production capacity resulting from the present abnormal demand will be reflected in the chemical industry in the peace to follow. When there have been made available large amounts of an inexpensive chemical, new uses have always followed with surprising rapidity.

The whole field of chemistry is extremely dynamic, but no branch of it today promises so much as the new petroleum chemistry. This progress in synthesis from petroleum hydrocarbons in recent years suggests that far-reaching effects are in prospect. An oil executive has looked to the future with these words, "Although prediction of future trends in the oil industry must be hazardous, there is no question but that the chemical manufacture will play an increasingly important role. In some instances there actually may be a reversal of the original position, i.e., the refinery may be utilizing by-products of the chemical factory, and not the factory, the by-products of the refinery. In any case a close relationship may be expected as the operations of both expand into new fields."

The paper was published in *The Oil and Gas Journal* 40, No. 38, 197-8, 205, 1942.

**The production of electric charges in water spray**, C. W. HEAPS, Rice Institute.—The mechanism by which the electric charges of thunder storms are produced is still by no means well understood. The following conditions appear to be necessary for the production of charges in clouds: (1) violently rising currents of air, (2) water drops falling through the air.

When a water drop five mm. in diameter falls through the air with a terminal speed of about eight meters per second it breaks up into smaller drops which fall more slowly. In case the air as a whole is rising with a speed of eight meters a second the larger drops remain practically stationary and the small drops rise upwards with the air. The small drops may be considered as a spray blown off from larger drops. This spray will be carried up with the rising air towards the top of the cloud.

Now it has been found in the laboratory that when an air blast breaks up a water drop there is a separation of electric charge. The water acquires a positive charge, the air a negative. The negative ions in the air stick to water particles and are carried along with the air. These laboratory experiments, therefore, appear to afford an explanation of the main features of electrification in thunder clouds. The difficulty is that observations in thunder clouds reveal a situation too complex to be explained by the simple process as described. Simpson and Scarse (Proc. Roy. Soc. A 161, p. 309, 1937) have sent up sounding balloons during thunder storms. They find a variety of distributions of charge in the clouds. Frequently there is a positive charge at the top, a negative charge in the middle, and another localized positive charge near the front and bottom.

The breaking drop theory does not account for the charge at the top. Simpson found that the cloud temperature at the top, in the region separating the positive and negative charges, was very low, usually about —10° C. The water droplets here would all be frozen into solid ice crystals, so that the breaking drop theory certainly cannot apply in the top portions of a thunderstorm. It is probable that the breaking drop theory must be supplemented by further hypotheses in order to secure the complete explanation,—for example, it has been suggested that air blasts passing over an assemblage of tiny ice crystals will produce electrical effects.

It is not generally realized that the basic principles of the breaking drop theory may be easily demonstrated with an ordinary atomizer. A gold-leaf electroscope is constructed in a cubical glass cell of edges about 4 cm. The slender gold leaf is stuck to the flattened end of a wire about 12 cm. long. The other end of the wire extends outside the box and is bent downwards along the axis of a short piece of ¼ in. copper tubing. A glass sprayer of the atomizer type, operated by compressed air, sprays air and water droplets through the copper tube. The presence of charged ions in the spray is proved by the falling of the leaf of the charged electroscope. With ordinary tap water and a good sprayer the leaf falls in about 4 sec. The discharging of the electroscope occurs when it is charged initially either positively or negatively, hence the atomizer blast must contain both kinds of charges. Separation of the ion groups has not occurred as in thunderstorms. It is possible that with long powerful jets some separation of this kind could be achieved, in which case the electrical effects could be more easily demonstrated.

## Aeronautical Engineering—Its Today and Tomorrow

M. J. THOMPSON, The University of Texas

A little over thirty-eight years ago, the Wright brothers made what we now recognize as the first successful flight of a man-carrying airplane. Although we have made many advances in airplane design since that day, the airplane of today is still basically the same form of machine which the Wrights originated. Its lifting force is developed by a wing, it is given forward motion by the action of a propeller driven by an internal combustion engine, and it is steered by a rudder. We have replaced the Wright system of wing warping for lateral control by the ailerons of the present-day airplane, but for the most part, it can safely be said that the basic principles by which airplane flight was first accomplished and those used today are essentially the same.

Improvements in airplane performance include tremendous increases in speed, range and economy of operation while at the same time the safety, reliability and comfort of aerial travel have been greatly increased. These remarks apply primarily to the airplanes built for transportation services and for private flying. In the military services, the offensive striking power of the airplane is now completely recognized and it is regarded as a weapon of comparable effectiveness with land and sea forces. Yet we realize that all these remarkable advances have largely been the result of painstaking and diligent research and development and that no fundamentally new and heretofore undiscovered principles have been added to aeronautical science. Thus we are compelled to pause and wonder if the uncharted future may not hold developments beyond the scope of the imagination of even those of us who have seen the present developments take place within the period of our own lives.

Before being carried away on a wave of prophetical speculation, it would appear wise to survey such recent advancements as have already been made in order that we may better be able to chart the paths of future developments. Such a discussion, pertaining to the work of the last year or two, must, unfortunately for this audience, be materially limited by the military restrictions placed on much of this work. It is possible, however, to describe briefly some of the broader trends in aeronautical development and in some cases to touch upon the latest forward steps that have been taken along these lines.

In the case of the propulsive unit of the airplane, that is, the engine and the propeller, much has been accomplished in increasing the power output of our engines without much change in the external dimensions. With the radial air-cooled engine, this has permitted the use of the higher powered units without much increase in the frontal area and therefore the air resistance. The battle between the devotees of the air-cooled and liquid-cooled engines still rages violently with no clear-cut decision having been reached in either one case or the other. It appears that the larger frontal area of the radial air-cooled installation is just about balanced in drag by the resistance of the cooling duct openings required with the liquid-cooled engine.

The improvements in engine design in general may be attributed largely to the development of alloys of increased strength, better cooling, and the availability of higher octane aviation fuels and improved lubricants. Improved cooling in the case of the air-cooled engine has been principally the direct result of the use of thinner and more closely spaced fins on cylinder heads and barrels. The basic research on this problem is for the most part the work of our own National Advisory Committee for Aeronautics, but a full share of the credit for this advancement must also go to our engine manufacturers who successfully developed the machining and casting techniques which led to the practical application of this work.

Various forms of dynamic balancing have added in the trend toward increased engine output, while the turbo-supercharger, developed by Dr. Moss of General Electric and by the Army Air Corps, is probably the most significant factor in the maintaining of engine output at high altitudes. On this point in particular, American designs are outstanding in their superiority.

Propeller development has, for the most part, consisted of steady refinement and improvement. The use of cuffs or fairings for improving the efficiency of the parts of the blade near the hub is now well known. Some interesting possibilities lie in the development of the hollow steel blade, particularly in the larger sizes. In order to evoid excessively large diameters where engines of high output are used, the so-called opposite-rotating propeller, that is, two units in tandem rotating in opposite directions, appears to have some excellent possibilities. A noticeable gain in efficiency results from the fact that the second propeller recovers a large portion of the energy put into rotation of the slipstream by the first propeller.

The second major line of improvement is related to the external form of the airplane or as we call it today, the air frame. Here both aerodynamic and structural considerations are involved, the former in decreasing drag and improving lift and the latter in decreasing structural weight, removing external bracing as in the cantilever type monoplane, and permitting the use of forms and arrangements of increased aerodynamic efficiency. We are already familiar with the retractable landing gear as an effective means of reducing drag in flight, but this is mainly a mechanical design problem of getting the gear to retract to the position desired. Engine cowling on both types of engines has done much to reduce drag and improve cooling and is a development of some years standing.

It is apparent that a good deal has been accomplished in the way of decreasing drag if it is noted that a modern pursuit type airplane of say, five or six thousand pounds gross weight and with an engine of 1,150-horsepower, has a resistance at maximum speed equivalent to a flat plate, set normal to the wind, and having dimensions of 22 by 22 inches. Fairly recent designs having flat plate areas of from 50 to 100% more than this figure are not at all uncommon. We seem to have reached a point where the law of diminishing returns has begun to catch up with us and it appears that the next improvements must be related to the remaining major items, the wing and the fuselage. The Northrop flying wing design in which several of these units are consolidated and a goodly portion of a separate tail unit eliminated, may have some good possibilities. In the case of the airplane wing alone, some gains have been made by using long slender planforms and a considerable amount of taper from wing root to tip. At high speed, however, the greater part of the drag for both wings and fuselage is the direct result of the viscosity of the air in producing skin friction and it is to a more complete understanding of this action that we look for further reductions in drag.

It is now known that the development of skin friction is largely confined to a thin boundary layer, close to the wing surface, within which the velocity of flow increases rapidly as we move out away from the wing. The magnitude of these skin friction forces is determined by the value of the Reynolds' number as in the case of friction losses in pipes, although with the wing, the Reynolds' number is defined as the product of the airspeed and the average wing width or chord, divided by the kinematic viscosity. The analogy goes further in that the boundary layer flow may, as in a pipe, be either laminar or turbulent. The latter is generally undesirable since at the high Reynolds' numbers of actual flight, say, ten million, the turbulent drag is between seven and eight times that for laminar flow. Thus every effort is being made to delay the development of boundary layer turbulence. Present methods include the use of extremely smooth external surfaces for the wing and fuselage, obtained by employing flush or countersunk rivets and by avoiding any overlapping joints in the outside plating. Jones of Cambridge has indicated that surface roughness will contribute to the development of turbulence when the average height of the roughness projections in inches is about one-tenth of the reciprocal of the velocity in miles per hour. Thus it becomes apparent that even the surface texture of the metal itself may be important in this respect. It may even be necessary to use thicker sheets for the outer surfaces of the wing so as to avoid buckling under load and the consequent wavy roughness. The magnesium alloys and some of the plastic bonded plywoods appear to have some good possibilities in this direction. If manufacturing difficulties involved in the use of the magnesium alloys can be solved, this situation may lead to a sizeable post-war use for that material in spite of other predictions to the contrary.

In addition to surface roughness as a factor hastening the onset of turbulence, it has also been known that the pressure distribution existing over the upper surface of a conventional form of airplane wing has a pronounced effect of the same character. With the usual airfoil sections, a very high velocity and low pressure is developed near the nose of the wing upon the upper surface. Moving back along this surface, we find a steadily increasing pressure, rising to about atmospheric near the rear of the wing. This positive pressure gradient in the direction of flow tends to make the boundary layer turbulent earlier than would otherwise be the case. The National Advisory Committee for Aeronautics has developed a so-called "laminar flow" airfoil for which little or no data have been released because of its military significance. However, it is known that in comparison with earlier forms, the leading edge is considerably sharper and thinner and the point of maximum camber or curvature is somewhat further back along the chord. Apparently the leading edge at its most effective angle of attack, permits the development of lift with a lower pressure gradient and a flatter pressure distribution and consequently with less turbulence. It would appear, however, that at other angles, the section would lose some of its effectiveness in this connection and might even be less satisfactory than the older blunter-nosed forms. If this speculation has any basis in fact, it might be possible to consider the hinging of the forward portion of the wing as to permit adjustment of its position with changes in the angle of attack, thereby making the design effective in holding back boundary layer turbulence over a wider range of angles. This laminar flow section is being tried out on several new designs and seems to hold some promise of reducing the resistance of the wing. It is also being employed as a propeller blade section with a considerable gain in efficiency thus being obtained.

So far this discussion of boundary layer behavior has been concerned with high speed and low angles of attack for the airplane wing. At the high angles of attack near the stall, we attain the highest lift from the wing and hence the lowest speed, which is desirable for landing. The stall itself is the result of boundary layer separation and wake development brought about by the friction losses occurring within the boundary layer. Hence any scheme which will add energy to this retarded flow, ahead of the normal separation point, will aid in delaying separation and thus make it possible to develop higher lifts or to obtain the same lift at a lower speed. The various forms of slotted wings which have been developed in the past are devices which operate on this basic principle and, when combined with the trailing edge flap, have been very effective in increasing the lift of wings. With the most effective of these devices, the Fowler flap, the wing flap moves down and to the rear, and when combined with the slot, it has been possible to obtain approximately twice as much lift as for a plain wing.

Another scheme which shows some promise involves control of the boundary layer either by blowing air tangentially along the wing surface or sucking the retarded boundary layer into the interior of the wing. In either case the auxiliary air is drawn from or discharged into the interior of the wing by means of an air pump; it is obvious that the other end of the air control system must be located at a point where it will produce no serious disturbance of the main airflow. Laboratory tests seem to favor the suction method as the more effective one and experimental results already indicate a lift increase of five or six times normal. Whether these results may be carried over into actual practice still remains to be seen. In this connection, it might be remarked that the roughness introduced by the necessary openings in the wing surface may add so much to the drag in the high speed range as to offset the gains in maximum lift.

The developments just discussed represent but a few of the more outstanding advances in aeronautical engineering which are either successfully developed or are in the transition from the experimental to the production stage. Although our research programs are being carried on with increased energy, it appears that at the present moment there is another problem of equal importance, that of production. We must take our best available designs and build as many of them as we can in the shortest possible time. It is axiomatic that the quality and performance of these designs must now be and must continue to be superior to those of our enemies, and in this latter phase of our present endeavors, research plays its equally important role. The need for increased production has led to the development of new techniques in aircraft manufacturing, many of which are based on lessons learned in the automotive industry. A recent technical training film summarizes the situation nicely when it closes with the following admonitions to the student engineer about to enter the industry:

1. Design for the speed of squeeze riveting.
2. Design for the speed of roll spot welding.
3. Design for assembly in the detail or bench sections.
4. Design for sub-assembly.
5. Design to speed up production.

This sudden jump from an airplane industry which operated on the basis of a few hundred airplanes of a particular model to one which now has its production lines and turns out several thousand airplanes a month has brought up a good many new and difficult problems. To those of us who are concerned with aeronautical engineering education, this situation has brought home to us the fact that we must do more than train our students in the fundamentals of aerodynamics, elasticity and thermodynamics. We must also give them training in the practical application of this basic knowledge to production design and manufacturing. A highly efficient airplane which never becomes more than an engineer's drawing will not be of very great effectiveness in fighting the enemy or in serving the needs of our air transport system. Since this practical training should be given without weakening the preparation in the basic engineering sciences, it will be realized that we educators also have our "production problems".

Many people today are keenly interested in the question of what the future of the aviation industry will be and express great concern over the necessity for retrenchment when the need for the present expansion no longer exists. Of course, our immediate goal, like that of every other American industry, is victory over the enemies of democracy. When that objective has been reached, there will of necessity be readjustments to be made in all phases of industrial activity and aviation should suffer no more than any other. In fact there are many indications that the adjustments should be less severe than in those industries now menufacturing guns, tanks and shells, for which there is no immediate peace-time counterpart. I am confident that our Army and Navy will, once they have built them up, continue to maintain the largest air forces in the world. Commercial aviation is only on the threshold of its greatest development and should do much to absorb the peace-time output of our growing industry. We may expect to find tremendous increases in air travel within our own borders and particularly in connection with transoceanic services. The carrying of all first class mail by air is another step to be anticipated in the future and a large growth in air express operation will contribute to this expansion. The technical developments which are now being used for increasing performance and military effectiveness may in times of peace be turned to increasing safety and economy of air transport, while still maintaining the necessary margin of speed over other forms of transportation. When all these facts are considered, I believe that we can face the future squarely, confident that aviation will do its share in winning the battles of peace as well as those of war.

## Some Aspects of Fat Metabolism

HERBERT C. TIDWELL, College of Medicine, Baylor University

The subject of this paper is listed as "Some Aspects of Fat Metabolism", but I wish to limit this discussion to the subject of fat absorption and some related factors.

During the last seventy years a mass of conflicting evidence regarding the absorption of fat in the animal body has been accumulated. "The reasons for such can be more easily understood if one recalls that these are drawn from the observation of many workers in all parts of the world, using a diversity of animals under a variety of experimental conditions", as Frazer[1] has so aptly stated. "Many experiments have been conducted on herbivores, with normally low fat intake, and others on carnivores with fundamentally different living conditions, diets, and needs." The difficulties in controlling the diet and many other variables have prevented much of the to be desired work on the human subject.

It has been necessary to overcome many special difficulties before the more recent rapid strides could be taken in the elucidation of problems of fat absorption and metabolism. One of these difficulties was the lack of methods for the determination of rapid changes in the fat content of the blood due to relatively large amounts of blood required for fat analysis. No doubt many erroneous conclusions have been based upon the analyses of infrequently collected blood samples. Several micro methods, requiring only a few drops of blood, have been developed that are sufficiently accurate to record significant changes in the fat content of the blood, although the quantitative relationships can only be regarded as relative at present. Two of these methods involve the use of the chylomicrograph and the spreading of fat on the Langmuir trough.

Also it has often been necessary to utilize experimental conditions that are far removed from the normal in order to exclude variable factors or provide sufficient material for analysis. "The feeding of gross amounts of abnormal fats, the interference with normal intestinal function and equilibria, the upset of intra-intestinal pressures, and the administration of cellular poisons in excessive doses are but a few of the procedures which have led to confusion in the interpretation of results. Although a wide basis of experimentation is highly desirable, and various experimental procedures may be necessary in order to emphasize and demonstrate one particular factor in the mechanism, the results of such work demand most careful consideration if a correct assessment of the mechanism in the normal intact animal is to be reached." (Frazer)

Important new tools for use in the study of fat absorption have been found in the tagged or labelled fatty acids, which have been used to determine the origin and the destination of the fat detected in the blood or that accumulating in the tissues. Among these are the radio-active phosphorus, first used by Hevesy; iodized fatty acids as used by Artom; elaidic acid by Sinclair; deuterium by Schoenheimer; and the conjugated fatty acids by Burr and associates.

The problem of fat absorption is essentially different from that of protein or carbohydrate, in that the fatty acids, the elemental constituents of the fat, are usually insoluble in water, while the corresponding hydrolytic products of protein and carbohydrate are readily water-soluble. These end products of digestion of proteins and carbohydrates are absorbed into the blood and transported as such, while the fats are apparently resynthesized during absorption and transported mainly by the lymph to be delivered into the blood stream. So the mechanisms necessary for the transportation of the fat and related compounds across the various cellular barriers are quite different from those provided for the other foodstuffs.

The sequence of events in the absorption of the fat from the intestine might be outlined as follows. The trace of fatty acids in the fat of the food is increased somewhat by traces of lipase in the stomach, possibly through the regurgitation of duodenal contents. Gastric secretion and motility is decreased by the fat in the food so it is delivered to the intestine in small amounts. After passage into the duodenum it is mixed with the alkaline secretions of the liver and pancreas. The bile and any soap formed aids in the rapid emulsification of the unsplit fat. This emulsified fat is rapidly hydrolized by the action of the pancreatic lipase. The fatty acids combine with the bile salts and these diffusible complexes are more readily absorbed. The digestion or hydrolysis of the neutral fat is speeded up by the removal of the split products by absorption. After an initial lag, it appears that most natural fats are absorbed at a nearly constant rate, according to Kohl[2], Deuel[3], and Barnes[4].

Earlier it was proposed that the fat after splitting by the lipase, was absorbed as soaps, but the shortage of necessary base and the slightly acid condition throughout most of the intestine would prevent much if any absorption of the fatty acids in the form of water-soluble soaps. Bile is probably the greatest single factor in the passage of the fat into the absorbing cells. Verzar[6] and others found stearic and palmitic acids to form with the bile salts soluble and diffusible complexes that were stable in slightly acid solutions. To account for the lack of sufficient bile salts to combine with all the fatty acids formed, they suggested that the bile salts became fixed in the intestinal mucosal membrane and by their solvent effect aid the passage of the fatty acids into the epithelial cells. The bile salts, moreover, lower the surface tension, thereby increasing the permeability of the epithelial cells and in this way probably promote the absorption of other substances as well.

Since the early work of Munk, it has been generally held that about 60% of the ingested fat is absorbed via the lymphatic system while the remainder probably passes directly into the portal blood stream. More than 40 years ago he advocated the idea that neutral fat was absorbed in a fine emulsion by the villous epithelium.

In his review, Bloor[7] states that from present evidence as regards normal intestinal behavior, it seems unlikely that any unsplit fat is absorbed as such, either swept in with the current of split products or by direct penetration. However, Frazer[1] points out that the lipolytic hypothesis must be regarded as unproven although the general belief is that fat must be split before it can be absorbed. He advances the following evidence to support this contention. (1) Fat splitting can occur only in appreciable amounts in the upper part of the small intestine, because of an unfavorable medium elsewhere. This does not seem to prevent almost complete hydrolysis since in cases when most of the ingested fat is excreted because of poor absorption in the absence of bile, it is nearly all split fat. Also in our studies[8] when a palmitin-stearin mixture was fed, there was less than 4% of unsplit fat in the feces, although only 60% of the ingested fat was absorbed. (2) Lipase is absent from the succus entericus of the cat and intestinal contents from the lower part of the cat's small intestine shows no signs of lipolysis, but active fat absorption can be demostrated. Others have reported particulate absorption in dogs and man, although at a very muchly decreased rate. (Kitagawa[9], Onozaki[10], Doubilet, and Reiner[11].) (3) The addition of extra lipase to a known amount of ingested fat results in a marked decrease of the post absorptive lipemia, proportional to the amount of the extra lipase added. The fat is absorbed but the extra lipase prevents its appearance in the systemic circulation. (4) Stained fats, oleic acid and olive oil, given rats show stained fat depots only with the ingestion of olive oil. Equal absorption occurs as judged by fecal analysis, and the weight curves are similar. In rabbits there is an increase in chylomicrons in the systemic circulation with the neutral fat and an increase in the portal circulation after injection of fatty acids and glycerol in the intestine. This was found to be true in humans as well. (5) A surprising shortage of bile salts is evident if all the fat is absorbed in the form of water-soluble complexes of fatty acids and bile salts. He estimated that not more than 30 grams of fat per day could be transported in this manner by the bile salts. This would not be true, of course, if a rapid turn-over of bile salts is possible as was suggested previously.

He finds it difficult to reconcile these findings with the supposition that all the neutral fat must be hydrolyzed before absorption, and suggests that perhaps the unhydrolyzed fat passes by way of the thoracic duct after absorption, while molecularly dispersed, to the systemic circulation and fat depots. The fatty acids freed are at the same time carried to the liver by the portal circulation.

Cantoni[12] has reported that the portal blood contained more fatty acids during absorption than did arterial blood. Also Eckstein[13] found a definite increase in the blood fatty acids during fat absorption after diversion of the thoracic duct lymph. However, Brochett, Spiers, and Himwich[14] were unable to find a change in the lipid content of the serum of portal blood during fat absorption in dogs. Recently Winter and Crandall,[15] using an angiostomy technique, investigated the absorption of fatty acids directly into portal blood of an unanesthetized animal. They found no significant arterio-portal or hepatic inflow-outflow differences in fatty acid content. They calculated that it was highly probable that an arterio-portal difference would have been detected if 10% or more of the fed fat had been absorbed by way of the portal system.

Some histological investigations of fat absorption have been made. Rossi[16] obtained absorption of fatty acids, but no neutral fat, by intestinal mucosa when it was immersed in a solution of them containing bile salts. Verzar and Jeker,[17] using staining methods, reported absorption of fatty acids and their conversion in a short time into another form, stainable by Sudan and presumably neutral fat. This work aided in developing the general belief that after the release of the fatty acid from the bile acid-fatty acid complex, an immediate resynthesis of neutral fat occurs within the epithelial cells. Nevertheless, the situation as regards the absorption of neutral fat directly into the blood stream remains unsettled.

The concept of phosphorylation in the intestinal mucosa as an essential part of the mechanism of fat absorption, has been generally accepted since Sinclair[18] demonstrated an increase in the phospholipids in the blood as well as a pronounced change in the composition of the phospholipid fatty acids of the intestinal mucosa during fat absorption. Earlier this theory was vigorously supported by Verzar[19] in an extensive series of investigations. He found an accelerated absorption when glycerol-phosphate was present and that absorption was inhibited by adrenalectomy as well as by the administration of phlorhizin or iodoacetic acid. The effects of these were attributed to the interference with phosphorylation.

However, Barnes and associates[20] have shown that fat absorption is normal in adrenalectomized animals if the salt balance is maintained. Also that in normal animals there is a very slow exchange of the conjugated fatty acids in the case of the mucosal phospholipids as compared with those of the neutral fat, indicating that phosphorylation is not an essential part of fat transport. Others have objected to evidence for phosphorylation, involving the use of iodoacetic acid and phlorhizin, because of the severe damage to the cells of the intestinal mucosa in those experiments. Frazer admits that some absorbed fatty acids evidently can be resynthesized under special conditions, as when mono-glycerides or ethyl-esters are fed, but believes it is not an essential or a normal process. Also, that some fatty acids undergo phosphorylation, not as an intermediary in glyceride synthesis as is generally held, but in the production of some needed phosphatids. The formation of the phospholipid fraction from some of the split fat is exogenous and involved in fat transport, while the major part of the neutral fat is absorbed in a molecularly dispersed form.

Channon[21] suggests that if this view is substantiated, it may be found that the liver has a direct call on the unsaturated fatty acids present in the food fat since it is possible that the liberation of the unsaturated acids from glycerides may be more readily accomplished by lipases than is that of the saturated acids of the same chain length. This, at least, agrees with the finding that in fat absorption, the fatty acids of the liver always have a higher degree of unsaturation than the fatty acids of the ingested fat. It might also aid in explaining why Eckstein[22], Cox[23], and Deuel have found no very short chain fatty acids deposited in the fat depots, for being more easily split than the longer chain containing fats, they would be transported directly to the liver instead.

The intestinal absorption of fats appears to be influenced by a number of factors. A deficiency of vitamins A, B, or D have been found to cause a decrease in the rate of absorption of fat, likely due to the general impairment of nutrition rather than any specific effect upon fat absorption. Barnes and associates have shown a decreased absorption in animals suffering from an essential fatty acid deficiency as well as a decrease in incorporation of labelled fatty acids in the intestinal mucosal phospholipids.

Higher mineral salt intake decreases the amount of fat absorbed, probably through the formation of increased amounts of non-absorbable insoluble soaps. In a study of fat utilization in infancy, Holt and associates found that the absorption of a mixed fat is favored by the presence of (a) fatty acids containing one or more unsaturated linkages and (b) fatty acids with relatively short carbon chains. It is impaired by the presence of long chain saturated fatty acids. Contrary to general belief, the melting point per se does not seem to be the determining factor in absorption. In a limited number of experiments, they found 25% more absorption of a hydrogenated corn oil than of a palmitin-stearin mixture. They both melted around 50 degrees C. but the hydrogenated corn oil had a much higher iodine value.

Recent studies[24] have shown a striking parallelism between the absorption of fats and their ability to inhibit gastric motility and secretion. In this study, acid in the stomach of the rats was used as a measure of secretion and motility was based upon the percentage of fat present after its introduction three hours before. The distance the stained fat had passed down the intestine served as another check upon gastric motility.

It was found that (a) fats containing more short chained fatty acids favored both an increased absorption and inhibition of gastric activity. (b) As found by Roberts and others, inhibition increased with the iodine value of the fat, although the relationship between them is not a linear one. Again both the absorption and inhibition seem to be augmented by the presence of unsaturated fatty acids, but they appear to depend more on the percentage of fatty acids containing one or more double bonds than upon the total unsaturation. Quigley and Meschan state that their results afford no confirmation of the report of Roberts that the delay in gastric evacuation is related to the degree of unsaturation. However they based this belief upon their results with oleic and ricinoleic acids, and the latter is known to be very poorly absorbed. (c) Splitting seems necessary for both absorption and inhibition. Roberts[25] obtained little inhibition with ethyl oleate and we have found it to be split with difficulty. McSwiney and Spurrell[27] and others have found mineral oil to be non-effective. Again, Quigley and Meschan[26] found neutral fat to be only slightly less effective inhibiting agents than the free fatty acids. They did not exclude the presence of any free acids in the fat fed nor eliminate entirely the possibility of some splitting in the intestine. There is still the possibility of triglyceride absorption as such.

These facts would indicate that the phenomena of gastric inhibition are precipitated by the absorption of some fat from the upper intestine, rather than any physical property of the fat itself. The absorption of at least a small amount of fat appears to be a prerequisite for the initiation of the hormonal control of gastric activity. If true, then it might aid in explaining why the fats that are more completely absorbed pass from the stomach more slowly. This fact would also have to be considered as a factor in the small difference in the rate of absorption of fats containing mixed fatty acids, as affected by the rate of passage into the intestine of the various types of fats.

Much progress has been made in the elucidation of the mechanism of fat absorption, but there still remains much to be done to have a completed picture.

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# The MKS System, Its Justification and Use

R. E. BEAM, *Southern Methodist University*

Three actions toward standardization of units and simplification of mathematical symbolism and dimensional formulae which are of great importance to engineers and physicists are: (a) The decision of the General Conference and the International Committee on Weights and Measures to discard the international ohm, ampere, volt, etc., in favor of those units based on so-called absolute measurements (1) (2); (b) The recommendation by the International Electrotechnical Commission at its sessions in 1935 (3) and 1938 (4) of the meter-kilogram-second (MKS) system of units and dimensions to include the practical units of electricity in an "absolute" system; (c) The action by various engineering and scientific societies and organizations toward symbol standardization (5) (6). The object of these actions is to eliminate or to minimize language impediment for the student and to provide desirable economy of mental effort for all concerned. None of the bodies sponsoring these actions has authority to require general acceptance of its proposals but must rely upon its recommendations winning approval by their own merit when they become known.

In order to develop some justifications for the existence and adoption of the MKS system of units and dimensions, the operational method of approach to the formation of systems of units and dimensions will be used, and several of the more important systems will be discussed before taking up the MKS system. Several important relationships of electric and magnetic theory are given in Table 2 in their MKS "subrationalized" forms in order to aid in adapting present textbooks to this system. Also tables of dimensional formulae and of relationships between CGS and MKS units are included.

It is the objective of this paper to attempt to influence in a small measure some classroom adoptions of the MKS system in engineering and engineering physics courses.

1. *Operational approach.* According to the operational viewpoint, the meaning of physical quantities and their relating expressions arises from the procedure used in obtaining them (7, p. 5). Hence, a quantity is associated with and defined by the operation used in obtaining a numerical measure of it. Symbols in a mathematical relationship of physical quantities are meaningless to an operationalist unless the symbols designate numbers. This is in contrast to the classical viewpoint in which symbols represent assumed properties which may be far removed from reality.

In order to formulate a physical theory it is first necessary to define and then relate quantities. This requires experimentation and experimentation requires measurement. Before a measurement of a given quantity can be made, it is necessary to define its unit of measure. In particular, a measurement may be expressed by q [Q], where q is the numerical measure and [Q] is the unit of measure. Operationally q [Q] represents the application of [Q], q times. A different rule of operational procedure is required in order to determine each measurable quantity.

A comparison of the same quantity measured with two different units leads to

$$q_1 [Q]_1 = q_2 [Q]_2 \qquad (1)$$

where $q_1$ and $q_2$ represent measure numbers, and $[Q]_1$ and $[Q]_2$ different units. Thus

$$[Q]_1 = \frac{q_2}{q_1} [Q]_2 \text{ or } [Q]_2 = \frac{q_1}{q_2} [Q]_1 \qquad (2)$$

and

$$q_1 = q_2 \frac{[Q]_2}{[Q]_1} \text{ or } q_2 = q_1 \frac{[Q]_1}{[Q]_2} \qquad (3)$$

illustrate the processes of comparing units and of converting measure numbers from one reference unit system to another, respectively. The ratios of two quantities of the same kind, such as $q_2/q_1$ and $q_1/q_2$, are independent of the units; they are pure numbers (8, p. 20).

An experimental investigation consisting of the determination of many measure numbers for each important quantity involved is the next step in theorizing. Then an assumption as to the continuity of the variations of the measure numbers is made. Following this comes a search for a mathematical relationship between them. The symbols in such a mathematical relationship represent the numbers which are the measures of the quantities. If a large number of similar experiments are performed in widely separated places, at widely separated intervals, with widely varying conditions and using a great variety of experimental objects, and if repeated confirmation results, then the symbolic description may be established as a physical law.

The very idea of symbolism implies that a symbol represents a concept transcending the particular operation which it is used to represent. If a symbol thus represents the synthesis of a large number of operations, then physical laws involving the concept for which the symbol stands have some relationship with one another (9, p. 20). Among certain symbols representing primitive concepts a few mathematical relations may exist from which can be deduced by purely mathematical operations a whole group of physical laws involving a single concept. In this case a physical theory is said to exist.

The symbols in the mathematical relationship expressing a physical law represent two types of quantities, namely, fundamental and derived. Fundamental quantities are assumed to be of an irreducible simplicity. Mass, length and time are frequently taken as fundamental quantities. Derived quantities are formed from fundamental quantities by means of mathematical operations involving the measure numbers for the various fundamental quantities. Velocity, acceleration and force are examples of derived quantities. Both fundamental and derived quantities must satisfy the requirement that the ratio of the numbers measuring any two concrete examples [Eqs. (1) to (3)] be independent of the size of the unit used in making the measurements. If this condition is satisfied, then the function representing a derived quantity in terms of the assumed fundamental quantities must be expressible in terms of the product of a constant and powers of the fundamental quantities (8, p. 21). This makes it possible to expand physical quantities in terms of power series.

The dimensions of a physical quantity are concerned with its equality or kind, not its magnitude. Dimensional analysis methods can be applied to the results of measurements of physical quantities which satisfy the requirement that the ratio of two quantities of the same kind be independent of the unit quantity.

The "dimensional formula" of a physical quantity is an expression involving the product of powers of the assumed fundamental quantities showing the manner in which they are combined to form that quantity. There is no restriction as to the number of fundamental quantities to be used in defining the dimensional formulae of derived quantities. The equations representing fundamental laws involve proportionality constants. It is the method of defining the proportionality constants which determines the number of fundamental quantities required. It is, however, more convenient and less confusing in most cases to have three fundamental quantities in mechanics, four in heat, and four in electricity and magnetism.

While there are exceptions, many authors call any system of dimensions based on any number of fundamental quantities an "absolute" system of dimensions. This definition will be adhered to in this paper.

2. *Interrelationship of electrical dimension systems.* To determine a general formula which will yield the interrelationship between electrical dimension systems, it is desirable to start with the two laws of circuitation. (*F* is used for script f.)

$$F = \int_c \mathrm{H} \cdot \mathrm{dr} = \mathrm{k}\ (\mathrm{Ni} + \frac{1}{4\pi} \frac{\mathrm{d}\psi}{\mathrm{dt}}) \tag{4}$$

and

$$\mathrm{e} = \int_c \mathrm{E} \cdot \mathrm{dr} = \frac{-\mathrm{k'N}}{4\pi} \frac{\mathrm{d}\phi}{\mathrm{dt}} \tag{5}$$

where $\psi = 4\pi q$ and $\phi = 4\pi p$. In Eq. (4) k is an undetermined constant; so also is k′ of Eq. (5).

From energy considerations it is possible to show that k′ = k as follows. Suppose that the magnetic energy stored in a given volume is considered. If there is no displacement current, $\frac{\mathrm{d}\psi}{\mathrm{dt}}$ is zero; therefore only kNi in Eq. (4) need be considered. In this case since

$$\mathrm{i} = \frac{F}{\mathrm{kn}} \tag{6}$$

and

$$e_{applied} = \frac{k'N}{4\pi} \frac{d\phi}{dt} \tag{7}$$

the energy delivered to the field is given by

$$W_d = \int_o^t e_a i dt = \frac{1}{4\pi} \frac{k'}{k} \int_o^t \frac{F}{N} N \frac{d\phi}{dt} dt \tag{8}$$

$$= \frac{1}{4\pi} \frac{k'}{k} \int_o^{\phi} F \, d\phi$$

The energy stored in the magnetic field is given by an expression analogous to

$$\int_o^t e_a i dt = \int_o^q e_a dq = \int_o^{\psi} e_a \frac{d\psi}{4\pi}; \tag{9}$$

namely;

$$W_s = \int_o^{\phi} \frac{d\phi}{4\pi} = \frac{1}{4\pi} \int_o^{\phi} F \, d\phi \tag{10}$$

The energy stored in the field must equal the energy delivered to it; therefore in order for Eq. (8) to be equal to Eq. (10), it is necessary that

$$k' = k. \tag{11}$$

The differential forms of Eqs. (4) and (5) for free space are (by using Stoke's theorem)

$$\text{curl } H = \frac{k}{4\pi} \epsilon \dot{E} \tag{12}$$

and

$$\dot{H} = \frac{-4\pi}{k\mu} \text{curl } E \tag{13}$$

If the curl $\dot{H}$ is formed from Eq. (13) and substituted in the partial time derivative of (12), the following is obtained:

$$\text{curl curl } E = \frac{-k^2\mu\epsilon}{(4\pi)^2} \ddot{E} \tag{14}$$

But

$$\text{curl curl } E = \text{grad (div } E) - \nabla^2 E \tag{15}$$

$$= -\nabla^2 E$$

since

$$\text{grad (div E)} = 0;$$

therefore

$$\nabla^2 E = \frac{k^2 \mu \epsilon}{(4\pi)^2} \ddot{E} = \frac{1}{v^2} \ddot{E} \qquad (16)$$

where

$$v = \frac{4\pi}{k\sqrt{\mu\epsilon}} \qquad (17)$$

Eq. (16) is the wave equation for electric field intensity. The velocity of propagation of the wave of electric field intensity is given by Eq. (17) (10, p. 43). For a vacuum, v has been shown to be the velocity of light, c (centimeters per second); therefore for a vacuum

$$v = c = \frac{4\pi}{k\sqrt{\mu_0 \epsilon_0}} \qquad (18)$$

Since $\frac{4\pi}{k\sqrt{\mu_0\epsilon_0}}$ must equal the velocity of light numerically and also have the dimensions of a velocity, only two of the three quantities k, $\epsilon_0$ and $\mu_0$ can be specified independently. The choice of dimensions made determines the dimensional system; the choice of units, the unit system.

3. *The CGS–ES and –EM systems.* The electrostatic system of units and dimensions is formed by using L, M and T as the fundamental dimensions with CGS units, $\epsilon_0$ equal to unity and dimensionless, k equal to $4\pi$ and dimensionless, and $\mu_0$ equal to $1/c^2$ ($c = 2.998 \times 10^{10}$ cms. per second, approx.) and having the dimensions of the reciprocal of velocity squared, $L^{-2}T^2$.

Table I gives the symbols, dimensions and units for the various quantities. For isotropic media, some fundamental relationships assume the following forms:

$$F = \frac{q_1 q_2}{Kr^2} \qquad (19) \qquad\qquad F = \frac{p_1 p_2}{\mu r^2} \qquad (20)$$

$$D = KE \qquad (21) \qquad\qquad B = \mu H \qquad (22)$$

$$\text{curl } H = 4\pi \left(\rho v + \frac{\dot{D}}{4\pi}\right) \qquad (23) \qquad\qquad \text{curl } E = -\dot{B} \qquad (24)$$

In these equations the *specific inductive capacity*, $K = \frac{\epsilon}{\epsilon_0}$, is a numeric, but $\mu$ is a dimensional quantity.

The electromagnetic system is formed in much the same way as the electrostatic system, the only difference being that roles of $\mu_0$ and $\epsilon_0$ are interchanged; hence $\mu_0$ is equal to unity and is dimensionless, $\epsilon_0$ equal to $1/c^2$ and has the dimensions of the reciprocal of velocity squared, and k is equal to $4\pi$, a numeric.

Table I gives the symbols, dimensions and units for the various quantities. The equations for the EM system corresponding to Eqs. (12) to (24) are as follows:

$$F = \frac{q_1 q_2}{\epsilon r^2} \qquad (25) \qquad\qquad F = \frac{p_1 p_2}{K' r^2} \qquad (26)$$

$$D = \epsilon E \qquad (27) \qquad\qquad B = K'H \qquad (28)$$

$$\text{curl } H = 4\pi \left(\rho v + \frac{\dot{D}}{4\pi}\right) \qquad (29) \qquad\qquad \text{curl } E = -\dot{B} \qquad (30)$$

In these equations the *magnetic specific inductive capacity*, $K' = \frac{\mu}{\mu_0}$, is a numeric, but $\epsilon$ is a dimensional quantity.

4. *Objections to the CGS–ES and –EM systems.* A comparison of the two sides of Eq. (21) shows that the quantities D and E have the same dimensions and magnitude in free space, while a comparison of the two sides of Eq. (22) shows that B and H are not dimensionally the same nor numerically equal even though these quantities are analogous to D and E, respectively.

From Eq. (28) and Table I, it is clear that B and H have the same dimensions in this system, but from Eq. (27), the analogous electric quantities D and E do not have the same dimensions. In other words, the roles of B and H, and D and E in the ES system have been interchanged in the EM system. Such differences in the two systems lead to difficulty for students and their instructors.

If both the ES and EM systems are taught, more confusion results because the same quantity does not always have the same dimensions in the two systems although based upon the same fundamental quantities, mass, length and time. For example, electric charge has the dimensions $M^{1/2} L^{3/2} T^{-1}$ in the ES system and $M^{1/2} L^{1/2}$ in the EM system. The ratio of their dimensional formulae is equal to the dimensional formula of velocity

$$\frac{[Q]_{ES}}{[Q]_{EM}} = \frac{M^{1/2} L^{3/2} T^{-1}}{M^{1/2} L^{1/2}} = L T^{-1} = [v] \qquad (31)$$

From this result it seems that the ratio of the unit charge of the ES system to that of the EM system should equal a velocity. The magnitude of this velocity must equal that of the reciprocal of the velocity of light. Since the ratio of units of the same quantity should be always a numeric, it would seem from Eq. (31) that it should be possible to express length in terms of time. Of course this can be done (8, pp. 23-25), but it is quite confusing to a freshman or sophomore.

Another criticism of these systems is the existence of fractional exponents in the dimensional formulae of many of the derived electrical quantities. The fractional exponents are inconvenient, difficult to justify physically, and also cause unneeded confusion for a beginning student.

For engineering purposes, as well as experimental and applied physics, the EM system is ordinarily preferable to the ES, but neither is well suited to the needs of these groups—the sizes of many of the units are unsatisfactory. The practical system of units was adopted to meet these needs. Conversion of practical values to EM values and vice versa, using a variety of powers of ten, has led to the condemnation of this solution.

Neither the ES nor the EM dimensional system is well suited to the needs of theoretical physicists according to the opinion of Page (11). He advocates either the Gaussian system which is a combination of the ES and EM systems, or preferably, the Heaviside-Lorentz system. He bases his opinions on his criterion of symmetry. From this viewpoint, the ES and EM systems taken separately have little to recommend them for theoretical work. Since the theoretical physicists have little difficulty with any system of units and dimensions, but base their preference on simplicity of form of Maxwell's equation, the loss to them in changing dimensional systems would probably not be great.

5. *The practical system of units.* The practical system was adopted by a succession of International Electrical Congresses (1881, 1889, 1893). Each unit of the practical system originally had the dimensions of the corresponding EM unit and differed from it by a power of ten.

The volt, ohm and ampere were represented by physical standards, the Clark standard cell, the mercury column, and the silver voltameter, respectively. After the 1893 Electrical Congress many countries, including the United States in 1894, established by law units based upon the definitions adopted by that Congress.

No clear distinction between the units represented by the physical standards and the corresponding multiples of the CGS-EM values was made until the International Electrical Congress on Electrical Units and Standards of 1908 did so (1). This Congress likewise decided to retain the physical standards for the ohm and the ampere. In 1910 the "international" volt was defined, using the values corresponding to the physical standards of the ohm and ampere in Ohm's law. The electromotive force of the Weston cell in international volts was assigned the value of 1.0183. The resulting unit system composed of the four fundamental units, the centimeter, the gram, the ohm and the ampere, is known as the international system. New, more convenient standards have been developed and used since 1910. In 1937 reports of measurements with reference to the CGS dynamical system of units with the permeability of free space equal to unity showed that the international ohm is about 1/20 of one per cent larger than $10^9$ abohms; the international ampere is about 1/100 of one per cent smaller than $10^{-1}$ abamperes (1). According to the plans of the International Committee on Weights and Measures, these new values were to be put into use starting January 1, 1940, following international agreement and verification. War has prevented common action of the important countries, and adoption has been necessarily delayed until peace is restored.

6. *Rationalization and subrationalization.* About 1870 Heaviside pointed out the advantages of standardizing electric and magnetic forces with reference to rectangular charge and pole distributions such as exist respectively in plane condensers and between opposed plane poles instead of with reference to point charges and poles. He called the electric and magnetic unit systems modified in this way "rationalized" systems. The classical systems he considered as being "unrationalized." Rationalized systems have the advantage of greater simplicity and symmetry of form of some fundamental relationships than do the unrationalized systems (11). Also, electric flux, $\psi$, becomes equal to electric charge, q, for point charge sources instead of equal to $4\pi q$; and, similarly, magnetic flux, $\phi$, becomes equal to magnetic pole strength, p, instead of equal to $4\pi p$. The Heaviside-Lorentz system is such a system.

Heaviside's proposed method for converting CGS electromagnetic units from classical to rationalized types required changing the volt, ohm, etc., the international practical standards, by awkward numerical factors involving $4\pi$ (13). This change would probably have caused much confusion. Subsequently it has been shown that it is possible to secure the benefits of rationalization without altering the size of the existing units, by injecting $4\pi$ into the space constants, $\epsilon_0$ and $\mu_0$. This procedure has been called "subrationalization" to distinguish it from Heaviside's method. Subrationalization has been applied to the MKS system.

7. *The MKS system.* In 1904 Professor G. Giorgi of Rome contributed a paper to the International Electrical Congress of St. Louis (12). He showed that all of the electromagnetic units in the practical system might be regarded as belonging to the MKS system in the same way that the dyne and erg belong to the CGS-EM system. The numerical coefficients relating the practical values of electrical quantities to the EM values could, therefore, be omitted from engineering textbooks, leaving the CGS systems undisturbed in their relations to general science. The space permeability, $\mu_0$, was to have the value of $4\pi \times 10^{-7}$ in this system instead of unity. The space permittivity, $\epsilon_0$, was to have the value of $10^7/4\pi c^2$ instead of $1/c^2$, where c is equal to $2.998 \times 10^8$ m./sec.; thus it was made possible to deal with all electrostatic phenomena directly through the practical electromagnetic values without having to use a separate electrostatic system (14). If a properly chosen fourth fundamental quantity, an electrical one, is also added to this system, the dimensional difficulties mentioned previously in connection with the classical systems are either eliminated or greatly reduced (see part 4).

The criterion expressed by Eq. (18) is satisfied by the Giorgi values of the space constants taken with $k = 4\pi$. A subrationalized system is determined by these values.

Eq. (18) is also satisfied by $\mu_0 = 10^{-7}$, $\epsilon_0 = 10^7/c^2$ and $k = 4\pi$. These values determine the unrationalized MKS system. But even though the question of rationalization has been left open by the international committees, it would be unfortunate to have two forms of the MKS system come into use; besides new names would be needed for certain unrationalized units. Only subrationalized units and the subrationalized forms of various fundamental relationships, therefore, are included in the tables of this paper.

Names and dimensional formulae for some important units of the subrationalized system are given in Table I. The numeric relationships between the units of this system and the corresponding units of the classical systems are given in Table II; the definitions of the various MKS units are also given in this table. With the aid of these tables a physics or an electrical engineering teacher should have little difficulty in his first use of the MKS system. Textbooks written in the classical form can be transposed to the MKS form by using these tables as guides. The transposition of problems in classical form can be handled by the instructor and student working together during the time used to make and discuss an assignment.

8. *Advantages of the MKS system.* Some of the advantages of the subrationalized MKS system over the classical combined with the practical systems have already been indirectly pointed out, but still others could be mentioned; the following is a short list:

1. With certain fourth fundamental quantities such as charge, mass length and time being the other three, the dimensional formulae involve only integral powers of the fundamental quantities.
2. Most of the advantages of rationalization are obtained.
3. The MKS system is a comprehensive one in which both electrostatic and electromagnetic phenomena can be conveniently handled.
4. It is not necessary to learn the decimal ratios which connect units in the classical and practical systems.
5. The electrical units are the practical ones in greatest use in the applied sciences.
6. No appreciable change in the existing literature or terminology is required.
7. When the period of change has passed, the problems in teaching units and their dimensions should be reduced.

9. *Textbook adoptions of the MKS system.* A number of recent textbooks have been written either using the MKS system entirely or as an alternative. Two in the following partial list are physics texts, the rest electrical engineering:

1. Corcoran, George F. and Edwin B. Kurtz, *Electrical Engineering Fundamentals.* John Wiley, 1941.
2. Cullwick, E. Geoffrey, *The Fundamentals of Electromagnetism.* Macmillan, 1939.
3. Harnwell, Gaylord P., *Principles of Electricity and Electromagnetism.* McGraw-Hill, 1938.

4. M. I. T. Elec. Eng. Staff, *Electric Circuits.* John Wiley, 1940.
5. Mueller, George V., *Introduction to Electrical Engineering.* McGraw-Hill, 1940.
6. Stratton, Julius Adams, *Electromagnetic Theory.* McGraw-Hill, 1941.
7. Timbie, William H. and Bush, Vannevar, *Principles of Electrical Engineering.* John Wiley, 1940.
8. Woodruff, L. F., *Principles of Power Transmission and Distribution.* John Wiley, 1938.

Table 1. SYSTEMS OF UNITS AND DIMENSIONS

| Quantity | Symbols | CGS-ESU System | | CGS-EMU System | | MKS-Giorgi System | |
|---|---|---|---|---|---|---|---|
| | | Dimensions | Units | Dimensions | Units | Dimensions | Units |
| length | $l$ | $L$ | centimeter | $L$ | centimeter | $L$ | meter |
| mass | m | $M$ | gram | $M$ | gram | $M$ | kilogram |
| time | t | $T$ | second | $T$ | second | $T$ | second |
| force | F | $M\ L\ T^{-2}$ | dyne | $M\ L\ T^{-2}$ | dyne | $M\ L\ T^{-2}$ | newton |
| work | W | $M\ L^{2}\ T^{-2}$ | erg | $M\ L^{2}\ T^{-2}$ | erg | $M\ L^{2}\ T^{-2}$ | joule |
| power | P | $M\ L^{2}\ T^{-3}$ | erg/sec | $M\ L^{2}\ T^{-3}$ | erg/sec | $M\ L^{2}\ T^{-3}$ | watt |
| electric current | i | $M^{\frac{1}{2}}\ L^{\frac{3}{2}}\ T^{-2}$ | statampere | $M^{\frac{1}{2}}\ L^{\frac{1}{2}}\ T^{-1}$ | abampere | $T^{-1}\ Q$ | ampere |
| electric charge | q | $M^{\frac{1}{2}}\ L^{\frac{3}{2}}\ T^{-1}$ | stat - coulomb | $M^{\frac{1}{2}}\ L^{\frac{1}{2}}$ | abcoulomb | $Q$ | coulomb |
| potential difference | V | $M^{\frac{1}{2}}\ L^{\frac{1}{2}}\ T^{-1}$ | statvolt | $M^{\frac{1}{2}}\ L^{\frac{3}{2}}\ T^{-2}$ | abvolt | $M\ L^{2}\ T^{-2}Q^{-1}$ | volt |
| resistance | R | $L^{-1}T$ | statohm | $L^{\frac{1}{2}}\ T^{-1}$ | abohm | $M\ L^{2}T^{-1}Q^{-2}$ | ohm |
| electric flux | $\Psi$ | $M^{\frac{1}{2}}\ L^{\frac{3}{2}}\ T^{-1}$ | line | $M^{\frac{1}{2}}\ L^{\frac{1}{2}}$ | | $Q$ | coulomb |
| electric displacement | D | $M^{\frac{1}{2}}\ L^{\frac{1}{2}}\ T^{-1}$ | line/cm$^2$ | $M^{\frac{1}{2}}\ L^{-\frac{3}{2}}$ | | $L^{-2}Q$ | coulomb/m$^2$ |
| electric field strength | E | $M^{\frac{1}{2}}\ L^{-\frac{1}{2}}T^{-1}$ | stat-volt/cm | $M^{\frac{1}{2}}\ L^{\frac{1}{2}}\ T^{-2}$ | abvolt/cm | $M\ L\ T^{-2}Q^{-1}$ | volt/ meter |
| capacitance | C | $L$ | cm. or statfarad | $L^{-1}\ T^{2}$ | abfarad | $M^{-1}L^{-2}T^{2}Q^{2}$ | farad |
| magnetic flux | $\phi$ | $M^{\frac{1}{2}}\ L^{\frac{1}{2}}$ | | $M^{\frac{1}{2}}\ L^{\frac{3}{2}}\ T^{-1}$ | maxwell | $M\ L^{2}T^{-1}Q^{-1}$ | weber |
| magnetic flux density | B | $M^{\frac{1}{2}}\ L^{-\frac{3}{2}}$ | | $M^{\frac{1}{2}}\ L^{-\frac{1}{2}}T^{-1}$ | gauss | $M\ T^{-1}Q^{-1}$ | weber/meter$^2$ |
| magnetic field strength | H | $M^{\frac{1}{2}}\ L^{\frac{1}{2}}\ T^{-2}$ | | $M^{\frac{1}{2}}\ L^{-\frac{1}{2}}\ T^{-1}$ | oersted | $L^{-1}T^{-1}Q$ | amp.turn/m |
| magnetomotive force | $F$ | $M^{\frac{1}{2}}\ L^{\frac{3}{2}}\ T^{-2}$ | | $M^{\frac{1}{2}}\ L^{\frac{1}{2}}\ T^{-1}$ | gilbert | $T^{-1}Q$ | amp. turn |
| reluctance | $\mathcal{R}$ | $L\ T^{-2}$ | | $L^{-1}$ | | $M^{-1}L^{-2}Q^{2}$ | rowland |
| inductance | L | $L^{-1}T^{2}$ | stathenry | $L$ | abhenry | $M\ L^{2}\ Q^{-2}$ | henry |
| permittivity | $\mathcal{E}$ | 1 | | $L^{-2}\ T^{2}$ | | $M^{-1}L^{-3}T^{2}Q^{2}$ | farad/meter |
| permeability | $\mu$ | $L^{-2}\ T^{2}$ | | 1 | | $M\ L\ Q^{-2}$ | henry/meter |

Table 2. MKS UNITS AND CONVERSION FACTORS

| Quantity | Symbols | Definition | Unit | No. CGS in 1 MKS |
|---|---|---|---|---|
| length | $l$ | Fundamental standard | meter | 100 cm. |
| mass | m | Fundamental standard | kilogram | 1000 gm |
| time | t | Fundamental standard | second | 1 |
| force | F | $F = ma$ | newton | $10^5$ dynes |
| work | W | $W = \int F \cos\theta \, dl$ | joule | $10^7$ ergs |
| power | P | $P = dW/dt$ | watt | $10^7$ erg/sec |
| electric current | i | $i = dq/dt$ | ampere | 0.1 emu or $3 \times 10^9$ esu |
| electric charge | q | Fundamental standard required | coulomb | 0.1 emu or $3 \times 10^9$ esu |
| potential difference | V | $V = W/q$ or $V = P/i^2$ | volt | $10^8$ emu or 1/300 esu |
| resistance | R | $R = V/i$ | ohm | $10^9$ emu or 1/(9x10'') esu |
| electric field strength | E | $E = F/q$ or $E = dV/dr$ | newton/coulomb or volt/meter | $10^6$ emu or $1/(3 \times 10^4)$ esu |
| capacitance | C | $C = q/V$ | farad | 9 x 10'' esu |
| permittivity | $\mathcal{E}$ | $F = qq'/4\pi\mathcal{E}r^2$ | farad/meter $\mathcal{E}_o = 1/(4\pi 8.98656 \times 10^9)$ f/m | $4\pi 9 \times 10^9$ esu |
| spec. inductive capacity | K | $K = \mathcal{E}/\mathcal{E}_o$ | | For free space $K = 1$ |
| inductance | L | $L\,di/dt = -V$ | henry | $10^9$ emu |
| magnetomotive force | $F$ | $F = Ni$ | ampere-turn | $0.4\pi$ gilberts |
| magnetic field strength | H | $H = \int i \sin\theta \, dl / 4 \quad r^2$ ($H = Ni/l$ for long sol) | ampere-turn/meter | $4\pi/10^3$ oersted |
| magnetic moment | M | $MH \sin\theta = T$ | weber-meter | $10^{10} / 4\pi$ emu |
| pole strength | p | $p = M/l$ | weber | $10^8 / 4\pi$ emu |
| magnetic flux | $\phi$ | $V = N d\phi/dt$ | weber | $10^8$ maxwells |
| reluctance | $\mathcal{R}$ | $\mathcal{R} = F/\phi$ | rowland | $4\pi/10^9$ emu(oersted) |
| mag. induction or flux density | B | $B = \phi/S$ or $dF = Bi \sin\theta \, dl$ | weber/meter$^2$ | $10^4$ gauss |
| permeability | $\mu$ | $\mu = B/H$ | henry/meter $\mu_o = 4 \quad /10^7$ henry/m. | $10^7/4\pi$ emu |
| mag. specific inductive cap. | $K'$ | $K' = \mu/\mu_o$ | | For free space $K' = 1$ |
| intensity of magnetization | I | $I = M/\text{volume} = p/S$ ($B = \mu_o H + I$) | weber/meter | $10^4/4\pi$ emu |
| electric displacement | D | $D = \mathcal{E} E$ | coulomb/meter$^2$ | $12\pi \times 10^5$ esu |
| electric polarization | P | $P = q/S$ ($D = \mathcal{E}_o E + P$) | coulomb/meter$^2$ | $3 \times 10^5$ esu |

See American Journal of Physics, October, 1940, page 318 for similar table.

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1. Green, Cecil H., Seismology.
2. Hendrix, Byron M., Coagulation and denaturation of proteins.
3. Karcher, J. C., Training of Physicists for work in geophysics.
4. Owen, Ed. W., The application of surface geology to petroleum exploration.
5. Proctor, D. C., Industry in the present emergency. "Texas Industry," 8, No. 6, 1942.
6. Suman, John R., The role of strategic materials in our national effort.

# BIOLOGICAL SCIENCES

Chairman: T. S. PAINTER, University of Texas

Professor S. W. Hewatt, Texas Christian University, was elected chairman of the section for 1942.

## ABSTRACTS

**Plant responses to *a*-and *b*-naphthoxyacetic, and *a* (b-naphthoxy) propionic acids,** EDNA L. JOHNSON, University of Colorado, and LEONARD R. FREESE, Texas Military College.—Both the *a* and *b* form of naphthoxyacetic acid and *a* (b-naphthoxy) propionic acid were physiologically effective in changing growth rate, amount of branching, and in the induction of leaf and stem anomalies in the plant species studied.

Observation of curvature response and formative effects indicate that in equal concentrations *a* (b-naphthoxy) propionic acid induced the greatest response, the beta form of naphthoxyacetic producing somewhat weaker effects, and finally the alpha form proving the least active. Both forms of naphthoxyacetic acid in lanolin emulsion caused increased branching in tomatoes, but the beta form was the more effective in this respect as well as in producing curled, twisted, skeleton-like leaves with deeply-divided leaflets or those in which the bases of the leaflets were united with the main axis and with the opposite leaflets. Growth resulting when three different concentrations of lanolin emulsion of *a*-and *b*-naphthoxyacetic were applied to the growing tips of Zinnia demonstrated a definite relation between degree of injury and concentration of emulsion used.

Abnormalities induced by the application of the three acids included enlargement of nodes and petioles, occurrence of skeleton-like leaves with very wide transparent midribs and narrow serrate or ruffled blades, altered phyllotaxy, union of blades for as much as four-fifths of their length causing formation of deep cups, and initiation of root primordia.

Histological studies indicate that leaves and stems of the experimental plants have a greater amount of Xylem tissue than do controls of the same age.

**Pollen studies with plums representing certain species and interspecific hybrids,** W. S. FLORY, JR., and M. L. TOMES, Texas Agricultural Experiment Station, College Station, Texas.—A knowledge of pollen conditions existing in the various available varieties is an important adjunct to a plum breeding program. It permits the more efficient selection of pollen parents. In the Southwestern United States most of the plum varieties grown have been derived from native species, from Japanese species, or—more preponderantly—are hybrids between American and Japanese plums. Certain pollen characters seem to throw additional light on the relationships existing between the different species and hybrids of Prunus represented by plum varieties in Texas. Anything which aids in deciphering genetic relationships is apt to facilitate solution of the perplexing sterility problems encountered in the Southwestern plums.

In 1940 and 1941 pollen of available varieties and species of plums was collected and studied with respect to: (1) apparent viability, (2) germination on artificial media, and (3) size of grain.

Apparent viability was assumed when grains appeared normal in shape, size and staining reaction. One-thousand-grain samples of 57 different varieties or species were studied. Twenty-six of the forms were pure species or their derivatives and these averaged 84.5 per cent of normal appearing pollen. Twenty-three hybrid varieties of rather certain parentage averaged only 56.4 per cent apparently good pollen. Hybrids among different species of native or among different species of Japanese origin had pollen very similar in viability to the pure species forms. Hybrids between American and Japanese species, however, had pollen much inferior to the parental forms. Neither season nor location of trees had any significant effect on apparent viability.

Pollen of 21 different varieties was germinated on nutrient agar. There was a highly significant correlation ($r = .845$) between apparent viability and actual germination when the 21 varieties were considered together. This indicates common causative factors and shows that varieties that are high in apparent pollen viability tend to be high in percentage of germination, and vice versa. Some important exceptions occurred.

Measurements were made of the greatest length and width of 20 pollen grains of all but one of the varieties studied for apparent viability. Forms belonging to different species with their average approximate lengths and widths follow: the native *Prunus americana* and *P. mexicana*, $51\mu \times 46\mu$; the European *P. domestica* and *P. insititia*, $51\mu \times 46\mu$; the native *P. angustifolia*, *P. hortulana*, and *P. munsoniana*, $43\mu \times 38\mu$; the Japanese *P. salacina* and *P. simoni*, $40\mu \times 35\mu$; hybrids between Asiatic and American species, $38\mu \times 33\mu$. Analysis of variance shows that while there are significant pollen size differences between varieties within some of the size groups, that the great majority of the variance encountered is intergroup. Pollen size is not only consistent within a variety, but is very apt to be similar between closely related forms. The converse of this is not necessarily true.

**Quantitative measurement of the velocity of water absorption in individual root hairs by a microtechnique,** HILDA F. ROSENE, The University of Texas.—A microtechnique has been developed which can be applied to quantitative studies of the absorption of water and solutes by individual root hairs. The apparatus is a micromodification of that previously used by the author in studies on water absorption in the onion root. Quantitative data were obtained on the volume of water absorbed per unit time and the velocity of absorption per unit area of different root hair cells of the same root and of different root hair cells of different roots. Data were also obtained on the distribution of the velocity of water intake along the longitudinal axis of a single root hair cell. The results furnished for the first time experimental data in support of the many investigators who have maintained, without direct experimental evidence ever since the time of the earliest microscopists in the seventeenth century, that root hairs function in the process of water absorption. Since root hairs are extensions of single cells the technique used provides a new approach not only to studies in relation to water and solute intake in roots, but also to absorption, nutrition, and growth of single cells; it is of significance not only to the fields of botany and more specifically plant physiology and agriculture, but also to the field of cell dynamics and, therefore, general physiology and biophysics. The technique also has a peculiarly significant relation to problems of soil science; individual micropotometers stimulate capillary passages in the soil and the technique provides an approach to the problem of determining why different plants do not avail themselves equally to soil moisture.

The paper is to be published in *Plant Physiology.*

**Reversible cyanide inhibition of exudation and absorption in the onion root,** HILDA F. ROSENE, The University of Texas.—In order to determine what role, if any, respiration might play in exudation and water absorption by roots, the effect of KCN on these processes was determined since it has been shown that cyanide exerts a specific inhibition upon certain enzymatic exudative systems in cells. It was found that volume exudation and volume absorption of individual isolated roots *(Allium cepa)* were reversibly inhibited when the roots were exposed to concentrations of .005 M and .0025 M KCN. Reversible inhibition also occurred when roots were exposed to .01 M KCN for a relatively short period of time; inhibition was irreversible when the time of exposure was the same as that in the experiments with .005 M KCN. Individual variations in percentage inhibition were manifested by different roots under similar experimental conditions; 100% inhibition was not observed.

The paper is to be published in *American Journal of Botany.*

**Correlation between mandibular morphology and food specificity in grasshoppers,** F. B. ISELY, Trinity University.—Introduction: The morphology of the mandibles and other mouth parts of the Orthoptera and related insects has been investigated by Nininger, Yuasa, Golden, Snodgrass, Uvarov, Walker, *et al.*

In the literature at hand, however, no mention is made of special adaptations of mandibles in phytophagous grasshoppers to different types of vegetation or plant parts, such as: grasses, forbs, buds, flowers, and seeds.

*Food specificity*—In earlier papers (Isely, 1938a, 1941a) it is shown that many of the common species of grasshoppers (Acrididae and Tettigoniidae) of north central Texas are selective feeders, and that the Acrididae are for the most part strictly oligophagous. Since the mandibles are the principal biting and chewing organs of these grasshoppers, it has seemed worth while to investigate adaptations to different types of vegetation, not only of acridians feeding on grasses and forbs, but also of plant-feeding and predaceous insect-eating Tettigoniidae. Food preferences and maintenance diet experiments previously cited and discussed point to but one conclusion: in common with all organisms from bacteria to man where diet requirements have been critically tested, grasshoppers demand for health, longevity, and reproductivity, an adequately balanced diet.

*Mandible patterns*—Four chief mandible models have been developed by southwestern and western United States grasshoppers (Acrididae and Tettigoniidae) to better adapt different groups (chiefly subfamilies) for wide-ranging diet possibilities. Besides the four major models, four combination-models have been evolved, making a total of eight.

Representative species have been discussed which exemplify the basic and combination models as follows: (1) forbivorous mandibles are found largely among the Cyrtacanthacrinae, Batrachotetriginae, many Oedipodinae, and a very few Acridinae; (2) graminivorous models are characteristic of the Acridinae, many Oedipodinae, and a very few Cyrtacanthacrinae; (3) carnivorous jaws are shown by the Decticinae; (4) seminivorous mandibles are most clearly seen in the special patterns of the seed-eating Corpiphorinae.

The combination-patterns are less easily defined but show interesting variations: (5) herbivorous mandibles belong to the mixed feeders, especially the notorious pest-grasshoppers *Camnulla pellucida* (Oedipodinae), *Melanoplus mexicanus* (Cyrtacanthacrinae), et al.; (6) florivorous-forbivorous mandibles include most of the Phaneropterinae; (7) lignivorous jaws seem to have reached only generic group differentiation and are represented by Pterophylla and Microcentrum (Tettigoniidae) and by several Schistocerca (Acrididae) which may be included here rather than in the forbivorous grouping given above; (8) seminivorous-carnivorous species, represented by the Conocephalinae, are here separated from other Tettigoniidae on account of their feeding behavior and no distinctive jaw pattern has been determined. Their mandibles are essentially carnivorous, but feeding activities suggest that further study may justify their separation from the more strictly carnivorous decticids. The omnivorous feeding behavior of *Anabras simplex* would appear to demand a separate group, but here, as in (8), the pattern is carnivorous.

Summary—1. Of 89 Acrididae examined, 34 had graminivorous, 37 forbivorous, and 18 herbivorous mandibles.

2. Among the Tettigoniidae studied, 10 had florivorous-forbivorous, 2 lignivorous, 2 seminivorous, 5 carnivorous, and 5 seminivorous-carnivorous mandibles.

3. Morphologically, mandibles are definitely correlated with food, but in the main, mandible patterns follow genetic lines. Strangely enough, certain of the species which have broken away from usual subfamily feeding behavior are also quite dissimilar in structure from typical of subfamily representatives as characterized by taxonomists, i. e., *Acrolophitus variegatus* (Acridinae), *Leptisma marginicollis* (Cyrtacanthacrinae), et al.

4. Variations in mandible structure within a species are especially marked among the mixed feeders.

5. Food specificity appears to offer tangible clues toward a better understanding of grasshopper communities and the inter-relationships between these Orthoptera and plants.

6. It should be evident that food specificity research is essential to further progress in working out the control of pest hoppers.

A more detailed account of these studies will be published elsewhere.

**Effects on the facial nerve of component substances uses in certain anesthetic mixtures dissolved in oil,** DONALD DUNCAN and WALTER JARVIS, The University of Texas, Galveston, Texas.—Comparisons were made of the effects of a mixture containing nupercaine hydrochloride 0.5%, phenol 1.0% and benzyl alcohol 10.0% dissolved in oil of sweet almonds, with those of the individual ingredients of this mixture. Small amounts (2-4 cc.) of the mixture, or the single substances, in oil were injected into the facial tissues of the cat. The duration of complete paralysis of the orbicularis oculi and the interval between injection and complete recovery were noted, followed by histological examination of the branches of the facial nerves in some cases. In others, the animals were sacrificed 10-14 days after injection and the nerves examined.

Similar comparisons were made between the separate ingredients and two other mixtures, one containing eucupin base 0.1%, ethyl-aminobenzoate 3.0% and benzyl alcohol 5.0%; the other containing procaine base 1.5%, butesin 6.0% and benzyl alcohol 5.0%.

Injection of the nupercaine mixture in 21 trials invariably produced complete paralysis of the orbicularis oculi with an average duration of 16 days. Complete recovery as evidenced by ability to close the lids required an average interval of 27 days. Practically identical results were obtained with 10.0% benzyl alcohol alone. In both series complete or nearly complete degeneration of the facial nerve branches followed by regeneration was established in every case examined. Injections of pure almond oil, 1.0% phenol in oil, 1.0% nupercaine hydrochloride, and a combination of the phenol and nupercaine produced no sign of weakness in the facial muscles and no degeneration was found in the facial nerve.

The mixtures containing 5.0% benzyl alcohol and the 5.0% benzyl alcohol alone produced variable results. Usually, no paralysis or weakness was evident; but occasional instances of weakness were encountered and in only one of 19 trials was a complete block produced. Degeneration of the nerve fibers varied from a slight amount to almost complete degeneration and paralleled the paralytic effects of each injection. Complete blocks lasting for several hours and unaccompanied by nerve degeneration were occasionally obtained with 2.0-10.0% procaine base in oil.

It is concluded that injection of anesthetic mixtures containing benzyl alcohol cause nerve fiber degeneration; and that their prolonged effects are largely due to destruction of the nerve fibers and not to gradual release of the anesthetic substances from the oil vehicle as generally assumed.

**Effect of sex and gonadotropic hormones on the development of the gonads in *Phrynosoma cornutum* during reproductive and non-reproductive phases,** GEORGE E. POTTER and SIDNEY O. BROWN, Agricultural and Mechanical College of Texas.—The effect of sex hormones and gonadotropic agents during the non-breeding season (October and November) and during the height of gonad development (April through June) are being investigated in the Texas horned lizard, *Phrynosoma cornutum.* Results to date show that during both seasons estrogens reduce the size of the ovary, the greater relative reduction being during the breeding season. Antuitrin-S during the non-reproductive period produced insignificant stimulation of the ovaries in the concentrations used (3-120 RU). Testosterone had no visible effect on the developing eggs during the spring period. Additional experiments are under way on the effect of gonadotropic and sex hormones during the non-reproductive phase. The animals have been observed to change from a light to dark color on the injection of oestrogens in oil.

**Histological changes with age in the liver of the mouse,** WARREN ANDREW, Baylor University College of Medicine.—A histological and cytological study of the liver was made, using a pedigreed strain of mice (C57 black) from the Jackson Memorial Laboratory. Animals ranging from youth through old age were included.

A definite and consistent difference in the histological picture of the liver in youth, middle age, and senility was found. In young mice the nuclei of the liver cells are very uniform in size and appearance, all being spheroid, 8-10 in diameter, and having only a few nucleoli, usually 2-5. The cytoplasm stains homogeneously with eosin.

In middle-aged animals there is considerably more variation in the nuclear size and form, some nuclei with many nucleoli, and a tendency toward a clear zone between nucleus and cytoplasm.

In the senile animals the nuclei of the liver cells show a high degree of variability in size and ranging from types similar to those in the young animal up to "giant" nuclei 20 microns or more in diameter and containing 30-40 nucleoli. Such giant nuclei are usually hyperchromatic and may present inclusions. These inclusions are commonly round or oval hyaline bodies which appear to be solid though not crystalline in character. They have very little affinity either for acid or basic stains. The size of the cells which possess such nuclei, while greater than the average, does not seem to correspond with the size of the nuclei. These giant nuclei are frequently irregular in form. Many of them are elongated, ovoid or rectangular, with outlines often angular.

The perinuclear clear space, seen to some extent in the middle-aged animals, is a conspicuous feature of cells of senile liver.

Another histological feature of the liver in the majority of senile animals is a great degree of periportal infiltration of lymphocytes and other cell types. These cells seem to replace extensive areas of hepatic tissue.

No changes in the amount of connective tissue were observed.

**Inheritance of an eye anomaly in the albino rat,** J. H. QUISENBERRY and S. O. BROWN, A. & M. College.—Expression of this character is extremely variable. Degrees of anomaly extend from a slight reduction in the size of one eye to the complete absence of both eyes. $F_1$ and reciprocal backcross progenies including 830 rats were studied. At least one major and one or more minor modifying factors determine the expression of this character. Significantly more females than males are affected. The left eye was more often affected, or affected to a greater degree, than the right eye. It was suspected that certain environmental factors like ration were causing part of the variability in the expression of this character. Responses to rations free of vitamins A and $B_1$ have been checked. The affected strain was equal to or better than a non-affected strain with which it was compared in terms of storage and utilization of these vitamins. Embryological development of this anomaly is being studied histologically.

**Limnological excursions in Texas and Mexico,** EDWARD S. DEEVEY, JR., Rice Institute, Houston, Texas.—This is a preliminary report of limnological investigations in Texas and Mexico in the summers of 1940 and 1941. Water analyses included, in addition to routine mineral analyses, total and seston phosphorus, total nitrogen, nitrate, silica, color and chlorophyll as an estimate of phytoplankton. Biological collections were made, some by means of the Ekman bottom sampler, and the final reports will include physical and chemical studies of recent bottom deposits, as well as of more ancient deposits of Lake Patzcuaro. Biological collections for the most part are still in the hands of specialists.

The lakes fall into three geographical groups:

(1) The lakes and springs of the arid trans-Pecos region, and one in Coahuila. These show a wide range of water type, although the carbonate type characteristic of humid regions was not encountered; chloride waters and highly concentrated waters were confined to playas in the Salt Basin. Total phosphorus and nitrogen were rather low for arid regions, and most (77-86 per cent) of the phosphorus was in the seston. The most interesting new biological record so far found is that of the rare bryophyte *Riella americana*, Howe & Underw., from Presa de Hipolito, Coahuila.

(2) The lakes of the southwestern coastal plain occupy subcircular depressions that may be deflation basins; they become deeper toward the Rio Grande, and the most remarkable are the salt lakes of Willacy and Hidalgo Counties. The salt is apparently borne inland as spray by the trade winds. The waters of the latter are of the chloride type, highly concentrated, and rich in plankton and phosphorus. The fauna of the most concentrated example, La Sal del Rey, apparently consist only of Artemia and Ephydrid fly larvae. La Sal Vieja has a sparse Chironomus fauna.

(3) The large lakes of the Mexican highlands, Pátzcuaro and Chapala, are tropical lakes in the sense that their temperatures do not go below 4° C. (Forel) but suptropical in the sense that their surface temperature varies within comparatively wide limits (Yoshimura). Thermal stratification is transitory, as the lakes are shallow (Pátzcuaro 17 m., Chapala probably 25 m.), but Pátzcuaro may develop a considerable oxygen deficit. The phytoplankton is moderately rich, and the zooplankton is rich in species. The bottom fauna resembles that of temperate lakes. The bottom deposits are very soft, thick, and uniform in Pátzcuaro, which occupies a closed volcanic basin, but more diversified in Chapala, which drains by way of the Río Lerma. The fishing culture of the Tarascan Indians of Pátzcuaro is of great ethnographic interest in that it is probably similar to that of the pre-Conquest Aztecs of the Valley of Mexico.

**Limnological investigations on Lake Dallas**, J. K. G. SILVEY and B. B. HARRIS, North Texas State Teachers' College.—Investigations on Lake Dallas cover the period 1936-1941. During the past three years intensive work has been carried out; frequently, daily observations were made and at no time has more than a month passed without complete limnological data.

During this time, algal blooms have changed their seasonal appearance from the middle of summer to the late winter and early spring. At the same time, the relative number of units of *Melosira* have increased during their maximum growth five fold. In the first three years of this work, Lake Dallas was the only lake under observation that produced a summer bloom of plankters. The others showed maximum production in the spring: now Lake Dallas appears to resemble Lake Worth and Eagle Mountain Lake. Lake Dallas now far exceeds any other body of water in this region in total production of plankton, both qualitatively and quantitatively. The major source of organic material is still due to *Melosira crenulata* which during a bloom composes about 95% when determined by the chromic acid method.

Temperature could not account for the increase in plankton production in Lake Dallas, since the data show only slight variations from year to year. Other general limnological data have the same tendency if one considers pH, oxygen, bicarbonates, silicates and chlorides. There is an evident correlation between phosphates and plankton blooms. This is best shown by opposite maxima. Algae in rapid growth appear to consume phosphates, which decrease to a minimum. As the algal bloom wanes, phosphates again become highly evident. These findings are in keeping with the results of the United States Public Health Service in Ohio.

Turbidity frequently destroys an algal bloom, especially if the turbidity is caused by a surface density current. Suspended silt in settling to the bottom carries practically all planktonic material with it, and deposits it in gelatin-like layers on the floor of the lake. During the past six years, the organic content of Lake Dallas mud deposits have increased about five hundred per cent. In August of each summer these deposits are reduced to a minimum; with the coming of cooler weather and later plankton blooms, the organic content is raised above the maximum of the previous year.

The continuous rise in fertility of Lake Dallas as evidenced by annual increases in plankton production is due at least in part to the organic and phosphate content of the feed-streams. Elm Creek does not show as much fertility as Lake Dallas, thus this source of available materials is not important. Pecan Creek at all times carries a high organic load. Phosphates in this creek water are always high, and since the flow of the stream is due in part to the effluent from Denton sewage disposal plant, the cooler weather contributes to a greater content of organic materials. This stream is an excellent example of how a small but continuous supply of very fertile water may in time influence the character of an entire reservoir.

**Pollution studies on the Trinity River at Fort Worth, Texas,** WILLIS G. HEWATT and DOROTHY ROSE, Texas Christian University.—The Trinity River in its course through Fort Worth receives the wastes from packing houses and the city disposal plant. In the present investigation three sampling stations were established along the river and an attempt was made to determine the degree of pollution. Station 1 was located on the West Fork of the river just before it formed its junction with the Clear Fork. Station 2 was located at a point below the packing houses. Station 3 was established about 1200 feet below the Fort Worth sewage disposal plant.

Chemical determinations were made at two-week intervals for the following factors: dissolved oxygen, free carbon dioxide, nitrate and nitrite nitrogen, hydrogen-ion concentration, and phosphorus as $PO_4$.

In addition to the chemical tests the plankton at the three stations was studied. The organisms were determined and counted.

The results of the chemical and plankton studies reveal that there is a high pollution of the water at Station 3; at Station 2 there exists only slight pollution and there is no domestic pollution at Station 1.

**Some experimental studies on pain,** R. M. MOORE and E. L. PORTER, State Medical College, Galveston.—In some nerve injuries the wound apparently heals completely but there follows a gradually increasing and often uncontrollable pain lasting weeks or months. The condition is known as causalgia or thermalgia because the pain is spoken of as burning.

There is some evidence that this condition is due to or at least aggravated by a reflex disturbance of the blood supply to the limb.

Without causing conscious pain we have imitated this condition and experimented upon it by using the "Spinal Cat", in which the brain is destroyed and the spinal cord alone left.

In such an animal if the toe pad is pricked the leg is drawn up reflexly. A shock to a nerve does the same. To make the study quantitative we have stimulated the posterior tibial nerve by a measured electric shock every 3 seconds and have recorded the reflex contraction of the tibialis anticus muscle near the threshold.

While this is being done a ligature previously placed around the femoral artery is pulled tight, thus shutting off the blood supply to the limb. In about 2 minutes the contractions rise markedly in height. This is due to summation of stimuli, for if the shocks are not given the muscle is perfectly quiet. If the ligature is removed from the artery the contractions usually diminish to their original height after a few minutes.

The same summation may be observed if instead of cutting off the blood supply a stimuli is given which would certainly cause pain in the conscious animal, such as application of a few drops of boiling water to the skin of toes or knee.

These experiments, we think, suggest the possibility that the pain of causalgia may be a summation phenomenon in which interference with the blood supply of the affected limb plays a part.

**A study of relationship between ventral receptacle and testes coiling in Drosophila,** L. E. ROSENBLAD, University of Houston, Houston, Texas.—An analysis of reproductive tract structures of numerous species of Drosophila and closely related genera shows high correlation between the number of ventral receptacle coils in the female and the number of testes coils in the male of a given species. The ventral receptacle serves as a storage space for the spermatozoa produced in the testes. This seems to indicate a need for more coils in the female to take care of the additional spermatozoa produced in the males having a greater amount of gonad tissue. A study of the size-relationship between testes and the spermathecae (also spermatozoa storage organs) in the female shows a positive correlation, but not as high as that between size of testes and ventral receptacle. Closely related species, particularly those which hybridize, nearly always agree in number of testes coils and ventral receptacle coils. Study of the relationship between number of ventral receptacle coils and the length of time the female retains the spermatozoa after copulation, seems to indicate that those species with longer coils retain the sperm longer. This evidence can not be considered conclusive, as other factors such as the retention of the spermatozoa in the spermathecae and uterus, may affect the results. The dissection methods employed in this study were the same as described by the author in previous studies.

**Rat parathyroids in relation to diet and pregnancy,** JOHN G. SINCLAIR, Department of Anatomy, The University of Texas.—This research is the morphological aspect of a collaborative study in progress since 1935. Dr. M. Bodansky and V. Duff are responsible for the care of the colony and for all chemical determinations. Miss Duff prepared the synthetic diets.

Using supposedly adequate diet and without appreciable change in serum values for calcium and phosphorus, the effect of pregnancy alone is an enlargement of the parathyroid gland. Successive pregnancies have a cumulative effect at least when closely spaced as they are in most rat colonies. This is not a function of body size. The parathyroids do not diminish even when the rat later becomes sterile. The effect of diet controlled with regard to calcium and phosphorus content is to change the serum values appreciably and to alter the size of the parathyroid gland inversely to the level of serum calcium. Serum phosphorus is positively correlated with gland size though less effectively. Diet high in calcium and low in phosphorus can be used to protect the maternal glands. Viosterol also helps. A low phosphorus dietary effect can be attained by reducing phosphorus in the diet or mixing in some substance, like aluminum acetate, which will precipitate out insoluble phosphate in the intestine and in this way improve calcium absorption and retention.

In general under synthetic diets the maternal parathyroid is heavier than normal and the fetal parathyroid weight is lower than normal except under diets that maintain a high serum calcium. This is not correlated with body weight. This is more significant when compared with the fact that under normal maternal diet there is a direct linear relation between body weight and parathyroid weight at birth. In mature rats again there is no correlation of gland and body weights.

In parathyroidectomized mothers the serum calcium falls and phosphorus rises under most diets and the fetal parathyroids are above normal in size. Two diets which maintain high serum calcium in spite of parathyroidectomy produce small fetal parathyroids.

It is suggested that parathyroid glands may be particularly sensitive to changes in calcium level by changes in capillary and epithelial permeability, leading to increased activity and hypertrophy of even hyperplasia. It is known that animals may become acclimated to increased levels of parathyroid hormone.

More than 1200 glands were reconstructed from serial sections.

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**The serology of the relapse phenomenon in relapsing fever,** V. T. SCHUHARDT, The University of Texas, Austin, Texas.—The relapse phenomenon in spirochetal relapsing fever is now generally conceded to be an immunological phenomenon resulting from the inherent capacity of the spirochetes to undergo one or more antigenic phase variation during the course of the disease. The nature of this antigenic variation is unknown, but there is a close similarity between this natural phenomenon in relapsing fever and the natural and the experimentally induced antigenic phase variations in the Salmonella H antigens.

Apparently only a few of the many spirochetes involved in an attack are able to accomplish this change in antigenic structure since the great majority are destroyed at the crisis of the attack. Possibly the spirochetes which are able to accomplish this phase variation are some of the relatively few which leave the blood stream during an attack to invade the brain or other tissues, and thereby become protected from immediate direct contact with newly elaborated humoral antibodies. Regardless of where they are formed the new phase spirochetes survive and multiply in the blood stream in the presence of antibodies developed against the preexisting phase spirochetes and give rise to the relapse.

The antigenic phase variation capacity of relapsing fever spirochetes seems to differ depending upon the source of the spirochetes, the transmitting vector and the experimental animal used. Louse-transmitted infections frequently give rise to attacks involving spirochetes belonging to a single antigenic phase, whereas tick-transmitted infections, in so far as they have been studied, seem frequently if not always to result in attacks involving multiple antigenic varieties of the spirochetes. Relapse phase spirochetes show a variable but consistent tendency to revert to pre-existing antigenic states.

The variable number of relapses especially apparent in tick-transmitted relapsing fever (1 to 12 in human beings) is probably best explained in terms of the large number of possible antigenic phases of the spirochetes, the number of antigenic varieties involved in the first attack and in each subsequent relapse and the continuing capacity of the spirochetes involved in each attack or relapse to accomplish a successful variation to an antigenic phase or phases not previously experienced during the course of the disease.

The paper has been included in a monograph published by American Association for the Advancement of Science.

**Yellow fever, plague and typhus—smoldering threats,** ASA C. CHANDLER, Rice Institute, Houston, Texas.—Yellow fever, plague and typhus are distinct threats, with efficient fifth columns in our yards, attics and cellars; plague and typhus are already firmly established in our midst, and yellow fever is less than twelve hours away by air.

Fourteen years ago yellow fever was for a brief period thought extinct in the Western Hemisphere, but events during the succeeding five years showed not only that it was not extinct; but that outbreaks could occur in places remote from any recent focus of the disease, and in places free from the yellow fever mosquito, *Aedes aegypti*. Development of "protection tests" by means of which the place and time of yellow fever outbreaks can be determined, and of a simple and reliable method for determining after death whether yellow fever was the cause, had demonstrated that yellow fever exists as a jungle disease over vast areas of South America, and constitutes an ineradicable threat not only to all South American cities, but also to our own, since we are less than twelve hours by air from some of the jungle strongholds.

Plague, primarily a rat disease transmitted by fleas, was introduced into San Francisco in 1900, and spread to ground squirrels on the outskirts of the city. Since then it has spread throughout the Coast mountains from San Francisco to Los Angeles, and in more recent years to the North and East, until now it is known to exist in 11 of 13 states. The disease has been discovered in 18 different kinds of wild rodents and is known to be transmissible by more than 30 species of fleas. Ground squirrels, prairie dogs, and wood rats are important reservoirs of infection, and are important in its spread. To what extent the disease will spread when it reaches the Great Plains remains to be seen. The possibility of its jumping back into cities and starting new rat-borne epidemics is a constant threat.

Typhus in its endemic form is another rat-borne disease, and one which is yearly becoming more prevalent and more widespread. The first cases were reported in the Lower Rio Grande Valley and in Georgia about 25 or 30 years ago. By 1925 and 1926 cases were being reported from the coastal states and from Texas to North Carolina. The total number of cases reported has increased from 5 to 20 a year from 1925 to 1930 to about 500 in each of the last four years; in its southern stronghold it was reported from 158 counties in 1930, from 660 in 1939. It has recently extended its range to Tennessee, Oklahoma and California, and within the past year has been reported from a half dozen northern cities in which it was not previously known.

It would be an unhappy situation for the cities of the prairie states if plague from the West and typhus from the South should both reach them in the next decade. Both diseases are on the march and both have able Fifth Columns to meet them, in the form of domestic rats.

Our only defense against any of the three diseases here discussed is as complete suppression as possible of their respective Fifth Columns—*Aedes aegypti* for yellow fever, and rats for plague and typhus. We ought to start the suppression now; tomorrow may be too late.

The paper was published in *The American Biology Teacher*, March, 1942.

# Cotton Root Rot, the Weather, and Cotton Yields*

WALTER N. EZEKIEL

The root-rot disease, caused by the fungus *Phymatotrichum omnivorum* (Shear) Duggar, is the outstanding plant disease of the Southwest. We have found this disease in more than 200 of the counties of Texas (Fig. 1). Its host range of some two thousand species takes in field crops such as cotton and alfalfa, native plants such as the mesquite and cactus, and fruit and ornamental trees and shrubs. However, the greatest economic damage in Texas is in the cotton fields, where root rot kills areas so large as to be visible even from airplanes passing over the fields.

The crop loss resulting from the killing of cotton plants is not so easily seen as the dead plants in the fields. While plant pathologists have estimated yearly reduction in cotton yields as 6 to 15 per cent for Phymatotrichum root rot alone, the Agricultural Marketing Service has yearly estimated reduction in the Texas cotton crop, from *all* diseases, as only about 2 per cent. There is apparently a difference in interpretation of the effect on the cotton yield of observed high prevalence of root rot. I am going to summarize some statistical studies that show our approach to this problem of root rot, weather, and yields, meanwhile indicating some of the complications that could lead to an incorrect solution.

Now within the areas of generally favorable soils and climate, in central and western Texas, there is great seasonal variation in prevalence of root rot from year to year and from point to point during the same year. For example, in 1937 root rot killed only about 15 per cent of the cotton plants in McLennan County, while in Bell County, adjoining on the south, there was about 29 per cent kill. But in 1938, there was about 32 per cent loss in McLennan County, and probably below 15 per cent for Bell County.

Such differences have generally been attributed to the weather (7, 8, 9, 11), and recent study of weather records together with county averages of losses from root rot made in some surveys (1, 2) fully bears this out. The groups of counties studied were within the Blackland Prairies section and were approximately uniform in including large areas of soils favorable for the disease. Root-rot figures for the 1937 data were averages of estimates in 770 fields in all; for the 1938 figures, for a total of 1,590 individual estimates. Analysis by the Bean method of graphic multiple curvilinear correlation made it possible to determine the individual effect on the percentage of root rot of the rainfall in each of the summer months, after allowing for the effect of the other variables considered.

In the 1937 data (1), increases in April, May, June, and July rainfall had progressively greater effect on the final prevalence of root rot. An inch of rain in April was associated with an increase of root rot of about 14 per cent; while an additional inch in July was associated with an increase of about 32 per cent root rot.

A notable feature of the regression lines showing the relation of 1937 rainfall and root rot was that there was no tendency to taper off with

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increasing rainfall—root rot must have been held back for lack of soil moisture in all of the counties studied in 1937. The 1938 data (2), however, included some counties with high rainfall throughout the season, and others with early high rainfall followed by drought. The regression lines were again steeper for the later months, but showed also the expected inflexion points beyond which additional rainfall did not appear to contribute further to the final amount of root rot. On the basis of these

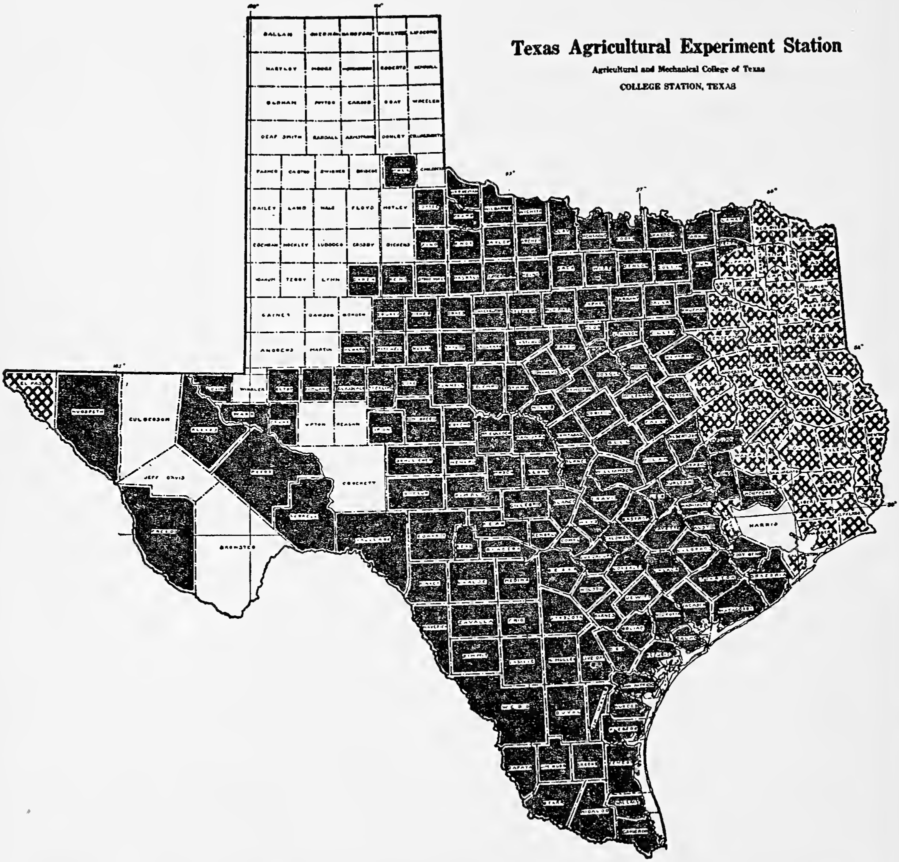


Figure 1. Known distribution of cotton root rot in Texas, by counties.

regression lines, for percentages of cotton plants killed by about October 10, 1938, these inflexion points were: June, about 4 inches of rainfall; July, 3.1 inches; August, 2.5 inches; and September, 2 inches.

To put the results in more general form, these particular studies showed: first, that the final percentage of root rot, within areas of favorable soils, is almost exactly a linear function of the rainfall during the several preceding months, with the same amount of rainfall having a greater effect later in the season (that is, with the regression lines for the different months becoming steeper); and second, that beyond an optimum amount for a particular month, additional rainfall will not cause further increase in the percentage of root rot. Greatest damage occurs with continued rainfall, month after month.

We can explain quite precisely why the same amount of rainfall is more effective late rather than early in the season. Young cotton plants are resistant to root rot. For example, in an experiment at College Station, cotton planted at intervals was all inoculated artificially the same day. Very few of the younger plants were attacked, while the older ones showed progressively more loss (Table 1). Only 2 to 3 per cent were killed of those plants inoculated when planted, while the loss mounted above 70 per cent for plants 14 weeks old at time of inoculation.

Table 1. Relation of age of cotton plants in replicated field plots to susceptibility to inoculation with Phymatotrichum root rot.

| Age of plants at time of inoculation July 28, 1939 | Plants succumbing to root rot within three months |
|---|---|
| | percent |
| 14 weeks | 71.1 |
| 10 weeks | 60.4 |
| 6 weeks | 42.4 |
| 3 weeks | 16.6 |
| 0 (planted at time inoculated) | |
| regular planting | 2.9 |
| special planting, adjoining the oldest plants | 2.0 |

So far we have been discussing the fairly simple question of the relation of the weather (chiefly rainfall) to prevalence of root rot. But what does the disease do to the yield? It would seem that since root rot kills the plants, the resulting crop loss should show up readily in lower yields of cotton.

But this is not the case when you consider *average* losses from root rot and *average* yields. As in the data in Table 2, increased prevalence of root rot over an entire county is instead accompanied quite generally by increase also in the average yield of cotton per acre, again for the entire county. It is only when prevalence of root rot exceeds a fairly high figure (in this table about 10 per cent for Ellis, Falls, Travis, and Williamson, and about 20-25 per cent for Bell, Hill, and McLennan counties) that a decline even in the county average yield can be noted with still further increase in prevalence of root rot.

This paradoxical relation has probably led to considerable misapprehension as to the actual crop losses caused by the disease. The real losses cannot be seen by examination of average figures of the sort shown in Table 2. We obtained a clearer picture from some data recorded over a period of years for experimental plots of the Temple substation. Multiple correlation study (5) of these plot records made it possible to find separately the effect of the percentage of plants with root rot on the yield, and the effect of rainfall on the yield. As was anticipated, the more root rot, the lower the yield; but the higher the rainfall, the higher the yield. This statistical result is thus in line with general knowledge that in the Southwest the cotton plant (as well as the root-rot disease), is usually supplied with less water than it needs. It is for this reason that in years when heavy rainfall increases the prevalence of root rot, the additional rainfall also increases yields in fields where the disease is not prevalent. Even in infested fields, the surviving plants bear more cotton during years of higher, favorable rainfall. In such years of favorable rainfall these combined increases can well mask in average figures the disastrous losses in the fields where root rot has attacked many plants.

The lower yields shown in Table 2 for seasons of highest root rot loss are possibly evidence of the intercorrelated effect of some other influences,

Table 2. Averages for some counties of Texas of percentages of cotton plants killed by root rot, as determined in surveys (1, 2, 3, 5) and yields of cotton as estimated by the Office of Crop Estimates (12, 13, 14).

| | *1928* | *1937* | *1938* | *1939* |
|---|---|---|---|---|
| *Bell County* | | | | |
| Root rot, percent | 20 | 29 | 14 | 10 |
| Cotton yield, pounds per acre | 184 | 146 | 157 | 135 |
| *Ellis County* | | | | |
| Root rot, percent | 9 | 16 | 9 | 12 |
| Cotton yield, pounds per acre | 178 | 207 | 200 | 210 |
| *Falls County* | | | | |
| Root rot, percent | 12 | 4 | 7 | 5 |
| Cotton yield, pounds per acre | 168 | 179 | 186 | 150 |
| *Hill County* | | | | |
| Root rot, percent | 17 | 22 | 14 | 15 |
| Cotton yield, pounds per acre | 174 | 170 | 162 | 172 |
| *McLennan County* | | | | |
| Root rot, percent | 25 | 15 | 32 | 15 |
| Cotton yield, pounds per acre | 173 | 155 | 140 | 148 |
| *Travis County* | | | | |
| Root rot, percent | 9 | 8 | 11 | 3 |
| Cotton yield, pounds per acre | 159 | 141 | 154 | 103 |
| *Williamson County* | | | | |
| Root rot, percent | 10 | 8 | 9 | 4 |
| Cotton yield, pounds per acre | 173 | 176 | 198 | 127 |

notably insect prevalence, on the yield of cotton. Whitaker (15) has pointed out that rainfall, root rot, and boll weevil occurrence all seem to be correlated. The observed declines in yield with extreme prevalence of root rot may result when the favorable effect of greater rainfall on the host plant is no longer great enough to exceed the greater loss from root rot, plus the effect of insects, plus other possible unfavorable effects of excess moisture conditions on the crop.

To find just what reduction in yield should be attributed to death of plants from root rot (remembering that some bolls are produced by the plants prior to attack by the fungus) we have used data from study of the yields in the plots at Temple (5). The slope of the regression lines, after allowing for the effect of rainfall on yields, indicates the apparent effect of the disease itself on the yield. A still better estimate was obtained by using paired data for two such plots, from the same substation, and correlating yearly differences in the percentages of root rot, with ratios of the yields for the same years. Seasonal effects on yield were thus avoided, the curve representing fairly well simply the effect on the yields of differences in root rot. A high correlation ($\bar{r} = -.83$) was found, and a regression line with a slope such as to give an estimating ratio of 1.02 for losses as compared to percentages of root rot. This ratio was between those calculated separately for the two plots.

Separate studies (4, 5, 6, 8) have been made also of the yields from individual cotton plants that succumb to root rot at different times during the season. These have given results in general agreement with the estimating ratios as determined from the plot data.

For practical use, I have suggested (5) and used a ratio of 0.9, rather than the higher one. Multiplying the percentage of plants killed by root rot at time of first picking by a factor of nine-tenths gives a reasonable estimate of the percentage crop reduction. For example, if 20 per cent of the plants have been killed, the crop loss is estimated as $0.9 \times 20$, or 18 per cent of the yield that would otherwise have been obtained. Calculations such as this are shown in Table 3, for the Bell County data from Table 2.

Table 3. Calculation of crop loss from the percentage of plants killed, illustrated with data for Bell County, from Table 2.

| | 1928 | 1937 | 1938 | 1939 |
|---|---|---|---|---|
| (a) Recorded percentages of plants killed by root rot, from survey data...... | 20 | 29 | 14 | 10 |
| (b) Estimated percentage reduction in yield [(a) × 0.9].................. | 18.0 | 26.1 | 12.6 | 9.0 |
| (c) Recorded cotton yields, lb. per acre... | 184 | 146 | 157 | 135 |
| (d) Estimated potential yields in the absence of root rot [(c)/100%—(b)].. | 224.4 | 197.6 | 179.6 | 148.3 |
| (e) Estimated crop losses from root rot [(d)—(c)], lb. per acre............ | 40.4 | 51.6 | 22.6 | 13.3 |

Omitting many interesting complications, we have now the final picture. The root-rot fungus and the cotton plant are both affected by the rainfall in somewhat the same manner. In years of "favorable" rainfall, yields may be higher even in root-rot areas. But this higher yield is still very much less than would be obtained were the disease not present. The root-rot disease tends to "*equalize*" production of cotton on the particular farms on which it occurs, *at the drouth level*, causing meanwhile percentage crop reduction that approaches the percentage of the plants killed by the disease.

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# Influence of Storage Conditions Upon the Germination of Onion Seed

F. R. BRISON, A. & M. College of Texas

Onion seed lose their viability in a relatively short time when stored in common storage in the South. Seed may produce good stands when planted in the spring, but fail to germinate entirely when planted the following fall. This uncertainty of germination is a matter of concern to growers and seedsmen alike.

Beattie and Boswell (1) stored seed of four different varieties of onions, some sealed and others not sealed under conditions that varied with respect to temperature and moisture content of seed. Germination tests of seed representing different treatments were made over a period of seven years. Results showed among other things that: (1) onion seed stored in sealed containers remain viable longer than when stored in non-sealed containers, (2) those with a low moisture content remain viable longer than those stored with a high moisture content, and (3) that seed remain viable longer at a low temperature than at a relatively high temperature.

The tests herein reported were begun in the spring of 1937. The Yellow Bermuda was the variety used. The seed were grown at the Texas Agricultural Experiment Substation No. 16 at Iowa Park, Texas, and were of the 1936 crop. From the time the seed were harvested in 1936 until the spring of 1937, they were stored in a field laboratory at the substation headquarters. In March of 1937, a germination test was made, and 93.6 per cent of the seed germinated and produced seedling plants. The seed was then divided into a large number of samples of 8 gms. each. The samples were placed in (a) cloth bags, (b) moisture-proof cellophane bags, (c) pint glass jars, which were sealed immediately, and (d) in pint glass jars, which were sealed immediately under vacuum equivalent to 15 inches of mercury. The cellophane bags were sealed by folding the top down several times and placing a rubber band tightly about it. A large number of samples representing each kind of container were prepared so that tests for viability could be made over a number of years. The samples were then divided equally into a *common storage* series, and a *cold storage* series.

Samples in the common storage series were stored in a cabinet in the work room of a greenhouse at College Station, Texas. The temperature extremes varied from about 40° F. in the winter to 90 and 95° F. during the summer months. Samples in the cold storage series were stored where the temperature ranged from 34° F. to 40° F. Germination tests were made of seed taken from the four types of containers of each series during the spring and fall of each year, except in 1940 and 1941, when only one test was made each year.

The tests were made by planting 500 seed of each sample in flats of sand —100 seeds in each of 5 rows. Tests in the fall of 1937 were made in sand which had not been sterilized. Considerable loss was caused by damping-off. Beginning in the spring of 1938 all tests were made in sterilized sand, and the results obtained represent more accurately the true viability of the seed than the earlier tests.

The results of all germination tests are summarized in Table I.

Seventy-one per cent of the seed stored in cloth bags germinated after 20 months in common storage, but none germinated in tests conducted after 27 months. The seed ceased to be viable between the 20th and 27th month since none germinated in the tests during the 27th month or any of the tests conducted afterwards. By contrast seed stored in cloth bags and kept in cold storage germinated fairly well (72.4%) after 44 months, but only poorly (17.8%) after 62 months.

Results of germination tests of seed stored in cellophane bags closely parallel those for seed stored in cloth, for both comman and cold storage. None germinated after 27 months in common storage; sixty-two per cent germinated after 44 months in cold storage, but only 3.2 per cent germinated after 62 months.

Onion seeds sealed in glass jars were viable when tested after having been stored for 44 months. There was little difference in the percentage of germination of those in cold and in common storage for the first 32 months. After that the seed that were held in cold storage germinated better than those held in common storage. A good percentage of seeds that were sealed were viable when tested after 44 months in common storage; whereas those stored in cloth bags in common storage ceased to be viable between the 20th and 27th month. For the samples kept in cold storage there was little difference in the germination of seed sealed in glass and those in cloth bags for the earlier tests; the sealed samples, however, germinated better when tested during the 39th and 44th months. Of the samples kept in cold storage there is little difference in the results for seed sealed in glass and those sealed in glass under vacuum; both germinated well throughout the duration of this experiment. Of those kept in common storage there is little difference for the first 32 months; after this the data show that those had a slightly higher germination percentage which had been sealed under vacuum.

Observations on vigor of seedlings were made in the spring of 1940; the seedlings were from seed which had been in storage 44 months. There were evident differences in the seedlings representing the several different lots of seed. Those seedlings from the two lots of seed which were kept in cold storage, sealed and sealed under vacuum, were the largest and most vigorous in appearance. The seed which were sealed, and those sealed under vacuum, and held in common storage, and those stored in cloth and in cellophane in cold storage produced seedlings which were comparatively weak and spindling.

These results are in close agreement with those of Boswell and Beattie with respect to the influence of temperature upon viability, and also with respect to the influence of sealing upon longevity. They further suggest the value of sealing under vacuum for long periods in common storage.

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TABLE I

A Comparison of the Viability at Successive Periods of Onion Seed Stored in Different Containers in Cold and in Common Storage

| Date of Germination Test | Interval in Months from Maturity of Seed Until Germination Test | Storage Container | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Cloth Bag | | Cellophane | | Sealed in Glass | | Sealed in Glass Under Vacuum | |
| | | Common Storage | Cold Storage | Common Storage | Cold Storage | Common Storage | Cold Storage | Common Storage | Cold Storage |
| Fall* 1937 | 15 | 38.2 | 61.4 | 22 | 58.4 | 35.8 | 63.8 | 35.2 | 40.6 |
| Spring 1938 | 20 | 71.2 | 96.2 | 28.2 | 96.2 | 93.2 | 90.8 | 95.8 | 93 |
| Fall 1938 | 27 | 0 | 78.6 | 0 | 74.8 | 88.2 | 90 | 89.2 | 91 |
| Spring 1939 | 32 | 0 | 86.6 | 0 | 86.2 | 93.4 | 93.2 | 94.2 | 91.4 |
| Fall 1939 | 39 | 0 | 68.8 | 0 | 54.2 | 62.0 | 86.4 | 77.0 | 90.6 |
| Spring 1940 | 44 | 0 | 72.4 | 0 | 62.2 | 70.4 | 93 | 85.2 | 95 |
| Fall 1941 | 62 | 0 | 17.8 | 0 | 3.2 | .... | .... | .... | .... |

*Low germination percentage indicated is probably due to loss from damping off.

## A Study of the Seasonal Distribution of Plankton in White Rock Lake

MARCILE PATTERSON, Southern Methodist University

Because of the immaturity of limnology in Texas only a few papers have been published in this field. Those of Dr. Wiebe and Harris and Silvey are the most notable.

The present paper is concerned with a study of the seasonable distribution of plankton in White Rock Lake and associated physico-chemical factors. The investigation was begun in October, 1938, by Dr. Mayne Longnecker, Dr. E. P. Cheatum, and Dr. Alvin Metler of Southern Methodist University, and Mr. Marion Toole of the Dallas Aquarium. My duties consisted of a systematic study of the plankters and an attempt to correlate the biological and physico-chemical data from the fall of 1938 through the summer of 1939.

Standardized methods for water analysis as given in *Standard Methods of Water Analysis* were followed in all cases, and determinations made for oxygen, carbonates, bicarbonates, carbon dioxide and the hydrogen ion concentration. A Foerst two-liter water-sampler was used for collecting water and plankton samples at the surface and two meter intervals thereafter.

The Rideal-Stewart or permanganate modification of the Winkler method was used for oxygen tests. Bicarbonates were measured with methyl orange as the indicator, and titrated with n/50th sulphuric acid. The pH was determined colorimetrically with a Hellige comparometer.

A reversing thermometer was used in taking the temperature, and turbidity was measured with a turbidimeter of the type used by the U. S. Geological Survey.

A 20 liter water-sample was strained through a plankton net of No. 20 bolting cloth. A 20 cc. concentrate was obtained from this, thereby making each cubic centimeter represent one liter of water.

Samples were collected consistently at only one station. The figures for the plankton given herein are based on one to four collecting series. In making counts, a one cc. Sedgwick-Rafter counting cell was used together with a 16 mm. objective and a 10x eyepiece.

White Rock Lake is a 38-year-old, 1,400-acre lake constructed to serve as an auxiliary municipal water supply. It has, however, become a pleasure lake. Its maximum depth is about ten meters. The lake is badly silted; during the past 25 years its capacity has decreased almost one per cent each year. Dredging operations and shore line improvements have been carried on during the last few years.

Association of physico-chemical findings with plankton distribution was very difficult and frequently impossible. However pulses and blooms were obvious on several occasions and a few interesting trends were noted.

The dominant protozoans were *Ceratium*, *Difflugia*, *Dinobryon*, *Vorticella* and *Arcella*. Of these only *Ceratium* appeared throughout the six months, and its maximum numbers were encountered at six and eight meters. The protozoans ranged from a minimum of two per liter in December to a maximum of 34 per liter in April.

The rotifers were the most abundant zooplankters. They averaged 120 per liter for the six months. *Keratella* constituted over one-fourth of the entire rotifer count with *Filinia* and *Polyarthra* being numerous also. Maximum numbers of rotifers for the period studied were recorded in March at the surface where bicarbonates and dissolved oxygen were least abundant. Rotifer eggs were also most abundant at this level. There was some suggestion of the possibility of rotifers serving as food for copepods since each rotifer pulse was accompanied by or followed by an increase of copepods.

More copepods were present in May than in the other months. This peak occurred at two meters where the minimum methyl-orange value for the six months period was recorded. *Diaptomus* was four times as numerous as the only other genus, *Cyclops*, with the former reaching its peak in February and the latter in May.

The reproductivity of the copepods was highest in February with the eggs being most numerous at the lower levels. These eggs were found attached to the adults *(Diaptomus)* in clutches of eight to fourteen, in most cases. Nauplii were more abundant than the adults throughout the six months (except in February when *Diaptomus* exceeded them slightly). Nauplii were at a maximum in May at six meters where oxygen was lowest for the entire six months.

Copepods were found most abundantly throughout the study at levels with highest values for dissolved oxygen and during three months at levels with lowest bicarbonates.

In January, February and May the depth-distribution of the copepods was strikingly similar to that of the rotifers.

Cladocerans and their eggs (most of them being *Daphnia)* were most abundant in March at eight meters where oxygen was low and bicarbonates more abundant than at other levels. *Daphnia* was the dominant cladoceran with *Ceriodaphnia, Bosmina* and *Diaphanosoma* also being encountered. Each genus attained its maximum numbers in a different month.

*Plumatella* statoblasts and ostracods were encountered infrequently.

The diatoms greatly outnumbered all other plankters. This was largely due to *Melosira*, the most abundant of all plankters encountered. In April a *Melosira* bloom occurred and thereby made April the month of maximum plankton-abundance. An average of 1,741 diatoms per liter appeared in April. It will be noted here that these counts for *Melosira* are in sharp contrast with Harris and Silvey's findings of 50,000 filaments per liter in Lake Bridgeport during March, 1938.

Algae other than diatoms were inconspicuous. Higher oxygen values were encountered at those levels where phytoplankters were most abundant. This might possibly have been due to the photosynthetic activity of the phytoplankters. In summary it may be said that the protozoans, copepods and cladocerans were found in maximum numbers at six and eight meters whereas the rotifers were most numerous at two meters and the surface. The phytoplankters were found in greatest numbers at a depth of two meters.

Physico-chemical findings may be summarized as follows:

Surface temperatures ranged from 8.8°C. in February to 28.5°C. in July. A thermocline appeared in June between four and nine meters.

Turbidity records were incomplete but those available showed White Rock to be less turbid during the same period than the four North Texas lakes investigated by Harris and Silvey.

Dissolved oxygen was present at all depths; depletion began in May and reached its lowest point in June. Stratification of dissolved oxygen was noted in June, July and August—with increase of temperature, dissolved oxygen in parts per million decreased.

Free carbon dioxide if present existed only in small amounts. In July carbon dioxide began appearing at the bottom of the lake and gradually diffused upward until it was present at all depths in August.

Methyl orange alkalinity ranged from 69.5 to 121 parts per million. Bridgeport, Eagle Mountain, Lake Dallas and Lake Worth have been reported less alkaline than White Rock was found to be. Alkalinity began increasing with depth in March and continued through November. The pH ranged from 8.3 to 7.2 with an average value of 8.1 for the winter and spring months. The waters were less alkaline in June An inverse relationship was shown to exist for pH values, and methyl orange alkalinity and carbon dioxide. As the pH decreased with depth, the methyl orange alkalinity and carbon dioxide increased.

As it may be seen, little correlation between physico-chemical factors and plankton-blooms and pulses could be established. However, it was observed that: (a) Rotifers reached their peak in March, at the surface when oxygen and bicarbonates were lowest; (b) Copepods frequented depths where oxygen was high and bicarbonates low; (c) Nauplii were most abundant in May at six meters where oxygen was lowest from December to June; (d) Cladocerans frequented the lower levels, probably because they are photo-negative; (e) Phytoplankters were usually most abundant at depths where oxygen values were highest. This higher oxygen index could perhaps be directly owing to their own photosynthetic activity.

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2. Bohls, S. W. and J. V. Irons, Laboratory diagnosis of relapsing fever.
3. Breland, Osmond P., Correlation between species of mantids and their egg cases.
4. Breland, Osmond P., Mantid egg cases and their parasites.
5. Brison, F. S. and W. S. Flory, Jr., Propagation of the Ness Hybrid Oaks.
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7. Bussey, Frank R. and Jule K. Lamar, Some observations on the diagnosis and treatment of male sterility.
8. Cheatum, E. P. and Mayne Longnecker, Limnological observations on an East Texas lake.
9. Corson, Samuel A., A new quantitative microinjection method.
10. Eaton, Frank M. and Hugh G. Gauch, A confirmation of the Atkins-Priestly Theory of exudation.
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## SOCIAL SCIENCES

Chairman: T. H. ETHERIDGE, Sam Houston State Teachers College
Re-elected for 1942

### ABSTRACT

**Conceptions of personality arising out of experience with hypnosis, F. A. PATTIE**, Rice Institute.—A critical review of recent experimental work in which an attempt has been made to correlate certain traits of personality with susceptibility to hypnosis. In addition the following topics were discussed: the possibility of using hypnosis as an aid in the investigation of normal personalities, pitfalls in the use of hypnosis due to the subjects' desire to give the operator the results they think he wanted to produce, the regression to early childhood and childhood levels of intelligence which allegedly can be produced, and whether the hypnotic subject can be made to injure himself or others. Almost all of the literature cited can be found in the bibliography of P. C. Young's review, "Experimental Hypnotism," in the Psychological Bulletin, 1941, vol. 38, pp. 92-104.

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## North of the Border

GEO. I. SANCHEZ, The University of Texas

Civilization in the United States is the product of a multitude of social and material factors. Unlike some nations, this country does not owe its greatness to the homogeneity of its people nor to uniformity in their cultural antecedents. Quite on the contrary. The United States derives its national sustenance from variety—from the contributions of many peoples and from a diversity of social and material resources. National culture in this country is a variegated pageant wherein many tongues and races have been fused into a unity that is greater than the sum of its parts.

Life in the United States reflects the peaceful, democratic coursing of the activities of many peoples who have joined together the assets of many cultures. It is in this union of cultural variety that American civilization finds its greatest strength. It is also from this lack of sameness—from cultural pluralism—that the American democracy receives its basic inspiration. The very essence of Americanism is observed in the right and duty of heterogeneous social and economic groups, as well as of individuals, to contribute from their respective cultural wealth to the welfare of the mass. This freedom to contribute represents the potential energy of the American nation to grow culturally. Therein lies a fundamental aspect of American democracy. Therein, also, resides a challenge to the agencies devoted to national cultural growth and development. Above all, there is where the nation's schools may find a source of inspiration for their action.

The strife and turmoil of the current world conflict lead us to examine more closely the possibilities and responsibilities of our own situation. Close scrutiny of our way of life will convince us that much of what we call Americanism is grounded upon the common right and duty of all elements of the population to contribute from their respective cultural resources that which will enhance the total culture. Hand in hand with that privilege and responsibility to use each of our resources for the common good, there goes the obligation to seek out the cultural assets of our fellow men that they, too, may participate in the common task.

*The Southwest.* No region in the United States is more advantageously situated with reference to cultural pageantry than the Southwest. This area is, indeed, the American frontier—culturally as well as geographically. Here the Spanish conquistador met the Navajo, the Pueblo, the Apache. Here the colonial traders, the "forty-niners," the men of the Texas Republic—the vanguard from the "States" to the east—met those older cultures of the New World and gave a new direction to life in the region. Here, too, is where the United States joins Latin-America, in the cultural as well as in the physical sense.

This region is the cultural and geographic threshold of Anglo and Latin-America. Here the two Americas meet on a common frontier to forecast the future of a hemisphere. The histories of two great civilizations merge in the Southwest to give a new character to the American way of life. Language and architecture, music and literature, industry and government—all phases of southwestern culture have been enriched by this merger. The Southwest reflects its multiple heritage and it stands as a vivid illustration of the power of a democratic nation to grow culturally.

The fusion of cultures is not an impersonal process. Cultural growth and development is the product of cultural contacts and conflicts, of the interaction among peoples. And it is among people that we must look for the source and inspiration of that growth. There is where we will find the explanation of the cultural level of today and the only reliable prophecy of the future attainments of our society.

Even a casual examination of the southwestern scene reveals that one of its prominent characteristics is represented by its Spanish-speaking population. In a total population of some thirteen million, five southwestern states (Texas, New Mexico, Colorado, Arizona, and California) include more than two million people whose home language is Spanish and whose cultural background is rooted in Latin-American history. When virtually one-sixth of the population of the region is Spanish-speaking, it is not to wonder that the Southwest is, in many ways, Latin-American. Roughly, one-sixth of the population of Texas, one-half of that of New Mexico, one-fifth of Colorado's, one-tenth of California's, and one-fifth of Arizona's population is of Spanish-Mexican descent. These are significant proportions and the figures are eloquent in setting forth a salient feature of southwestern life and culture.

While gross figures reveal that, numerically, the Latin-American holds an important place in the total population of the region, those figures do not depict the true magnitude of his position. As a matter of fact, those figures tend to give an erroneous impression. The Spanish-speaking population is not evenly distributed over the Southwest. There are some sections where there are very few members of this group and other sections where they constitute the great majority of the population. Eastern New

Mexico and northwestern Texas are in the first category—those sections have few Latin-Americans. On the other hand, there are counties in northern New Mexico where the Spanish-speaking people make up more than ninety per cent of the population. Bexar County, in central Texas, has over one hundred thousand "Mexicans" out of a total population of about three hundred thousand. Webb, El Paso, Cameron, and Hidalgo counties have a combined Spanish-speaking population of almost two hundred thousand and, in each of those counties, those people constitute more than half of the total population. Of some one million Latin-Americans in Texas, almost one-half of them are concentrated in twelve (out of 254) counties.[1]

This uneven distribution of the Spanish-speaking population of the Southwest raises issues and presents possibilities which are not revealed by state or regional population figures. Though California is faced with the fact that about ten per cent of its inhabitants are Spanish-speaking, most of those Spanish-speaking people are in and near the city of Los Angeles. While this circumstance does not diminish the significance of that population group to the State of California, it does portray the cultural situation of the Los Angeles area in a very vivid manner. Similarly, the fact that Texas has almost one-half of the Latin-American population of the Southwest is worthy of note and consideration by the entire state. However, the fact that most of this group is concentrated in a few localities in Texas—largely along the Rio Grande and in the south central part of the state—means that those localities have special opportunities and responsibilities over and above those facing the state as a whole. The same can be said with reference to southwestern Colorado, to southern Arizona, and to northern New Mexico.

Just as there is lack of uniformity in the distribution of the Latin-American population of the Southwest, there is also a lack of uniformity in the composition of that population. This is a point to which the average person gives little thought. The Spanish-speaking population of the region is not a monogenous group—in social or economic status, in education, in cultural background and history, or even in the degree to which its members are, in truth, Spanish-speaking! There is as much cultural variety within this group as there is to be found within any other similar sector of the population in the nation.

Racially, the Latin-American group ranges from the "pure" Indian to the "pure" white. The Indian strains vary from the Aztec to the Navajo and the white strains from the North European to the Basque, the Semitic, the Mediterranean. Even a casual analysis of Spanish and Spanish-American history and culture will reveal that Latin-Americans are far from being a homogeneous group anywhere in the Western Hemisphere. More particularly, the Latin-American of the Southwest is, in part, the product of Spain—once the cultural crossroads of the Old World; in part, of New Spain—a cultural crossroad in the New World; and in part, of modern Mexico and of the Southwest—cultural crossroads in their own right. It

[1]For a comprehensive analysis of these figures, the reader is referred to: Manuel H. T. The Mexican Population of Texas. *The Southwestern Social Science Quarterly.* Vol. XV, No. 1, June, 1934.

is folly to over-simplify his cultural status by a casual reference to "Mexicans" or "Spanish-Americans."

This cultural variety would be complex enough if it existed among peoples whose present social and economic status showed little variation or in a group that had a common history in the region. But, as suggested above, these factors exhibit great variability too! Rich and poor, ignorant and educated, pecan shellers and college professors, humble laborers and esteemed statesmen—they range the scale of American life. Some have been in the Southwest for centuries, long before Jamestown and Plymouth Rock. Some have just arrived from Mexico. Some fought for Texas at the Alamo. Some molded a new frontier and a new culture around Santa Fe and in California. Many have come across our southern border within the last fifty years. Many of these were common laborers, some were professional men and skilled tradesmen. Of these relative newcomers, some came as refugees to seek safety and freedom, others as migratory workers seeking a livelihood. Thus the Latin-Americans of the Southwest have grown to large proportions. Of varied origins and cultural stature, ranging widely in means and manners, they constitute a diverse and highly heterogeneous group.

*Latin-Americans and the School.* It is understandable that a people of such varied backgrounds and achievements should present a great variety of opportunities and problems to the forces of education. As all educators know, even a "homogeneous" group of pupils is usually uniform only with regard to one factor in their educational status. For example, the children in such a group may, for a period, exhibit uniformity as regards their achievement in a given school subject but they will differ widely in almost every other characteristic—age, home life, personality, physique, social maturity, achievement in other school subjects, and the like. The Latin-American is not an exception to this principle of individual differences. Furthermore, as suggested by their diversified cultural origins, the Spanish-speaking children of the Southwest cannot be characterized or pigeon-holed, educationally, as a group. In race and language, in intelligence and achievement, in cultural background and home life, in health, and in wealth, they differ as widely among themselves as do the members of any other unselected heterogeneous group. That is to say that "the problem of the Spanish-speaking child" is a fictitious generalization insofar as it presupposes uniformity in the educational status or prospect of Latin-Americans in the United States. Any educational practice based on that assumption is ill-conceived and dangerous.

It is impossible, in this article, to do more than suggest broadly the nature of the various problems involved or to indicate possible remedies except in very general terms. As there are many pitfalls within the bounds embraced by the viewpoints set forth herein, the reader should regard this paper simply as an overly simplified introduction to a highly complex professional topic.

In general, the problem of educating Latin-American children is just the same one presented to teachers by other children. Some are bright, some dull, and some are mediocre. For the group, the brightness, dullness, or mediocrity of Spanish-speaking children is no greater and no less than that of other pupils. The same can be said of those other characteristics which reflect the native talents of a person. Inherently, insofar as the fundamental approaches of the school are concerned, Spanish-speaking children are no different from other children. They learn just as readily, they require just as good teachers and instructional facilities, and they need the same careful study of their individual differences as do other children.

Were it not for two considerations, one arising out of their cultural background and one resulting from the current socio-economic status of a large sector of the group, the education of Latin-American children would require no special attention. As a matter of fact, *except for his Latin-American cultural heritage*, the Spanish-speaking child cannot be distinguished, educationally, from any other child of a comparable socio-economic status. In addition, as suggested before, many Latin-American children cannot be distinguished educationally from the rest of the pupils in the average school in any way—irrespective of the cultural background or the socio-economic status of those Spanish-speaking children.

However, the present social and economic status of a large percentage of the Latin-American group is a consideration of large import to the educative process. Many thousands of "Mexicans" live a hand-to-mouth existence in the Southwest—as farmers, as seasonal laborers, and in various occupations of low economic returns. The social counterparts of this lack of financial sustenance are too well known to require elaboration here. Poor health, poor home life, poor citizenship, poor education—these are almost inevitable by-products of poor wages. Just as with other economically underprivileged groups, the Mexican pecan-shellers, cotton pickers, and beet choppers cannot attain a social stature beyond their means. In this regard, this sector of the Latin-American group is simply a phase of the great problem presented by tenants, sharecroppers, and migratory laborers elsewhere in the nation. The nature of his social position, and the by-products of his economic poverty, are no different for the Mexican than they are for the "poor whites," the "Oakies," and the "Joads."

The poverty-stricken Latin-American laborer has no patent on that condition or on its social effects. His status is not peculiar to his group. It is a circumstance which has nothing to do with the fact that he is Spanish-speaking. Under those conditions, he would be just as undernourished, just as ignorant, and just as bewildered if his home language were English, or German, or pig-Latin! By the same token, his socio-economic situation is one which will respond to the same remedial measures which have been found successful with other similarly underprivileged sectors of the population.

It is self-evident that inequitable and unjust treatment of Spanish-speaking children in the public schools is not conducive to the solution of the issues presented by the economically underprivileged sector of this group. The social and economic problems of a democracy are not solved by the application of the concentration camp idea—and the segregation of "Mexican" children in some schools of the Southwest cannot be regarded as other than the infusion of an undemocratic "ism" to educational policy.

The defeatism, the gross indifference—the corruption of American educational ideals reflected in many of the segregated schools for these children indicates that this problem has not been regarded in its true light. Most of these schools simply inbreed the evils resulting from the socio-economic insufficiency of their patrons and often serve to foster and promote the caste system originally created by a wage scale. Such schools are not only pedagogically unsound but they are also un-American. Instead of aiding in the solution of the problem, they complicate and aggravate it.

As stated before, within the space of this paper it is not possible to set forth, in any detail, how the issues raised by the Mexican laborer can be met by the schools. However, the malady suggests the cure. A clear understanding of the causes for his backwardness, together with conscientiously professional behavior on the part of educators, will lead to the initiation of appropriate remedial measures. The children from this group manifest certain deficiencies—in health and sanitation, in school attendance, in home life, in vocational proficiency, in academic achievement, and the like — which are products of their economically underprivileged condition. The remedies suggest themselves and their application is far from being without precedent in American education. Other children, both here and elsewhere in the nation, are in the same situation and schools everywhere are meeting the problems they raise. Enriched curricula, better teachers, school lunches, health services, vocational guidance and training, and similar enlightened measures will do as much for the Spanish-speaking child as for other children. It seems almost trite to state that his malady will respond to the same cure found useful with other children suffering from the same complaint.

It is a common misconception to assume that the problems referred to above are products of the fact that the "Mexican" child is Spanish-speaking. Time and again, educators confuse the language question with the by-products of a standard of living dictated by the economic situation of many Spanish-speaking people. As suggested before, poverty and its social effects are not peculiar to any one racial, language, or cultural group. Those effects are the attributes of poor people—irrespective of race, nationality, or language. This must be appreciated fully if an understanding of the educational problems of Spanish-speaking children is to be reached. Such an appreciation is a prerequisite to the recognition of the many subtle ways in which the foreign home-language of these children enters into an already complex problem. That home-language complicates the problem but it does not create it. Therefore, remedial measures which are designed solely to meet the language question fall far short of meeting the major issue—the growth and development of children in an American society.

Linguistics enters into the education of Spanish-speaking children only as it affects teaching method and instructional materials. It has nothing to do with educational goals or the basic processes of the school. When schools allow the language question to dominate their outlook upon the problem of educating Spanish-speaking children they are distorting not only the significance of the home language but the function of the school as well.

It should not be implied from this that the Spanish-speaking child does not require special attention because of his home-language. He does. However, that attention should not be regarded as the excuse for segregation as now practiced in many schools. It should be analogous to the special attention accorded to any other group of children who manifest an equally difficult scholastic deficiency. The observance of this point is particularly important as the degree to which these children in the Southwest are Spanish-speaking varies greatly from community to community, from child to child, and, often, from subject matter to subject matter. This variation is understandable in the light of the varied backgrounds of these children and in view of the fact that there is no force active in standardizing attainment in the home language. This means that those segregated schools and classes which are designed to accommodate Spanish-speaking children (in all subjects!) "because of the language problem" and which, under the best of circumstances, are organized on the assumption of uniformity in the home-language of the children, find no justification in the facts of the case. Any doubts on this point will be dispelled by the application of a comprehensive examination in Spanish!

The foreign home-language does have a significant role to play in the field of instructional method and in curricular enrichment. The fact that a child has been accustomed to express himself and to think in a medium other than the official language of the school calls for special measures in his school work. That is self-evident. The additional fact that, often, that same child comes from an impoverished environment—one wherein the normal conditions presupposed by the school for the average child do not obtain—gives added importance to his language problem. In the latter instance, the child not only does not know English but what he knows in Spanish is incompatible with the norms upon which the school work, including English, expected of him is based. This means that the school's primary problem (with the child from an underprivileged or a typical home) is that of enriching his store of fundamental concepts so that he may have a suitable base upon which to build his knowledge of English and of the other school subjects. It seems reasonable to propose, then, that the enrichment process can be carried on most effectively in the child's home language. Once that process has adjusted him to the new environment and the new norms of conduct and attainment, the Spanish-speaking child will be equipped to make the transition to the normal language of the school—to English.

*Prospect.* Latin-Americans north of the border—the Spanish-speaking people of the Southwest—represent a significant sector of our population and an important aspect of our culture. As suggested briefly above, the condition and the potentialities of this group of people merit careful consideration by the educators of the region.

As set forth before, Spanish-speaking children present a serious challenge to the forces of education. The varied character of their cultural and historical antecedents as well as the fact that they spread themselves over a wide range of social and economic conditions makes these children particularly difficult of treatment in the ordinary school. This diversity of background and conditions is made even more trying by reason of the fact that the majority of these children are from economically underprivileged homes. In addition, the fact that they use a foreign home-language aggravates a difficult problem still more. All these considerations are phases of the "problem of the Spanish-speaking child." Only by careful study and analysis of the multiple aspects of this problem will suitable remedies be developed. School practices based on an incomplete understanding of this complex question, or those motivated by personal prejudices and unfavorable social attitudes, are to be deplored not only as unprofessional but as un-American as well.

As indicated before, the home language of the Latin-American child is an important phase of his educational problem. From another point of view, the home-language of the Spanish-speaking child presents to the school not an obstacle but an opportunity. The Spanish language needs no "sales talk" in the United States—it has long been accepted as a part of our secondary and higher education curricula. Furthermore, recent international events give added importance to the study of this language and augur that Spanish may soon become the second language of the United States. Those children who already speak Spanish offer a rare opportunity to the nation's schools. In the Southwest alone there are more than half a million pupils who speak the language—a "natural resource," culturally, that the schools can conserve with but little effort. These children, and their English-speaking fellow students, are in an enviable cultural situation. Potentially, this situation constitutes a tremendous "head start" to the curriculum designer who is seriously concerned with adjusting the program of education to the demands of the hemispheric and world order that, already, looms large on our national horizon. It would be regrettable if such a prize should go unclaimed, forfeited to traditional inertia.

While Spanish, as a language, is an asset of undeniable worth and too much cannot be said in encouraging its use, it must be emphasized that our interest in that language is not motivated simply by an interest in its structure but by our sincere desire to understand the people who speak it as a native language. We are interested in cultures, not linguistics. From this approach, the school is concerned with the history and traditions, with the customs and attitudes, and with the talents and achievements of Spanish-speaking peoples. Their language serves merely as the vehicle which facilitates our acquaintanceship with their ways of life. Therefore, Latin-American music and art, industries and crafts, folklore and literature constitute, to the American school, the indispensable attributes of Spanish. Through our study of that language we seek to tap the vital cultural resources of the Spanish-speaking peoples not only to the end that we may understand those peoples better and, therefore, be able to join with them in promoting the common welfare but also to the end that our own American culture may be strengthened and enriched.

*Conclusion.* The world-wide strife and turmoil which we are experiencing today leads us to examine more closely than ever before the possibilities of our own situation. That examination will convince us that much of what we call American democracy is grounded upon the right and duty of the peoples of this country to contribute from their respective cultural resources that which might enhance the total culture. Cultural freedom, as much as political freedom, accounts for the favored position held by our citizens over people in other nations.

The schools of the United States can find in the national pageantry of cultures and in the privilege of cultural self-determination and tolerance the keynote for their efforts. The American child can identify himself with world culture by understanding and appreciating his fellow Americans. His classmates and his neighbors possess cultural gifts which he can have for the asking. He, in turn, can share with them those cultural assets with which his forbears and his social group have endowed him. All can glory in this boundless social and intellectual freedom and in this virtually unlimited cultural wealth. In this connection, the Spanish-speaking child in the United States—the Latin-American north of the border—presents a challenging opportunity to the forces of national cultural growth and development.

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**Other Papers Presented by Texas Authors at the Meeting of the A. A. A. S. in Dallas**

1. Bergson, Abram, The incidence of an income tax on saving. The Quarterly Journal of Economics, February, 1942.
2. Buechner, Helmut K., Emergent evolution as applied to ecology.
3. Goldstein, Marcus S., Indian skeletal remains from Texas.
4. Gonzales, M. C., Prejudice and discrimination.
5. Manuel, H. T., The language factor.
6. Rader, Frank, Evolution of the industrial pattern of the Southwest. Southwestern Banking and Industry, 42: No. 1.
7. Rowland, Loyd W., The role of age and sex in vocational preferences in 1940.
8. Sellards, E. H., Terrace deposits as an aid to age determination of early men. Abstract. Geo. Soc. Amer. Bulletin, 52, No. 12, 2007, 1941.
9. Thompson, Charles E., Ophthalmic Scoliosis. The Research Quarterly, 13, No. 1, p. 314, 1942.
10. Yarborough, Joseph U., The first year of the merit system council in Texas.

## GEOLOGICAL SCIENCES

Chairman: CHARLES L. BAKER, A. & M. College

L. W. Blau, Houston, was elected chairman of the section for 1942.

AND

## CONSERVATION

Chairman: ELLEN S. QUILLEN, San Antonio

Gordon Gunter, Texas Game, Fish, and Oyster Commission, Rockport, was elected chairman of the section for 1942.

### ABSTRACT

**Abandoned Pecos Valley across Reynosa Cuesta, South Texas,** W. ARMSTRONG PRICE, consulting geologist, Corpus Christi, Texas.—An abandoned valley (?) 6 to 8 miles wide which seems indicated by a somewhat obscure linear depression crosses the cuesta parallel with and 35 miles north of Rio Grande Valley. It is cut off at the west by the Bordas scarp at Randado, Jim Hogg County, and seems to terminate eastward just east of Sal Vieja salina, near Raymondville, Willacy County, at the Ingleside shoreline of Mid-Beaumont (Pleistocene) age.

Analysis is made of the topography of a warped valley depressed Gulfward on an axis inclined 60° to that of the valley and somewhat modified after abandonment by local valley-side erosion and eolian deposition. The resulting form seems to agree well with that of this linear depression and to explain its obscurity. The two large saline playas of South Texas lie in it.

If the valley hypothesis is correct, the Linn and Rio Grande valleys were simultaneously occupied by streams of sub-equal size. The Pecos was the probable agent of Linn-valley cutting, and piracy at Laredo the cause of abandonment.

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## The Gravimeter

D. H. CLEWELL, Magnolia Petroleum Co., Dallas

Geologic structures significant to the location of subterranean oil deposits are the source of minute anomalies in the gravitational field of the earth because of the differing densities of the various structure components. Gravity exploration to discover these anomalies is possible with either the Torsion Balance or the Gravimeter. The former instrument measures the gradient of gravity and for this reason is relatively more sensitive to the surface terrain of the earth. The Gravimeter measures the small variations in the total force of gravity and is therefore adaptable to more varied terrain conditions and is at the same time three to four times more rapid.

Because the gravimeter measures small variations in a relatively large force (of the order of several parts in 100,000,000) the precision and constancy of all its components must be maintained to the same order. Temperature of the gravimeter must not change by more than several thousandths of a degree C per hour.

The fundamental operation of any gravimeter is the provision of a mechanism to translate changes in gravity into increments of some observable quantity such as length or time. Thus the period of a pendulum $T = 2\pi\sqrt{l/g}$ might be observed as a function of g or the extension of a mass loaded spring, $L = \frac{mg}{k}$, (k = stiffness of spring.) The latter type "static instrument has proven to be the most practical for oil exploration largely because of the availability of elastic materials whose k can be held constant to the order of several parts in $10^8$.

Static gravimeters may be classified as either unastatized or astatized. The former classification is illustrated by the simple coil spring supporting a constant mass at its lower end and anchored to a fixed support or housing at its upper end. Changes in g produce proportional changes in the extension of the spring. The sensitivity defined as the ratio of the extension or displacement of some observable member of the instrument for a least important change in gravity is proportional to the length of coil spring or other elastic members.

Gravimeters of the astatized class employ particular geometrical configurations of elastic members and levers to introduce points of unstable equilibrium in the immediate neighborhood of the operating point of the suspension. The sensitivity can now be made large without the necessity of a large instrument. Both types of static gravimeters are used; the unastatized types of low mechanical sensitivity gain sensitivity through the use of mechanisms to greatly amplify the small displacements while the astatized types use relatively simple means for detecting displacements of the suspension.

One astatized gravimeter which is particularily adapted to rapid field survey consists of a pivoted beam whose gravity moment about its pivotal axis is elastically balanced. To balance the beam the elastic torque $\tau = mgr$ (r is distance from center of gravity to pivotal axis.) To produce high sensitivity by astatization the partial derivative of $\tau$ with respect to $\Theta$ must approach zero ($\Theta$ is angular disposition of the pivoted beam) and to provide stability the second partial of $\tau$ with respect to $\Theta$ is approximately equal to $-$ mgr. A minimum of level sensitivity is maintained by placing the pivotal axis in the same horizontal plane as the center of gravity of the beam. These requirements lead to a torque function of the form $\tau = A \sin \Theta$ with A approximately equal to mgr and $\Theta$ in the neighborhood of $\pi/2$.

Magnetic or electric fields are rather unsatisfactory as the source of force to balance the gravitational force because of the difficulty of maintaining these fields constant to the necessary degree of several parts in $10^8$. A permanent magnet field may eventually be practical if the hysteresis properties of permanent magnet materials can be sufficiently reduced. Gas pressure has been used as the source of elastic forces but the large temperature coefficient of pressure is disadvantageous.

Because elastic hysteresis is characteristic of most ordinary materials, present gravimeters usually use either quartz or a special iron-nickel alloy that has been severely cold-worked and lightly annealed. At present these two materials seem to be the only practical source of a sufficiently constant force.

The gravimeter described is capable of detecting a change in altitude of three inches and a change in latitude of about 150 feet. The highest speed of operation reported to the author has been 31 readings spaced ½ mile apart in one hour. The probable error of a single reading can be as low as $\pm$ 0.015 milligals when allowance is made for the "drift" of gravimeter.

# Seasonal Condition of Texas Oysters

GORDON GUNTER, Texas Game, Fish and Oyster Commission

Statistics on the various phases of the oyster industry of the Gulf Coast (other than gross annual production), such as will be necessary before oyster culture can be put on a sound factual base, are practically nonexistent.

In Texas all oysters come from natural reefs. Matagorda Bay and connecting bays supply about half of the annual production, and this locality is the center of the industry for the state. For the year 1932 to the present, the Crawford Packing Company of Palacios, Texas, has handled oysters from the reefs of Matagorda, Tres Palacios, and Karankawa Bays. Contrary to general practice this company kept a record of the gallon yield to the barrel and its variation from time to time is available. The accumulated figures yield information on seasonal variation in quality and condition of Texas oysters that should be of interest to both biologist and industrialist.

In Texas, oysters are bought by the gallon, shucked out from a boatload; and shuckers are paid by the same count. Tickets are made out on each load, and since they have a monetary value they are kept accurately. The figures are for fresh and not dry-packed oysters. The writer compiled the figuures given in the tables from oyster tickets kept as part of the company records. The Texas oyster barrel measure is 30 x 20 x 13½ inches. The standard iron wheelbarrow when loaded to full capacity holds a barrel of oysters and this was the measure used in determining the number of barrels to a load. The figures from month to month are strictly comparable. The same men recorded the oyster loads throughout the years. The number of barrels was not recorded for every load and figures do not represent the total production of the company. The open season on Texas oysters is from September to March, inclusive, and this is the only season which the figures cover. Most of the oysters were taken by dredges and there was no change in the method during the time covered.

Although not concerned with the central point of interest in this paper, it is worth noting that the average number of barrels to the boatload declined after March, 1934. From December, 1934, to December, 1940, the average load has been 12.8 barrels. This was due to the fact that the Colorado River mouth was opened up artificially, induced to cross the east arm of Matagorda Bay and empty into the Gulf of Mexico. It covered Tiger Island, Dog Island, Shell Island, and Middle Channel reefs, from which Palacios boatmen obtained a large part of their oysters and lowered the available supply in Matagorda Bay. Furthermore, since the remaining reefs were not so far away, overnight trips were not made and the loads were smaller.

Table 1 gives the monthly figures for each year. It shows that the condition of oysters varied from month to month, but was better during the spring months than during the fall. Table 1 and Table 2 show that oystering was carried on less actively during the fall, and for several years there are no statistics for September, October, and November. This is partly due to lower quality and lower demand for oysters during the fall months and partly due to the fact that most boatmen are engaged in the more remunerative shrimp fishery until the season ends in December. It was found in preparing Table 2 that exclusion of years in which there were no data for the fall months made a difference of only 0.04 of a gallon for any given month, at the most, and there was no divergence from the trend shown when all data were used. Therefore, for the sake of completeness, all years and months were used in compiling the table.

Table 2 combines the statistics of Table 1. It shows clearly that the average quality of Texas oysters increases steadily from a low point in early autumn to a high point in March. This betterment in condition may be due to increase in size or greater fatness or both. We have no data to clarify this point. Oysters grow fastest in winter. However, they are fished rather heavily and the average size probably does not increase very much—possibly it decreases. In all likelihood the increased gallon yield to the barrel, as the season progresses, is chiefly due to increased fatness, but this cannot be stated as a positive conclusion until more data are at hand.

*Discussion.* These figures verify what is known in a general way about the seasonal condition of Texas oysters. Condition, as measured here, depends on the volume of the oyster before opening and firmness of the meat. Animals with a large amount of glycogen are white or creamy and firm. They are called "fat" and do not bleed excessively after being shucked. Poor oysters are clear and are referred to as "water bags," because they lose liquids and the volume decreases greatly after shucking. The writer has previously given a more extensive discussion of the quality of American oysters (Gunter, 1938).

The European oyster, *Ostrea edulis*, gets fattest in the fall. According to Orton (1937), little or no feeding goes on in winter, but the food reserves are maintained until spring because the animals are inactive. The American oyster on the Gulf Coast of the United States feeds and grows most during the winter and is fattest in late winter and early spring. Coulson, Levene and Remington (1932) state that winter oysters in the North Atlantic and Gulf Coasts have higher iron and copper contents than spring oysters. Coulson's (1933) explanation of this, on the grounds that the spring samples were taken after the winter period of inactivity and hibernation, is erroneous with respect to the Gulf Coast. Their winter samples were taken in November and December, 1931, and the spring samples were taken in April. Since, as is shown here, the monthly condition of oysters is not the same from year to year, then analyses of samples covering more months and years would be of greater value. The results of these writers are not complete enough to be indicative of the general situation, and it is questionable that midwinter oysters have a higher mineral content than spring oysters.

Oysters feed largely on diatoms. No study of abundance fluctuations of diatoms on the Gulf Coast has been made except for that of Hopkins (1931) in Galveston Bay from April to August. Steuer (1911) has pointed out that in southern climes there tends to be one annual maximum during the winter. This agrees roughly with the time of best condition of oysters on the Texas Coast.

Texas oysters begin to have developing gonads in February and March. The gonads are firm and tend to cause the oyster to hold up after shucking. Part of the better spring yield may be due to this cause. The poorer yield shown in Table 2 for the month of October is possibly due to the fact that most oysters have spawned out during September and were therefore lower in food reserves as well as lacking in gonadal material during the following month.

| Month | Year | Number of Gallons | Average Gallons to the Barrel |
|---|---|---|---|
| September | 1937 | 655.3 | 1.6 |
| | 1938 | 112.8 | 1.1 |
| | 1940 | 73.5 | 1.4 |
| October | 1937 | 1,275.0 | 1.5 |
| | 1938 | 1.5 | 0.7 |
| | 1939 | 93.0 | 1.7 |
| | 1940 | 274.3 | 1.4 |
| November | 1933 | 296.0 | 1.5 |
| | 1937 | 940.5 | 1.3 |
| | 1938 | 226.8 | 1.4 |
| | 1939 | 571.5 | 1.9 |
| | 1940 | 891.8 | 1.7 |
| December | 1932 | 1,284.0 | 1.7 |
| | 1933 | 1,059.0 | 1.5 |
| | 1934 | 534.8 | 1.6 |
| | 1936 | 548.0 | 1.7 |
| | 1937 | 4,198.8 | 1.5 |
| | 1938 | 1,025.5 | 1.9 |
| | 1939 | 495.3 | 1.6 |
| | 1940 | 44.0 | 2.1 |
| January | 1933 | 3,065.8 | 1.7 |
| | 1934 | 2,214.0 | 1.9 |
| | 1935 | 1,508.8 | 1.5 |
| | 1936 | 512.8 | 1.9 |
| | 1937 | 2,856.0 | 1.7 |
| | 1938 | 3,414.8 | 1.5 |
| | 1939 | 2,888.0 | 1.7 |
| | 1940 | 20.0 | 1.7 |
| February | 1933 | 3,205.8 | 1.8 |
| | 1934 | 2,322.0 | 1.9 |
| | 1935 | 1,260.5 | 1.3 |

| Month | Year | Number of Gallons | Average Gallons to the Barrel |
|---|---|---|---|
| February............. | 1936 | 1,191.0 | 1.7 |
| | 1937 | 4,656.0 | 1.9 |
| | 1938 | 3,001.8 | 1.6 |
| | 1939 | 1,949.5 | 1.5 |
| March................ | 1933 | 2,420.8 | 1.7 |
| | 1934 | 2,224.8 | 1.6 |
| | 1935 | 1,722.5 | 1.5 |
| | 1936 | 515.5 | 1.7 |
| | 1937 | 5,849.8 | 1.9 |
| | 1938 | 2,756.3 | 1.5 |
| | 1939 | 1,870.0 | 1.5 |

Table 1. The table gives the number of gallons of oysters handled and the average gallon yield to the barrel at the Crawford Packing Company, Inc., Palacios, Texas, for the various months from December, 1932 to December, 1940. All oysters were from wild reefs of the eastern part of Matagorda Bay and vicinity. This does not represent the total production of the company.

| Month | Loads | Barrels | Gallons | Average Barrel Load | Average Gallons to Barrel |
|---|---|---|---|---|---|
| September...... | 46 | 565.2 | 841.5 | 12.3 | 1.49 |
| October......... | 81 | 1,131.0 | 1,643.7 | 14.0 | 1.45 |
| November...... | 135 | 1,898.2 | 2,926.5 | 14.1 | 1.54 |
| December....... | 397 | 5,749.3 | 9,189.3 | 14.5 | 1.60 |
| January........ | 644 | 9,869.5 | 16,479.3 | 15.3 | 1.67 |
| February........ | 706 | 10,366.3 | 17,586.5 | 14.7 | 1.70 |
| March.......... | 678 | 10,231.8 | 17,630.5 | 15.1 | 1.72 |
| Totals...... | 2,687 | 39,812.3 | 66,297.3 | 14.8 | 1.67 |

Table 2. This table is a summary of Table 1 with addition of barrel figures. Table 1 should be consulted for a full explanation. It shows chiefly that the average gallon yield from a barrel of Texas natural reef oysters increases gradually from a low point in the fall to the highest point in the spring.

### Literature Cited

Coulson, E. J., Studies on the nutritive value of oysters. U. S. Bur. Fish., Investigational Rep., No. 17:1-30 pp., 1933.

Coulson, E. J., Harold Levene, and Roe E. Remington, Oysters and anemia. Amer. Jour. Pub. Health, 22:1141-1146, 1932.

Gunter, Gordon, Comments on the shape, growth and quality of the American oyster. Science, 88:546-547, 1938.

Hopkins, A. E., Factors influencing the spawning and setting of oysters in Galveston Bay, Texas. Bull. Bur. Fish. 47:57-83 pp., 1931.

Orton, J. H., *Oyster Biology and Oyster Culture.* 211 pp., Edward Arnold & Co., London, 1937.

Steuder, Adolf, *Leitfaden der Planktonkunde.* 382 pp., B. G. Teubner, Leipsig, 1911.

---

## Other Papers Presented by Texas Authors at the Meeting of the A. A. A. S. in Dallas

1. Bacon, Charles S., Preliminary report on the stratigraphy and structure of the Confustion and Conger Ranges, Western Utah. (Abstract) Geo. Soc. Amer. Bull., Dec., 1941.
2. Barnes, Virgil E., Cretaceous overlap on the Llano uplift of Central Texas. (Abstract) Geo. Soc. Amer. Bull., Dec., 1941.
3. Bridge, Josiah & Barnes, Virgil E., Stratigraphy of the Upper Cambrian, Llano uplift, Texas. (Abstract) Geo. Soc. Amer. Bull., Dec., 1941.
4. Broadhurst, W. L., Recharge and discharge of the groundwater reservoirs on the high plains in Texas. (Abstract) Geo. Soc. Amer. Bull., 52:12, 1941.
5. Chambers, W. T., The Redlands of Central Eastern Texas.
6. Guyton, W. F., Results of pumping test of the Carrizo Sand in the Lufkin area, Texas. (Abstract) Geo. Soc. Amer., 52:12, 1941.
7. Moulden, Mildred P., The weed impurities found in some seed samples utilized in soil conservation.
8. Moulden, Mildred P., Preliminary notes on the germination behavior of rescue grass (Bromus catharticus Vahl.).
9. Sayre, A. N. and Bennett, R. R., Recharge movement and discharge of ground water in the Edwards-Georgetown Reservoir, Texas. (Abstract) Geo. Soc. Amer., 52:12, 1941.
10. Sellards, E. H., Progress of excavating the Odessa Meteor Craters. (Abstract) Geo. Soc. Amer., 52:12, 1941.
11. Smith, J. Fred, Laramide and later orogenic times in the Southeastern part of Western Cordillera.
12. Tharp, B. C., Natural vegetation areas in Texas.

# Proceedings and Transactions

*of*

# THE TEXAS ACADEMY OF SCIENCE

## 1942

VOLUME XXVI

Houston, Texas
Published by the Academy
1943

# Proceedings and Transactions

*of*

# THE TEXAS ACADEMY OF SCIENCE

# 1942

VOLUME XXVI

Houston, Texas

Published by the Academy

1943

# FOREWORD

During 1942, The Texas Academy of Science held two regional meetings: on the eighth and ninth days of May at Houston, and on the fifteenth and sixteenth days of May at Corpus Christi. The annual meeting was held at College Station on the twelfth, thirteenth and fourteenth days of November. One hundred and fourteen papers and addresses were listed on the programs of these meetings. The chairmen of the various divisions solicited manuscripts for the Transactions of the Academy; that their efforts were successful is attested by the fact that the present volume compares favorably, despite the great difficulties presented by war conditions, with previous annual volumes.

The funds of the Academy were insufficient to defray the costs of printing and mailing. The volume could not have been published this year, or it would have been necessary to limit its size to less than one-half, but for the generous gifts of the geophysical contracting companies listed on another page. The interest of these Texas organizations in the Academy is deeply appreciated. The Publications Committee extends heartfelt thanks.

The list of those who helped in the work of publishing is too long to find room here; the Publications Committee wishes to thank all for their aid and cooperation.

The statements and opinions expressed in these papers are those of the authors and are not binding on the officers of the Academy or on the membership. The right to reprint portions or abstracts of the papers is granted on the condition that especial reference be made to the source.

*Chairman, Publications Committee.*

September 1, 1943

# SUGGESTIONS FOR THE PREPARATION OF MANUSCRIPTS

Papers are published only in English. Manuscripts should be original typewritten copies (not carbon copies), on white paper, 8½ x 11 inches, either double or triple spaced, with wide margins. References should be numbered consecutively, to avoid repetition, and should include author's name, journal, volume number, page, listed in the order given. Attention should be given to captions for tables and legends for figures. These should be complete in themselves in all cases so as to render the data intelligible to the reader without consulting the text.

Special care should be given to mathematical expressions. Only the very simplest equations may be typewritten; all others should be carefully drawn with pen and ink for photographic reproduction. Fractional exponents should be used everywhere to avoid radical signs. Extra symbols should be employed to avoid complicated exponents. The solidus (/) should be used wherever possible for fractions.

All illustrations should accompany the manuscript and should always be referred to in the text. Line drawings must be made with India ink on plain white paper sufficiently large to permit reduction to one-half without impairing legibility. Coordinate paper is not desirable, but if used must be blue-lined with all coordinates to be reproduced drawn with India ink. Lettering should be of sufficient size to be legible after reduction. All captions should be submitted on a separate sheet and not included in the drawing.

In biological papers, indicate, by underscoring, all words to be italicized.

Omit all references to persons, incidents, or dates which will not be comprehensible to the reader a few years after publication.

Write concisely and clearly; do not use the first person singular. Write impersonally whenever possible.

Do not expect the return of any materials submitted for publication.

## CONTRIBUTORS TO THE PUBLICATIONS FUND OF THE TEXAS ACADEMY OF SCIENCE, 1943

BROWN GEOPHYSICAL COMPANY,
P. O. Box 6005, Houston

GENERAL GEOPHYSICAL COMPANY,
Gulf Bldg., Houston

GEOPHYSICAL SERVICE, INC.,
1311 Republic Bank Building, Dallas

GRAVITY METER EXPLORATION COMPANY,
Mellie Esperson Bldg., Houston

HOARD EXPLORATION COMPANY,
Esperson Bldg., Houston

INDEPENDENT EXPLORATION COMPANY,
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P. O. Drawer 2061, San Antonio

ROBERT H. RAY, INC.,
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2044 Richmond, Houston

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# OFFICERS, BOARDS, AND COMMITTEES FOR 1943

## OFFICERS*

*President,* FREDERICK A. BURT
*Executive Vice-President,* W. R. WOOLRICH
*Vice-President, Section* I, PAUL C. WITT
*Vice-President, Section* II, C. S. SMITH
*Vice-President, Section* III, C. A. NICHOLS
*Vice-President, Section* IV, FREDERICK B. PLUMMER
*Vice-President, Section* V, GORDON GUNTER
*Secretary,* LEO T. MURRAY
*Assistant Secretary,* GEORGE E. POTTER
*Editor,* L. W. BLAU
*Treasurer,* CURTIS J. HESSE, *replacing* JAMES E. NORTON, *resigned.*
*Representative to A.A.A.S.,* S. W. BILSING
*Chairman Collegiate Division,* C. C. DOAK
*Chairman Junior Division,* GRETA OPPE

## BOARDS

*Directors:* O. A. Ullrich (1945), Chairman, Frederick A. Burt (1943), Leo T. Murray (1943), Secretary, W. T. Gooch (1943), James E. Norton (1944), W. Armstrong Price (1944), Clyde T. Reed (Life).

*Constitution and Judiciary:* W. T. Gooch (1944), Chairman, Frederick A. Burt (1948), Secretary, E. P. Cheatum (1947), O. A. Ullrich (1946), F. B. Isely (1943), Leo T. Murray (1948).

## COMMITTEES

*Program:* W. R. Woolrich, Chairman, Paul C. Witt, C. S. Smith, C. A. Nichols, Frederick B. Plummer, Gordon Gunter, C. C. Doak, Greta Oppe, and Leo T. Murray.

*Publications:* L. W. Blau, Chairman, Paul C. Witt, C. S. Smith, C. A. Nichols, Frederick B. Plummer, Gordon Gunter.

*Auditing:* Luther G. Jones, Chairman, John A. Yarbrough, H. A. Damon.

*Nominations:* Hal P. Bybee, Chairman, S. W. Bilsing, E. P. Cheatum, O A. Ullrich.

*Affiliations:* W. R. Woolrich, Chairman; officers of learned societies of Texas as members.

*Finance:* James E. Norton, Chairman until July 10, 1943; since July 10th, Curtis J. Hesse, Chairman, Luther G. Jones, Secretary, W. T. Gooch, Don O. Baird, Frederick A. Burt, Leo T. Murray, Ellen S. Quillin, Charles H. Winkler.

* These officers and the immediate past President, E. P. Cheatum, constitute the Executive Council of the Academy.

*Library:* S. W. Bilsing, Chairman, C. J. Hesse, F. E. Turner.

*Membership:* Charles La Motte, Chairman, J. Brian Eby, F. D. Fuller, G. W. Goldsmith, T. H. Etheridge, Charles Winkler.

*Regional Meetings:* E. P. Cheatum, Chairman, Frederick A. Burt, Leo T. Murray.

*Research Grants:* E. P. Cheatum, Chairman, C. D. Leake, R. E. Hungate, W. Armstrong Price, B. L. Warwick.

*Collegiate Division:* C C. Doak, Chairman, J. C. Godbey (1944), Otto O. Watts (1944), V. A. Greulach (1945).

*Junior Division:* Greta Oppe (1945), Chairman, R. W. Strandtmann (1943), Velma Wilson (1943), S. W. Hayes (1944), Adda Reid Templeton (1944), Addison Lee (1945), Leo T. Murray (1943).

## SPECIAL COMMITTEES

*Publicity:* George E. Potter, Mayne Longnecker, Victor Greulach, Ellen Schulz Quillin, Greta Oppe, Addison Lee.

*New Fellows:* J. C. Godbey, George E. Potter, Gordon Gunter, Willis Hewatt.

*Necrology:* Clifton C. Doak, Don O. Baird, E. N. Jones, John A. Yarbrough.

*Handbook Science:* W. Armstrong Price, B. C. Tharp, F. B. Iseley, S. W. Bilsing.

*Oberholser Bird Book:* O. A. Ullrich, S. W. Geiser, Ellen Schulz Quillin, Walter P. Taylor.

## SOCIETIES AFFILIATED WITH THE ACADEMY

Central Texas Section, American Chemical Society
Dallas Astronomical Society
Dallas Nature Study Club
Dallas Ornithological Society
El Paso Archaeological Society
Houston Museum and Scientific Society
North Texas Biological Society
San Antonio Science Club
Texas Archaeological and Paleontological Society
Texas Association of Science Teachers
Texas Entomological Society
The Texas Folk-Lore Society
Texas Nature Federation
University Science Club
The Texas Society of College Teachers of Education
West Texas Historical and Scientific Society

## RESUME OF THE MEETING OF THE GENERAL BUSINESS SESSION OF THE TEXAS ACADEMY OF SCIENCE, ANNUAL MEETING, NOVEMBER 13, 1942, 5:30 P. M., COLLEGE STATION, TEXAS

President Elmer P. Cheatum, Presiding

1. The president expressed his appreciation of the work of the local committee in arranging the meeting. He likewise expressed his appreciation for the work done by Mrs. Gladys H. Baird as Chairman of Section III (Social Sciences) and to Dr. W. H. McCorkle of Section I (Physical Sciences) both of whom took over the responsibilities of the respective positions after the resignations of the elected chairmen.

2. Report of the Secretary, Dr. Leo T. Murray. Approved as read.

3. Report of the Treasurer by F. A. Burt for Dr. Otto Watts. Approved as read.

4. Dr. Gooch moved to instruct the secretary to write a letter of appreciation to Dr. Otto Watts for his work as treasurer. Motion seconded by Ullrich and carried.

5. Program Committee, G. E. Potter, Chairman. The program of the meeting was filed with these minutes. The chairman expressed appreciation for the cooperation of the other members of the committee in arranging the meeting, and particularly for the work of the local committee.

6. Publications Committee report by Rev. Frank O'Hara. Approved as read.

7. The president announced that the research fund which has been allocated to the Academy by A.A.A.S. will be held over, and that it is still good until 1944.

8. The report of the Regional Meeting Committee by O. A. Ullrich; to be incorporated in the Secretary's report.

9. Report of the Collegiate Division by Dr. C. C. Doak. Approved as given.

10. Report of the Library Committee by Dr. S. W. Bilsing. Approved as read.

11. Report of the Committee on Fellows by G. E. Potter, moved the election of E. R. Alexander, A. & M. Coll.; G. O. Clough, S.M.U.; M. L. Williams, Southwestern; and Victor A. Greulach, Univ. Houston. The motion was seconded and carried.

12. Report of the Resolutions Committee by Walter P. Taylor. Motion for adoption carried.

13. Report of Membership Committee by Dr. Hungate, Chairman was adopted and the 43 senior members and 41 Collegiate members proposed by the committee were elected. The list of these new members is attached.

14. Dean O. A. Ullrich made a motion that the list of new members proposed by the East Texas Branch be presented to the Executive Committee and, if the applications are in proper form with a recognized sponsor, that they be elected as of this meeting. The motion carried.

15. Dean Ullrich also moved that any new applicants for membership, who are recommended and sponsored by present members in good standing, be elected by a committee composed of the President, Exec. Vice President, Treasurer, and Secretary. The motion carried.

16. The report of the Necrology Committee given by C. C. Doak was approved. Dr. Doak moved that the assembled members pause and stand silently for a moment out of respect for the memory of these deceased members. The motion was passed and executed.

17. Dean Ullrich reported for the Oberholser Bird Book Committee that this project is at a standstill and likely will be for the duration of the war. He recommended that this endeavor be kept alive by the Academy in order that it may be taken up again at the close of the emergency. The report was approved.

18. Dean Ullrich presented a motion proposing that the President of the Academy instruct the Constitution and Judiciary Board to include, as a part of its plan to revise the constitution, a study of a modification of the present method of nominating and electing officers and bring in recommendations for next year's annual meeting. The motion carried. In this connection the board, through Dr. Gooch, requested all members to send to the board members suggestions and criticisms concerning modifications of the constitution.

19. W. T. Gooch moved that the Secretary and Treasurer be empowered to carry all Academy members who are in the armed forces on the membership list for the duration of the war without dues. The motion carried.

20. G. E. Potter moved that the editor or curator of publications be instructed to send a copy of the latest issues of the Transactions of the Academy to each newly elected member as soon as convenient after the election. The motion carried and the editor was so ordered.

21. W. T. Gooch brought in the report of the Nominating Committee, and the slate of new officers for the ensuing year was presented. The President called for further nominations from the floor. There was none, so the President entertained a motion to elect those nominated. The motion carried, and the action was completed.

There being no further business to come before the assembled body, a motion for adjournment was made and carried.

Respectfully,

G. E. POTTER, Assistant Treasurer.

## ANNUAL REPORT OF THE SECRETARY FOR THE YEAR Dec. 28, 1941, to Nov. 12, 1942

The Academy held its regular annual meeting in 1941 in conjunction with the annual meeting of the American Association for the Advancement of Science in Dallas, December 29, 1941, to January 3, 1942. The East Texas Branch of the Academy held a regional meeting at Houston, May 8-9, 1942. The South Texas Branch held its regional meeting at Corpus Christi, May 15-16, 1942. On account of the rubber crisis, the West Texas Branch canceled plans for a meeting at Abilene.

The Academy is divided scientifically into five sections, regionally into three branches, and scholastically into three divisions. The five sections are: I. Physical Sciences, II. Biological Sciences, III. Social Sciences, IV. Geological Sciences, and V. Conservation. The branches of the Academy comprise the South Texas, the West Texas, and the East Texas Branches, named in the order of their organization. The scholastic divisions of the Academy are the Senior Division, the Collegiate Division, and the Junior Division.

At the annual meeting in Dallas the Senior Division held no sectional sessions. The Collegiate Division held two scientific meetings in Hyer Hall, Southern Methodist University, at which nine papers were presented. The Junior Division met in two regular sessions in Hyer Hall, December 31, 1941.

The business of the Academy is conducted by three boards and various committees. The Executive Council held two meetings during the year, one at Dallas, and one at College Station. Various committees held several meetings during the year.

The Academy had a paid-up membership of 609 at the close of the Academy year, exclusive of Collegiate members and Junior Academy Chapters. LEO T. MURRAY, Secretary.

## PUBLICATIONS COMMITTEE

The Proceedings and Transactions of the Academy were combined and published at a cost of $552.60 in 1942. The following changes in Policies of Publications were adopted by the committee: 1st, change section 8 of the Handbook, Transactions XXII, 1939, p. 15 to read — "Short articles will be printed and 100 or more reprints furnished to the writer at cost of reprints." 2nd, change section 9 to read "only such material shall be included in the Transactions as has been presented by the author in abstract, in toto, or in title at a regular meeting." Thus the words "in title" were added. 3rd, change section 11 to read — "For the year 1942 the Proceedings and Transactions are to be one publication." This year, the membership list was published separately by the secretary and in the future it is to be published every third year by the Treasurer. It was distributed to each member with a copy of the Proceedings and Transactions by the Publications Committee. It is suggested that a list of new members be distributed in mimeograph form each year.

## FINANCE COMMITTEE

The meeting was held in the Geology Seminar Room, Petroleum-Geology Building at 9:30 p. m. Members present were:

Mr. Don O. Baird
Mr. Frederick A. Burt

Mr. C. J. Hesse
Mr. Luther G. Jones
Mr. Leo T. Murray

In absence of the chairman it was moved by Mr. Gooch that Mr. Burt be elected chairman pro tem; this was seconded by Mr. Baird, and the motion carried. Mr. Murray then moved that Mr. Hesse be made secretary of the committee for the year; this was seconded by Mr. Jones and the motion carried.

### FINANCIAL STATEMENT DRAWN UP BY FINANCE COMMITTEE

| | | |
|---|---|---|
| In cash, registration fees, dues, etc. at the present meeting, the Academy has taken in up to Saturday morning, November 14, 1942 | | $152.00 |
| Cash, brought forward from last year | | 201.41 |
| Total cash on hand Nov. 14, 1942 | | $353.41 |
| Outstanding bills, presented at meeting. | | |
| Dr. Cheatum, President | $ 8.94 | |
| Frederick A. Burt, Ex. V. P. | 3.25 | |
| F. E. Turner | 1.50 | |
| Committee (Nominating) telephone calls | 2.25 | |
| G. E. Potter, postage and telegraph | 4.85 | |
| L. Jones, banquet tickets and guests | 42.00 | |
| Total | $62.79 | |
| Printing programs | 25.55 | |
| Auditing books | 6.00 | |
| Expenses Mr. Ward (etc.) | 30.00 | |
| Total | 124.34 | 124.34 |
| Cash on hand | | $229.07 |
| Estimated dues year 1942-1943 | | 560.00 |
| Estimated back dues | | 100.00 |
| Total estimated Income 1942-1943 | | $889.07 |

### BUDGET FOR YEAR 1942-1943, RECOMMENDED BY FINANCE COMMITTEE

| | |
|---|---|
| President, past year $75.00, this year | $ 25.00 |
| Stationery, past year, $60.00, this year | 20.00 |
| Secretary, past year $25.00, this year | 25.00 |
| Treasurer, past year $75.00, this year | 100.00 |
| Collegiate Division and Library, past year $25.00, this year | 25.00 |
| Junior Division, past year $60.00, this year | 35.00 |
| Membership Committee, past year $75.00, this year | 25.00 |
| Auditing, past year $25.00, this year | 10.00 |

| | |
|---|---|
| Annual meeting, past year $25.00, this year | 25.00 |
| Constitution Board this year | 35.00 |
| Contingent fund this year | 100.00 |
| Total recommended budget | $425.00 |
| Publications Committee | 464.07 |
| Total budgeted expenses 1942-1943 | $889.07 |

On motion of Leo Murray, seconded by L. Jones, the committee voted to recommend to the Executive Council the adoption of the above budget for the ensuing year.

C. J. HESSE, *Secretary*.

Note: At its meeting Saturday morning, November 14, 1942, the Executive Council of the Academy voted to adopt the budget as above recommended with the amendment that the Collegiate Division Committee would divide its appropriation $10/$15 with the Library Committee.

In view of the probable difficulty that will be involved in calling together the Executive Council during the coming year, the Council voted to leave in the hands of the Finance Committee the authority to apply to the Contingent Fund any income to the general fund in excess of that anticipated in the budget.

They further recommended that if excess funds thus accumulated in the Contingent Fund, the Finance Committee transfer them to the Publications Committee so far as that Committee might be able to use them advantageously.

SUPPLEMENTAL REPORT OF THE FINANCE COMMITTEE

At a meeting of the Finance Committee of The Texas Academy of Science on November 18, in the Petroleum-Geology building, the following business was transacted.

Mr. Potter turned over to Mr. Burt:

| | |
|---|---|
| Membership fees from new members | $50.00 |
| Dues, from members current and past | 14.00 |
| Total | $64.00 |

This amount is in addition to that of $152.00 taken in at the Meeting up to November 14, 1942.

Out of the cash on hand the committee paid the following bills:

| | |
|---|---|
| To Mr. Burt | $ 3.25 |
| To Mr. F. E. Turner | .50 |
| Nominating Committee, telephone calls | 2.25 |
| To Mr. Potter, postage and telegraph | 4.85 |
| To L. Jones, banquet tickets, etc. | 42.00 |
| Total bills paid | $52.85 |

Mr. Burt, Mr. Luther Jones, Mr. Potter and C. J. Hesse were present at this meeting.

On Friday, December 11th, another meeting was held to clear up the final expenses and bills of the local Meeting. Mr. Burt, Mr. L. Jones, Mr. Potter, Mr. Bilsing and C. J. Hesse were present.

The following bills were presented for payment by the Treasurer, Rev. James E. Norton.

Outstanding bills to be paid:

| | |
|---|---|
| To / Mr. H. B. Ward, University of Illinois, Urbana, Illinois. Expenses, travels, etc. | $43.19 |
| To / Aggieland Inn, College Station, Texas, Mr. Ward's Hotel bill | 4.00 |
| To / Mr. Cheatum, past president, postage, telephone, etc. | 8.94 |
| To / A. & M. Press, College Station, Texas | 25.55 |
| To / Mr. L. Jones, College Station, Texas, Expenses for audit of books | 5.00 |
| Total outstanding bills | $86.68 |

It was moved and seconded that the above bills be paid, and the resolution passed.

C. J. HESSE, *Secretary of the Finance Committee.*

Auditing Committee
Texas Academy of Science
Dear Sirs:

I have examined the recorded receipts and disbursements of The Texas Academy of Science for the period from December 19th, 1941, to November 7th, 1942. The records examined were prepared by the Treasurer, Dr. Otto O. Watts.

There is presented herewith a statement of Treasurer's Cash Receipts and Disbursements for the period covered by the examination.

In making the examination I traced the recorded receipts to the bank account in the Farmers and Merchants National Bank of Abilene, Texas. Checks cancelled by the bank were examined and compared with the recorded disbursements. The disbursements were supported by bills and letters from officers and committee members in charge of disbursing funds.

An examination was not made of the assets and liabilities of The Texas Academy of Science. The cash balance on November 7, 1942, was reconciled with the balance shown on the bank statement of the Farmers and Merchants National Bank of Abilene, Texas. There was no direct confirmation from the bank.

The Treasurer's records listed the following assets:

| | |
|---|---|
| U. S. Savings Bonds, No. C786167C, C786168C, with maturity value of | $200.00 |
| Savings Account with the First Federal Savings and Loan Association of San Antonio | 31.23 |
| Research Apparatus | 110.00 |

The Savings Bonds were indicated to be in the safety deposit box of Dr. Otto O. Watts. An account book of the First Federal Savings and

Loan Association of San Antonio was examined and found to have a bal ance of $31.23, as of June 30th, 1942.

The records showed the following unpaid bills presented by the officers of the Academy:

| | |
|---|---|
| Unpaid expenses of Frederick A. Burt | $ 3.27 |
| Unpaid expenses of E. P. Cheatum | 8.94 |
| Total | $12.21 |

With the time allotted for preparation of this report it was not possible to make a detailed examination or prepare a detailed analysis of expenditures.

The Treasurer is to be commended on the manner in which the records of the Academy were prepared.

Respectfully submitted,

N. D. DURST, *Certified Public Accountant.*

THE TEXAS ACADEMY OF SCIENCE
STATEMENT OF TREASURER'S CASH RECEIPTS AND DISBURSEMENTS

December 19th, 1941, to November 7th, 1942

| | | |
|---|---|---|
| Cash Balance, December 19, 1941 | | $ 267.72 |
| Receipts: | | |
| Dues from members | $853.00 | |
| Life Membership | 25.00 | |
| Book Sales | 3.00 | |
| Cactus Book Account | 283.10 | |
| Interest refund | 6.80 | $1,170.90 |
| | | $1,438.62 |
| Disbursements: | | |
| Retirement of Notes Payable | $300.00 | |
| Interest on Notes Payable | 6.00 | |
| Bills from prior year | 85.25 | |
| President's Office expenses | 20.13 | |
| Secretary's Office expenses | 58.96 | |
| Treasurer's Office expenses | 47.08 | |
| Junior Academy expenses | 54.00 | |
| Publications Committee Expenses | 558.61 | |
| Collegiate Division Prizes | 25.00 | |
| Houston Meeting expenses | 69.00 | |
| Balance of American Academy Research grant | 12.18 | |
| Refund on overpayment of dues | 1.00 | 1,237.21 |
| CASH BALANCE, November 7, 1942 | | $ 201.41 |

## LIBRARY COMMITTEE

The library of the Academy is housed in the main Library Building of A. & M. College of Texas. The Academy has added four new exchange publications to its exchange list, making in all at present a total of 68 such exchanges. The library consists of approximately 2,200 separate publications, including books, bulletins, reprints, etc. About 600 of these have been added since the report of last year. The library has been administered entirely gratis. The only expenditures have been for freight and postage.

## MEMBERSHIP COMMITTEE

### NEW SENIOR MEMBERS—ELECTED FALL MEETING, 1942

Dawson, E. T., 714 Pizer St., Houston, Texas.
Weaver, Paul, Gulf Oil Corp., Houston, Texas.
Bernard, C. H., A. & M. College, Physics Dept., College Station, Texas.
Hall, Wm. C., Agricultural Economics Dept., A. & M. College, College Station, Texas.
Clark, R. T., Jr., Abilene Christian College, Abilene, Texas.
Flory, W. S., Jr., Experiment Station, Horticulture, A. & M. College, College Station, Texas.
Wharton, Linda T., Department of Zoology, University of Texas, Austin, Texas
Griffen, Allen B., Department of Zoology, University of Texas, Austin, Texas
Leake, Dr. Chauncey D., Dean, University of Texas, Medical Branch, Galveston, Texas
Myers, Jack, Department of Zoology, University of Texas, Austin, Texas.
Sperry, John J., Department of Biology, A. & M. College, College Station, Texas
Nelson, Bernard A., Chem. Department, Baylor University, Waco, Texas.
Mathews, A. A. L., Department of Geology, A. & M. College, College Station, Texas.
Mogford, Joseph S., Department of Agronomy, A. & M. College, College Station, Texas.
Weaver, David Andrew, Dean, Baylor University, Waco, Texas.
Pershing, Alvin V., Department of Physics, Texas Tech., Lubbock, Texas.
Wilhite, J. G., Department of Physics, Texas Tech., 905 S. 11th, Stalon, Texas
Dolecek, R. L., Department of Physics, Texas Tech., Lubbock, Texas.
Sheppard, Miss Carrie, ETSTC, 1508⅛ Bois darc, Commerce, Texas.
Christianson, L. C., Department of Mathematics, Texas Tech., Lubbock, Texas.
Clarkson, Miss Helen, Department of Physics, Hardin Simmons, Abilene, Texas.
Busch, Karl H. D., Corpus Christi Junior College, Corpus Christi, Texas.
Alexander, Kliem, Chemical Department, WTSTC, Box 775, Canyon, Texas.

Graham, Edna, WTSTC, Box 451, Canyon, Texas.
Webb, Donald L., Department of Mathematics, Texas Tech., Lubbock, Texas.
Martin, Dial, Department of Entomology, Box 1067, A. & M. College, College Station, Texas.
Johnston, George L., Box 381, Dallas, Texas.
Banks, Reba, Senior High School, Corpus Christi, Texas.
Sweet, R. B., Box 98, College Station, Texas.
Street, W. E., Engineering Drawing Dept., A. & M. College, College Station, Texas.
Runck, Mrs. Lillian, Senior High School, Corpus Christi, Texas.
Dalberg, F. J., Animal Husbandry Department, A. & M. College, College Station, Texas.
Lokey, Clarence W., 409 E. 27th, Bryan, Texas.
Delaplane, John P., Veterinary Medicine, A. & M. College, College Station, Texas.
Turk, R. D., Veterinary Medicine, A. & M. College, College Station, Texas.
Berry, R. O., Experiment Station, A. & M. College, College Station, Texas.
Gray, James A., Animal Husbandry Department, A. & M. College, College Station, Texas.
McLaren, Barbara A., Experiment Station, A. & M. College, College Station, Texas.
Sheybani, M. K., Box 2152, A. & M. College, College Station, Texas.
Patterson, R. E., Genetics Department, A. & M. College, College Station, Texas.
Eskew, Cletis T., Biology Department, Hardin Junior College, Wichita Falls, Texas.
Brock, Fred D., Feed Control Service, Experiment Station, A. & M. College, Box 484, College Station, Texas.
Dr. Pierre Bernard Hill, 106 E. Goodwin, Victoria, Texas.

## NEW COLLEGIATE MEMBERS — ELECTED FALL MEETING 1942

Green, Bill James, Department Biology, Baylor University, Waco, Texas.
Largent, Ben F., Department of Biology, Baylor University, Waco, Texas.
Lewis, Kelley, Abilene Christian College, Station A., Abilene, Texas.
Cone, J. D., Abilene Christian College, Station A., Abilene, Texas.
Cox, Jim, Abilene Christian College, Station A., Abilene, Texas.
Sells, Norvelle, ETSTC, Commerce, Texas, c/o Mrs. Emily Barry Walker.
Abernaty, Billie, ETSTC, Commerce, Texas, c/o Mrs. Emily Barry Walker.
Bennett, Wanda, ETSTC, Commerce, Texas, c/o Mrs. Emily Barry Walker.
Eagleton, Ethie, ETSTC, Commerce, Texas, c/o Mrs. Emily Barry Walker.
Colley, L. D. ETSTC, Commerce, Texas, c/o Mrs. Emily Barry Walker.
Pickett, Ardelia, ETSTC, Commerce, Texas, c/o Mrs. Emily Barry Walker.
Hodges, Harold, ETSTC, Commerce, Texas, c/o Mrs. Emily Barry Walker.
Frankline, Frances, ETSTC, Commerce, Texas, c/o Mrs. Emily Barry Walker.

Thompson, Jean, Incarnate Word College, San Antonio, Texas.
Range, Haskell, Hendrick Memorial Hospital, Hardin-Simmons, Abilene, Texas.
Everton, Marta Ve, Hardin-Simmons, 1945 Simmons Ave., Abilene, Texas.
Stool, Sylvan, 1102 Sycamore St., Abilene, Texas.
Williams, E. H., Poultry Husbandry Department, A. & M. College, College Station, Texas.
Kelsey, Joe, Dairy Husbandry, A. & M. College, College Station, Texas.
Howard, Martin, A. & M. College, Box 5283, College Station, Texas.
Oxford, W. F., Jr., Chemistry Department, A. & M. College, Box 2507 College Station, Texas.
Roming, John A., A. & M. College, College Station, Texas.
Bailey, Leo. L., A. & M. College, College Station, Texas.
Kirk, Ed., Abilene Christian College, Station A., Abilene, Texas.
Rister, Dorinne, Hardin-Simmons, Box 77, Abilene, Texas.
Roberts, Doman, Hardin-Simmons, Hendricks Home for Children, Abilene, Texas.
Stel, A. L. Jr., Hardin-Simmons, Box 57, Abilene, Texas.
Sikes, James Klingman, Abilene Christian College, Abilene, Texas.
Lynn, Tom Watson, Abilene Christian College, Abilene, Texas.
Peck, Gerald, Southwestern University, Georgetown, Texas.
Benold, Douglas, Southwestern University, Georgetown, Texas.
Melbert, James, Southwestern University, Georgetown, Texas.
Behrens, Howard, Southwestern University, Georgetown, Texas.
Deschner, Anton, Southwestern University, Georgetown, Texas.
Meredith, MacLaurin, Southwestern University, Georgetown, Texas.
Fowler, Alma Jean, 710 S. 53rd Street, Temple, Texas.
Adair, Lucille, 325 Hollywood, Dallas, Texas.
Farrow, Lilian, ETSTC., Commerce, Texas.
Arnold, Maurice, ETSTC., Commerce, Texas.
Garner, Herschel, ETSTC., Commerce, Texas.
Butler, Betty, ETSTC., Commerce, Texas.
Phillips, Emily Sue, ETSTC., Commerce, Texas.
Elliott, Betty Jo, ETSTC., Commerce, Texas.

Elected to membership by the Executive Committee in May, 1943:
Whisenhunt, Matt H., Box 207, Isabel, Okla.
Kirk, Samuel Kieth, R.F.D. No. 1, Harrold, Texas.
Fort, Milton G., 604 North 23 Street, Waco, Texas.

These men won membership as awards for papers presented before the United Science Club of A. & M. College.

## REPORT OF THE RESOLUTIONS COMMITTEE

1. RESOLVED, That we express our appreciation for the efficient work of the local committee and the A. and M. College for providing facilities for carrying forward the program and the entertainment of the visiting members. This includes financial aid courteously extended to

the Academy by the President of the A. and M. College to help bring the Academy speaker to College Station for this meeting.

2. RESOLVED, That we express our appreciation for publicity given the meeting of the Academy by the Bryan Daily Eagle, the Battalion and the State Press.

WHEREAS The Texas Academy of Science, despite many desirable features, is not as effective in serving science in Texas as it might be, be it

RESOLVED, That the Academy express appreciation and approval of the critical study of the organization begun by President Cheatum and his committees, and that this program of self examination be continued and serve as a basis for future improvements in the Academy.

WHEREAS the members of The Texas Academy of Science should make freely available to the State and Nation whatever abilities, experience, and training they may possess in teaching, research, administration, publication, or other lines, in this most serious crisis in America's history, and

WHEREAS, this important objective can be effectively served by the cooperation, coordination, and personal acquaintances which result from the regular work of The Texas Academy of Science—its meetings, publications, and conferences, therefore be it

RESOLVED, That the members of The Texas Academy of Science assembled at College Station, Texas, do hereby express their opinion that the organization can make its best contribution to the war program and the peace which will some day follow by (1) maintaining its organization in the most effective possible manner, (2) enlarging its scientific activities to accord with the needs of the times, (3) strengthening the publication program, (4) offering its technical services to the Governor and the Legislature of the State of Texas, (5) holding regular meetings, including, if practicable, the annual and sectional gatherings.

VICTOR A. GREULACH,
W. P. TAYLOR,
F. B. ISELY, *Chairman.*

## NECROLOGY COMMITTEE

After the reading of the names of those Academy members who had passed since our last meeting, as chairman of the Necrology Committee, Dr. Doak made the following resolution before the assembled Academy while in business session. "Out of respect for the services rendered to the cause of science in Texas and to the Academy, I move that we pause in our haste and stand for one moment in silent respect to these and any other deceased members of the Academy." The body responded unanimously.

Those who passed away during the year were:

Mr. Frank L. Chase of Dallas, Texas. Mr. Chase was an employe of the Lone Star Gas Company and was elected to the Academy in 1939.

Mr. Forrest Kirkland of Dallas, Texas, who was elected a member of the Academy in 1938 and a fellow in 1942. Mr. Kirkland was employed with the Kirkland Studio.

Mr. Fred Elmer Rightor was elected to the Academy in 1939 and made a fellow in the same year. Mr. Rightor was an engineer of wide experience and held numerous offices in fraternal and engineering groups.

Mr. Julius I. Olsen, Dean of Hardin-Simmons University, Abilene, Texas.

Dr. O. M. Ball, Curator of the Museum, A. & M. College, College station.

## NOMINATING COMMITTEE

Nominations for officers for the year (1942-43) are:

*President,* FREDERICK A. BURT, A. & M. College of Texas, College Station.

*Executive Vice President,* W. R. WOOLRICH, University of Texas, Austin.

*Vice President Section I,* PAUL C. WITT, Abilene Christian College, Abilene.

*Vice President Section II,* C. S. SMITH, Southwest State Teachers College, San Marcos.

*Vice President, Section III,* C. A. NICHOLS, Southern Methodist University, Dallas.

*Vice President, Section IV,* F. B. PLUMMER, University of Texas, Austin.

*Vice President, Section V,* GORDON GUNTER, Texas Game, Fish and Oyster Commission, Rockport.

*Editor,* L. W. BLAU, Humble Oil & Refining Company, Houston.

*Secretary,* L. T. MURRAY, Baylor University, Waco.

*Assistant Secretary,* G. E. POTTER, A. & M. College, College Station.

*Treasurer,* J. E. NORTON, St. Edwards University, Austin.

*Representative to A.A.A.S.,* S. W. BILSING, A. & M. College, College Station.

*Place on Board of Directors,* O. A. ULLRICH, Southwestern University, Georgetown.

## COLLEGIATE DIVISION

The first attempt to have a Collegiate Program at a regional meeting was undertaken at the Houston meeting. Since no prize money was available, the contest feature of the program was abandoned. Five papers of high quality representing three schools were read.

The Collegiate Division held two meetings during the Fall Meeting at College Station; at least six colleges were represented.

Announcement was made of a grant of $100.00 by Westinghouse Electric and Manufacturing Company for Collegiate Science prizes. Fifty Dollars and two emblems were earmarked for this contest. The remainder had been given by the company for prizes in local inter-club contests for the United Science Club of A. & M. Five papers were read, two in the research division and three in the essay. Awards were as follows: Research—1st place, John A. Roming, gold medal and $15.00 in cash; 2nd place, S. V. Burks, $12.00 in cash. Essay Division—1st place, Leo Bailey, gold medal and

$10.00 in cash; 2nd place, Martin Howard, $8.00 in cash; 3rd place, Joe Kelsey, $5.00.

Mr. Wilbert E. Tschirhart of A. & M. was elected President; Mr. George Roushner of Southwestern University, Vice-President; and Miss Jeanne Thompson, Incarnate Word College, was elected Secretary.

## JUNIOR ACADEMY DIVISION

### OFFICERS: 1942-1943

*General Chairman,* GRETA OPPE, Ball High School, Galveston.
*Secretary-Treasurer,* ADDISON LEE, Austin High School, Austin.
*Editor,* SIGMAN HAYES, Austin High School, Austin.
*Counselor,* LEO T. MURRAY, Baylor University, Waco, Texas.
*Regional Directors,* Velma Wilson, South Texas; Helen Dumont, Central Texas; Willie Mae Floyd, West Texas; Mrs. Edna Miner, East Texas.

### ANNUAL FALL REPORT, 1942

The annual meeting of the Junior Academy Division was held at the Agricultural and Mechanical College, College Station, November 14, 1942, in the Animal Husbandries Building. Due to transportation difficulties only two papers were presented, one from Galveston, Ernest Wittig, III, reading Hayes Slaughter's paper, "Hobbies of Great Men," and the other from Austin, the Chicago Apparatus Award Contestant, "A Study of Reptiles," by Floyd Potter of the Raymond L. Dittmars chapter who received this annual award of the Chicago Apparatus Company. Due to the war, this contest is now discontinued by the company. The Junior Academy Division expresses its appreciation of this gracious gesture over a period of years which stimulated so many to be active participants in the annual and regional programs.

The A. A. A. S. honorary junior memberships were awarded to Robert Lee Hennig, Brownsville chapter, and to Ray McIver, student editor of *TexSciana,* Austin High School. Honorable mention went to Warren Binnion, East Texas Ornithology Club, Demonstration School, E. T. S. T. College, Commerce and to Peggy Crooke, Conroe High School.

Following the program, Dr. C. J. Hesse, curator of the Museum, conducted the Junior Division on a tour through the Museum, following which they were entertained at lunch as guests of the cadets of the college with Dr. Luther Jones as host.

Club sponsors attending the annual meeting were: Mrs. Emily Barry Walker, Commerce; Mr. Addison Lee, Mr. Sigman Hayes and Miss Helen Boysen, Austin; Mrs. Edna Miner, Houston; and Miss Greta Oppe, General Chairman, Junior Division, Galveston. The towns represented at the annual meeting were: Galveston, Houston, Austin, and Commerce. Eighteen clubs, according to the secretary's report, were affiliated with The Texas Academy of Science during 1942.

Mary Adele Robert, member of the East Texas Ornithology Club, Chapter I Junior Academy of Science, read her paper entitled "The Wild Flowers of East Texas" before the annual meeting of the Tennessee Academy of Science in Nashville, Tennessee, November 28, 1942. At this meeting, the Tennessee Academy of Science organized a Junior Academy Division.

## The Aims, Purposes, and Present Status of Junior Academies of Science

EMILY BARRY WALKER, Assistant Professor of Biology,
East Texas State Teachers' College, Commerce

The term "Junior Academy" refers to a subdivision of the state Academy of Science which is made up of High School students of science. Most of the state academies of science throughout the country have this type of organization worked out and functioning to a greater or lesser degree. There seems to be no doubt in the minds of the Academy of Science members that such a division as the "Junior Academy" is a desirable auxiliary, but we should know more about it.

We are constantly talking about the needs and the aims of the youth of today, but, as Mark Twain said about the weather, "Why doesn't somebody do something about it?" Last year Dr. Harry Carpenter, in his address entitled "Youth Speaks for Science," pointed out that science is providing the answer. Speaking of the boys and girls who are adjusting themselves in this kaleidoscopic world, he said: "Science appears to have provided them with a philosophy of living which enables them to rationalize the good and bad uses of the results of science. It appears to have given them a mental development that will carry them safely through emergencies as they take up an increasing share of the world's work."

It is not necessary to justify the presentation of a problem concerning the needs of science and our youth of today, but perhaps it might be pertinent to bring before our minds the fact that there is a real need to establish an understanding concerning the work of a very important integral part of the organization of the state academy of science. Perhaps it will be well to give the background and history of the movement which is termed "Junior Academy."

Historically, the idea of including secondary school science seems to be of long standing, for at least twenty years ago the Illinois State Academy of Science appointed a committee to consider high school science. In 1919, four high schools affiliated with the senior academy. In 1929, the first organization of a Junior Academy of Science was consummated. Other states followed the lead of Illinois, and soon, Indiana, Kansas and Iowa established Junior divisions.

In 1929, at the meeting of the Academies Conference of the American Association for the Advancement of Science, Mr. Astell presented a paper on encouraging students in science in high school by means of the state academy organization. Again in 1930, at the Cleveland meeting, the Academies Conference discussed the junior academy movement. A mimeographed bulletin was prepared and distributed through the affiliated state academies by Dr. Otis Caldwell, Mr. Astell, and Mr. Oesterling.

In 1935, Dr. Ender, Chairman of the Indiana Junior Academy, made the following statement, "The Junior Academy movement clearly is the outstanding achievement which has grown out of the formation of the Academies Conference." During the same year, the Junior Academy Division in Texas was established, and the constitution and requirements for membership were written into the constitution and by-laws of The Texas Academy of Science.

There are today 14 well established Junior Academies, and several more are being developed. It is impossible to estimate the value of the work that has been carried on by the Juniors and their Sponsors in all the various fields of science. More than 15,000 young science students are by this means yearly brought under the guardianship, so to speak, of the senior scientists of the state academies.

The principal difficulty encountered in the affiliation of high school science clubs with the state organization has been failure of the senior academy members to explain to the sponsors of the high school clubs the value and purpose of the state academy organization in the future of the junior scientist of today. This failure on the part of the senior organization members is no doubt due to lack of understanding of the work of the Junior Academy Division. The Academies Conference leaders have recognized this need and have sought in many ways to further the work of the Junior Academy Divisions by holding meetings for this purpose from time to time. The fact that the Academies Conference continues to take especial interest in the Juniors and their work is of great significance. Many important decisions have been worked out by the group of people who meet and consider the problems confronting the Junior Science organizations from year to year.

On December 28, 1940, the Special Committee of the Academies Conference met in Philadelphia and set forth a number of important policies. Among these was the suggestion, which has been carried out with success by several states, to make up traveling kits containing interesting and instructive materials for the use of the clubs. On March 28, 1942, another Conference Committee met to consider important questions relative to the Juniors and their future connections and plans. A brief summary of the work of this committee follows; the senior members should be acquainted with all the activities of the various organizations connected with the Academy.

1. The Committee agreed to supply the Washington Office of the A.A.A.S. with the names and addresses of state Junior Academy officers and club sponsors. The purpose is to create a list of Junior Academy officers which will be available for correspondence.

2. The Committee agreed that attempts should be made to interest state departments of education in the junior academies.

3. The distribution of traveling kits was endorsed.

4. A national journal for the use of science clubs was considered necessary. It was decided to obtain, from high school science teachers,

information relative to the nature of the material desired in such a journal. It was deemed desirable to acquire this information before any recommendations would be drawn up relative to starting a national science journal. A questionnaire is to be prepared and circulated from the office of the General Secretary of the A.A.A.S.

The interest and care of the senior academy could not be more clearly shown than by the work of this committee. It proves also that the Juniors are an integral part of the state academies as well as of the A.A.A.S. The actual relationship with the A.A.A.S. has been a moot question. Actually, the relationship is the same as that of the State Academy, which is an affiliated organization, but the connection is much closer. The Junior Academy of Science members of today are the scientists of tomorrow. Therefore, it is hoped that the members of The Texas Academy of Science will give their unqualified support to the work of the Junior Academy Division.

# TRANSACTIONS

## SECTION I: PHYSICAL SCIENCES

DR. W. H. MCCORKLE, Chairman. Served after the resignation of Dr. W. M. Craig.

Dr. Paul C. Witt was elected Chairman of the Section for 1943.

### ABSTRACTS

**Isotomic Points and Lines with Reference to the Triangle**—SISTER TERESA JOSEPH CONNORS, Incarnate Word College, San Antonio. The isotomic transformation is a particular case of the general quadratic transformation in which points correspond to points, and lines correspond to conics passing through three given points.

Isotomic points and lines were defined by means of proofs in which the Theorems of Ceva and of Menelaus were employed.

The Gergonne and Nagel points were shown to be isotomic points; the median point and the ex-median points were shown to be isotomically self-conjugate.

That the isotomic transformation changes lines into circumscribed conics was proved by means of synthetic projective geometry and analytic projective geometry. Then the question as to the type of conic to be expected was discussed. Since the Steiner ellipse represents the locus of points isotomically conjugate to points on the ideal line, it is evident that the type of conic will depend on the relationship which the line to be transformed (L) bears to the Steiner ellipse. If the line L cuts the Steiner ellipse in two real and distinct points, then the locus of points isotomically conjugate to points on L will have two real and distinct points in common with the ideal line and therefore will be a hyperbola. If L is tangent to the Steiner ellipse then the locus will be a parabola, and if L does not intersect the Steiner ellipse then the conic will be an ellipse.

**Some Relations of Physics to the Present War Effort**—F. T. ROGERS, JR., University of Houston, Houston, Texas. A brief discussion was given, based only on material which was already published and available to the public, of the part played by physics and physicists in: (a) the development of new weapons, and (b) the use of present weapons. Outlined were the general features, together with a few pertinent technical details, of bombing from airplanes, of submarine detection by ships at sea, and of the detection of airplanes by radio means. It was pointed out that the many problems of development are largely those of physics, and that the uses cannot be most effective unless the users are themselves well acquainted with a large body of physics.

**The Polarization of Sodium Resonance Radiation in a Magnetic Field**—MARGUERITE M. ROGERS, University of Houston, Houston, Texas. The degree of polarization of the resonance radiation excited in sodium vapor by the yellow sodium doublet was measured for magnetic fields applied parallel to the electric vector of the incident plane polarized light and varying from zero to 150 Oersteds. A graph of percent. polarization vs. field H was made. Computations were carried out on the Zeeman intensities of the two lines $S_{1/2}$—$P_{1/2}$ and $S_{1/2}$—$P_{3/2}$ for the nuclear quantum number I=3/2. These values were plotted on a graph of percent. polarization vs. H/A, where A is the hyperfine separation constant. By fitting the two curves together, the value of A was determined. Combining this value of A with I = 3/2, the nuclear magnetic moment of sodium was found to be 2.5 nuclear magnetons, in good agreement with values found by other methods.

**On the Theory of the Electrostatic Beta-Particle Energy Spectograph III**—F. T. ROGERS, JR., University of Houston, Houston, Texas. A discussion is presented of the focusing action of the electrostatic analyzer (the electric field between two concentric cylindrical-segment electrodes) on particles of relativistic speed. A variation of focal length with particle speed is derived, and its effect on the use of the analyzer for continuous spectra is examined. In contradistinction to an earlier paper of the same title, the central angle of the electrode segments here appears (for angles less than 127° 27′) as a parameter.

**Opportunities for Research in Applied Physics**—E. G. SMITH, Agricultural and Mechanical College of Texas, College Station. Research in Applied Science is attractive to members of the faculties of technical schools and of small colleges which do not have funds for the purchase of equipment. Professor Brown's harmonic analyzer and synthesizer is a fine example of successful research in an old field of applied physics. Cooperation of departments often produces results not attainable by any one department alone. Thus, at A. & M. College, a procedure was developed which involved the measurement of the apparent electrical resistivity of soil, and the correction of the resistivity values for temperature, for the determination of the moisture content of orchard soils and, incidentally, of the time when irrigation was required. Several departments cooperated in research directed to the elimination of pumps in residential heating systems with a view to the reduction of the costs of installation and operation and the elimination of noise. It was necessary to modify the analysis employed hitherto, applicable to systems in which the supply mains were located *above* the radiators, to adapt it to systems in which the supply mains lay *below* the radiators. By increasing the difference between the temperature of the water in the supply mains and the temperature of the water in the return pipes, more pressure became available for the circulation of the water, and it was thus possible to reduce pipe sizes. The revised results were incorporated into tables for general use.

The following hints may prove useful to those engaged in research in applied physics: 1, Use dimensional analysis in all complicated problems; 2, Work carefully and determine the effects of simplifying approximations; 3, Incorporate the results in tabular form for use in general design procedures; 4, Plot simple graphs when the construction of tables is too laborious.

**X-Ray Studies of Paving Asphalts**—C. L. WILLIFORD, Texas Engineering Experiment Station, College Station. Twenty-five samples of paving asphalts, from widely separated sources, are examined by X-ray diffraction methods and the results correlated with chemical analyses, molecular weights and some physical properties. Comparison is also made with results on allied petroleum products, such as paraffine wax, petrolatum, asphaltenes, and asphaltic coke.

The method is shown to be suitable for the study and evaluation of asphalts and to yield results not obtainable by standard conventional tests. Asphalts meeting identical conventional specifications are shown to be considerably different in their interior constitution. Sulfur content is shown to be directly related to the formation of asphaltic bodies. The method is adaptable to use in specifications for paving asphalts.

# On the Continuation of the Investigation Concerning the Influence of Long Waves Combining with Short Waves on the Limiting Potential of Einstein's Photoelectric Law

ERICH MARX, Trinity University, San Antonio

## I.

In the year 1930 I demonstrated, at the Science Research Association at Breslau, Germany, a new photoelectric effect by the following experiment: Upon the potassium electrode of a highly evacuated photoelectric cell, white light of a carbon arc was incident. The illumination could strike the anode neither by direct nor by reflected light. It was demonstrated that the limiting potential of the potassium electrode increased when the illuminating white light was filtered by a blue glass which absorbed the red and yellow lines of the carbon spectrum. The same effect was shown by a method which did not subtract, but added, light to the illuminating blue ray which first was incident upon the potassium electrode. The limiting potential of blue light was lowered if red light was admitted besides the blue.

The effect seemed, as is also emphasized in the well known American textbook of Hughes and Du Bridge on "Photoelectric Phenomena," "quite surprising," because the fundamental Einstein law does not give evidence for such influence of photons of smaller energy if photons of a greater energy are hitting the electrode at the same time. But, really, it was shown by mathematical derivation that such an effect was to be expected by the theory. The quoted textbook was, however, essentially finished when the theory of the effect was published, and the simple mathematical proof was not placed in the textbook. Let me therefore above all give briefly the mathematical evidence that indeed the extremely important Einstein law has to be extended.

In any experimental arrangement for measuring the limiting potential by charging up the illuminated electrode, we have to realize that those electrons which have not acquired sufficient velocity to escape the illuminated photoelectrode will return to the electrode from which they started. This must be the case for all electrons generated by photons of smaller energy, if besides them photons of greater energy are effective. The Einstein law is written in the form

$$h\nu - P = \varepsilon V$$
$$\text{or } h\nu - h\nu_0 = \varepsilon V$$

where h and $\varepsilon$ are the known universal constants, $\nu$ the frequency, and P the work to be done by the electron to overcome the forces which retard it. P is a characteristic constant *of the material* on the illuminated electrode. The frequency $\nu_0$ indicates that frequency below which there is no photoelectric effect of the electrode. According to this law, V is the measure of the fastest electrons leaving the illuminated electrode. V depends only on the highest frequency. Hughes and Du Bridge call the influence of any light of lower frequency on the limiting potential "a surprising one," because the Einstein law does not indicate any effect due to the influence of lower frequency. At the place, however, where the velocity of the retarded electrons reaches the value zero, the electron is effective as a space charge. From this, it is evident that the distribution of space charges along the axis of propagation of the electrons, that is the distribution of electrons which can not escape due to the retarding potential of the illuminated electrode, is the same as the distribution of velocity which is revealed by the measurement of velocities of electrons generated by a certain monochromatic ray. If the state in the tube has become a stationary state, the electrons corresponding to the highest frequency have to pass the space charge resulting from the retarded slow electrons corresponding to smaller frequencies.

II.

We now have to consider the events in such an experimental arrangement in a more quantitative way.

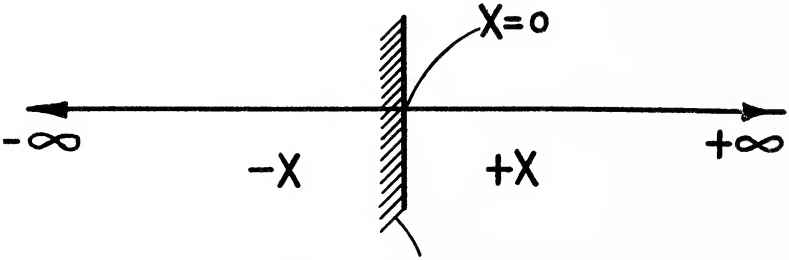



Fig. 1—Electrode Arrangement

In Figure 1, the x-axis extends from $-\infty$ to $+\infty$. The surface of the electrode is at $x = 0$. The electron, starting from the electrode in the direction of the x-axis has to travel against a retarding field E, because the electrode is charging itself positively. Therefore, we have

1) $$E = -\frac{dV}{dx}$$

and for the work A which is to be done by the electron:

2) $$dA = \varepsilon\, E\, dx = -\varepsilon \frac{dV}{dx} dx$$

Integrating, we obtain

3) $$A = \varepsilon \int_{-\infty}^{+\infty} \frac{dV}{dx} dx$$

We now introduce the space charge $\rho$, applying the Poisson equation;

4) $$\frac{d^2V}{dx^2} = -4\pi\rho$$

Substituting

$$\frac{dV}{dx} = \int_{x=-\infty}^{x=x} \frac{d^2V}{dx^2}\, dx = -4\pi \int_{x=-\infty}^{x=x} \rho dx$$

in formula 3), we get

5) $$A = 4\pi\varepsilon \int_{-\infty}^{+\infty} dx \int_{-\infty}^{x} \rho dx$$

Equation 5) shows *that the work A to be done by the electron increases with increasing space charge.* Therefore, it is proved that the Einstein law, which contains as the only work to be done by the electron the retarding contact potential of the illuminated electrode, must be extended to account for the work which the electron has to do to overcome the space charge which is always present even in monochromatic light and in the best vacuum.

To account for the outcome of experiment and theory we have to *extend* the Einstein law in the form

$$h\nu - (P + A) = \varepsilon V$$

where A is the work indicated by equation 5). The extension of a law of such a fundamental importance is of a significant interest.

*Not only is the material of the cathode effective in determining the limiting potential in vacuum, as given by Einstein's law, but also the electrical state of the penetrated vacuum itself.*

The evaluation of the integral of equation 5) requires a knowledge of the distribution of space charge along the x-axis $\rho = f(x)$. This is evidently the same as the distribution of the velocity of electrons which are set free by a monochromatic ray. This distribution of electrons was measured by Ramsauer. He showed that the curves of velocity distribution for all spectral lines can be brought to coincide if the maximum velocity in the different curves is always taken as unity. If $V_1$ is any limiting potential, then K, the coordinate of the maximum, is always the same fraction of the limiting potential, and we have

$$\overline{C_o}\, V_1 = K$$

where $\overline{C_o}$ is a universal constant for all frequencies. We thus obtain as a general expression for the dependence of the number y of electrons in terms of the velocity the equation

$$6) \qquad y = f(x) = a\left(\frac{x}{K}\right)^4 \left(e^{\frac{2x^2}{K^2}} - 1\right)^{-1} = f(\rho).$$

This substituted in equation 5) gives the work to be done in overcoming the space charge, where the constant a has here the dimension of a space charge. The constants K′ and a′ refer to the coordinates on the negative x-axis.

$$5)' \qquad A = 4\pi \left\{ a' \int_{x=-\infty}^{x=o} dx \int_{x=-\infty}^{x=x} \left(\frac{x}{K'}\right)^4 \left(e^{\frac{2x^2}{K'^2}} - 1\right)^{-1} dx + a \int_{x=o}^{x=\infty} dx \int_{x=o}^{x=x} \left(\frac{x}{K}\right)^4 \left(e^{\frac{2x^2}{K^2}} - 1\right)^{-1} dx \right\}.$$

The integration of this rather complicated equation gives an amazingly simple result

7) $$A = 4\pi\varepsilon C_0 a K (K + K')$$

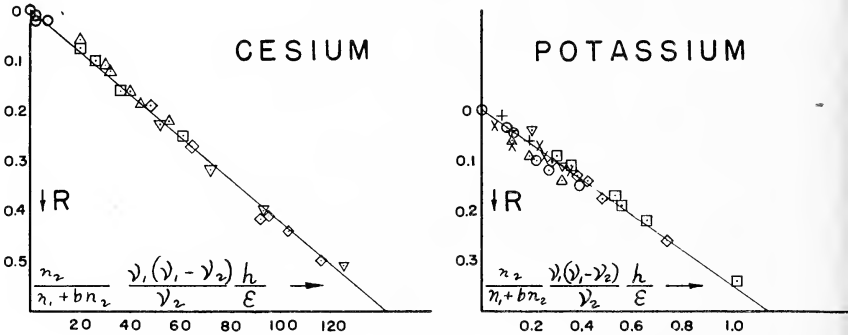
The only variables are here K and K′, the coordinates of the maxima of the space charge: outside of the electrode K, and inside of the metal K′.

I performed the experiments with the spectral lines of the mercury arc. A double monochromator provided for collecting the dispersed lines which illuminated the electrode in varied intensity always at the same spot of the electrode. The law for the falling-off effect of limiting potential, if two frequencies are effective, gave the result:

8) $$R = c \frac{bn_2}{n_1 + bn_2} (\nu_2 - \nu_1) \frac{\nu_1}{\nu_2} \frac{h}{\varepsilon}$$

Here c and b are constants conditioned by the experimental arrangement, h and $\varepsilon$ the known universal constants, $n_1$ and $n_2$ numbers of electrons set free by the two beams of the frequency, $\nu_1$ and $\nu_2$.

The law is independent of the four variables $n_1$, $n_2$, $\nu_1$, $\nu_2$ and of the material of the illuminated *alkali* electrode. The graphs of Figure 2 show the slope of the falling-off effect for a wide range of varied parameters, frequency and intensity.




| ALL WAVELENGTHS IN ÅNGSTROM UNITS | $\lambda_2$ / $\lambda_1$ | 4358 | 4916 | 5461 | 5770-5791 |
|---|---|---|---|---|---|
| | 4047 | ⊙ | + | ◇ | ▽ |
| | 4358 | | X | ⊡ | △ |

Fig. 2—Falling-off Effect of Limiting Potential for Cesium and Potassium

It scarcely looks at first sight that this empirically found law (equation 8) is the same law as given by equation 7) as the result of the integration of the differential equation laid down by the theory. But despite the dissymmetry of the empirical equation, some special physical consideration shows its complete agreement with equation 7) and gives positive evidence of the correctness of applying purely potential theory to the derivation. To do this, we have to consider that every space charge near the illuminated plane electrode is effective as a quasi-condenser charged up to a certain potential and a capacity that is a function of the distance and the extension of the space charge. In equation 7), the constant a has the dimension of a charge per unit volume. It can therefore be described by the expression

9) $$a = \frac{|K_1| C}{d_1^3}$$

if $|K_1|$ is numerically equal to the x-coordinate of the maximum intensity of the velocity distribution K, but has here the dimension of a potential in volts. In this case only one beam with the frequency $\nu_1$ is incident. C is the influenced capacity of the quasi-condenser and $d_1$ the mean thickness of the space charge.

If, however, two frequencies $\nu_1$ and $\nu_2$ share the charging of the quasi-condenser, the resulting charge must be a function of the numbers of electrons set free by each of the two combined rays. Then we have

10) $$a_1 = \frac{|K_1| C}{d_1^3} \frac{n_1}{n_1 + bn_2}$$

11) $$a_2 = \frac{|K_2| C}{d_2^3} \frac{bn_2}{n_1 + bn_2}$$

After calculating the difference in the work done by the electron without a combined ray, and with it, we obtain, after transformation given by the relations between C, d, K and V,

$$\Delta A = R = \text{const} \frac{\nu_1 - \nu_2}{\nu_2} \frac{bn_2}{n_1 + bn_2}$$

exactly the empirical result in agreement with the mathematical derivation.

III.

The continuation of this investigation which is now in progress at the Department of Physics of Trinity University has been made possible by a grant from the Primrose Fund of the American Philosophical Society. The new research is dealing with the influence of the polarization of the monochromatic light on the falling-off effect of the limiting potential. A second question opposite in principle will be investigated with the arrangement used for the first after having decided the first question. The investigation of the influence of polarization of light is disposed in the following way:

*The falling-off effect:*

1, a) If the incident ray of higher frequency is polarized, and the combining ray of lower frequency is not polarized.

b) If the state of the two merged rays is exchanged.

c) If both components of the ray are polarized.

The second investigation is to be based upon the realization that the space charge is in a dynamic equilibrium, because the electrons in the space charge are partly in motion vertical to the plane photoelectrode in both directions. It appears desirable to investigate:

*The influence of space charge;*

1, a) On the polarized ray itself if it does not touch the electrodes, but only passes the space charge.

b) On the limiting potential if only the space charge is irradiated by polarized light, and the photoelectrode itself is not touched by polarized light.

Of course, it has to be taken into consideration that the direction of the electric vector in the polarized ray will have the known influence on the photoelectric effect. But such an effect is not the content of our investigation. It is rather evident from equation 7) for the work necessary to overcome the space charge that, if the distribution of velocity of the electrons building up the space charge is changed by the influence of polarized or unpolarized light, then also the limiting potential is submitted to change, for the distance of the maximum of space charge at the coordinate K influences the decreasing effect of limiting potential proportional to the square of K.

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**Other papers listed on the programs of meetings**

1. Chemistry and Chemical Warfare in Civilian Defense Work. F. W. Jessen, Humble Oil & Refining Company, Houston.
2. Magnesium, Its Sources and Physical and Chemical Properties. Paul Weaver, Gulf Oil Corporation, Houston.
3. Construction and Calibration of a Gamma-Ray Spectrograph. Charles Mandeville, The Rice Institute, Houston.
4. Reaction of Phenylmagnesium Bromide with Cylic Acetals. B. A. Nelson, Baylor University, Waco.
5. Heat Absorbance of a Two-Layer Interior Wall. S. S. Share, A. & M. College, College Station.

# SECTION II: BIOLOGICAL SCIENCES

DR. W. G. HEWATT, Chairman

Dr. C. S. Smith was elected chairman for 1943.

## ABSTRACTS

**Spring-Flowering Plants in the Vicinity of Nacogdoches**—ROY ADAMS, Stephen F. Austin State Teachers College. The pine-oak forest region of East Texas abounds in spring-flowering species of plants. These plants are represented in very early spring by bluets, crow poison, spring beauty, spring cress and violets, followed by numerous others that color the hillsides and woodlands until the usually dry summer limits the number of species.

Three hundred and nine species of the spring-flowering plants, exclusive of grasses and sedges, in the vicinity of Nacogdoches, have been collected, identified and recorded in the Stephen F. Austin State Teachers College Herbarium. This collection resulted from collections made by the writer and his advanced students. Identifications were verified by recognized authorities.

These plants represented 76 families and 178 genera. While far from complete, this list of species will be of value to botany students in this region.

**The Effect of Long to Short Day Transfer on Onion Bulb Formation**—VICTOR A. GREULACH, University of Houston, Houston, Texas. Garner and Allard[1] and various other investigators have found that onions will usually form bulbs only under long photoperiods. Magruder and Allard[2] tested a large number of varieties of onions and found that all formed bulbs only under photoperiods of 12 hours or more, except that 10% of the Yellow Bermuda plants formed bulbs under 10 hour photoperiods. Thompson and Smith[3] found that not only long photoperiods, but also temperatures above 60° F. were essential for bulb formation. Since Hamner and Long[4] have reported that tuberization in *Helianthus tuberosus,* which initiates tubers only under short photoperiods, continued after long photoperiods had been substituted for short ones, the writer attempted to determine whether a similar after-effect might exist in regard to onion bulb formation.

Seeds of White Portugal onions were planted directly in porous clay pots on June 14 and were kept under nine-hour photoperiods until June 18, by which time most of the plants had emerged. The plants were thinned so as to leave only plants as uniform as possible, and all plants appearing after this time were removed. On June 18, all but 10 plants were transferred to the naturally long photoperiods. The following day one set of 10 plants was returned to short photoperiods, this being repeated for 25 consecutive

[1] W. W. Garner and H. A. Allard, Jour. Agric. Res., 23:871-920, 1923.
[2] R. Magruder and H. A. Allard, Jour. Agric. Res., 54:719-752, 1937.
[3] H. C. Thompson and O. Smith, Cornell Agric. Expt. Sta. Bull. 708, 1938.
[4] K. C. Hamner and E. Long, Bot. Gaz. 101:81-91, 1939.

days. One group of 10 plants was retained under long photoperiods until the close of the experiment on August 23, a period of 70 days. The long photoperiods were kept at a minimum of 15 hours by supplementing the natural photoperiod with Mazda light. The temperature during the experiment ranged between 60° F. and 90° F. On August 23 the plants were harvested and the maximum diameter of each plant in the bulb region was determined by means of calipers.

None of the plants returned to short photoperiods after exposure to long photoperiods was enlarged in the bulb region. These averaged 4.7 mm. in diameter as compared with 4.4 mm. for the plants retained continuously under short photoperiods. All plants retained under long photoperiods formed bulbs, ranging up to 17 mm. in diameter and averaging 11.2 mm.

It is evident that there is no photoperiodic after-effect, insofar as bulb formation is concerned, in the White Portugal onion even after exposure to as many as 25 long photoperiods. The inhibition of bulb formation by short photoperiods is evidently complete.

**The Ineffectiveness of Localized Short Photoperiods in Inducing Dormancy**—VICTOR A. GREULACH, University of Houston, Houston, Texas. Moskov[1] has reported that trees subjected to short photoperiods during the summer became frost resistant, and that even localized short photoperiods applied to the stem tips were effective. It has been established that leaf abscission in many species of trees will be delayed by placing them under long photoperiods in the autumn, and Kramer[2] has found that *Liriodendron tulipifera* and several other species of trees became dormant sooner than the controls when placed under short photoperiods in the summer. Previously, Garner and Allard[3] had conducted similar experiments on *L. tulipifera, Rhus glabra,* and *R. copallina.* When placed under 10 hour photoperiods in the summer, these plants developed an unthrifty appearance and ceased growth, and their leaves became dark green, lost moisture, and assumed evergreen characteristics, but leaf coloration, abscission and dormancy failed to occur. They suggested a gradual decrease in the length of the photoperiods might be necessary to induce leaf abscission.

In an effort to determine the influence of localized short photoperiods on leaf abscission and dormancy, the writer conducted experiments on medium sized trees of *Liriodendron tulipifera* and *Ulmus pumila* and on *Rhus canadensis* at Columbus, Ohio.

Quart-size cylindrical cardboard cartons such as are used in packing dairy products were painted black inside and aluminum outside. The lid was slit to a small circular hole in the center made to accommodate the stem. The slit was fastened together with adhesive tape, and the lid was held in position on the stem with plastic clay, this serving also to make the assembly lightproof. With the lid in position permanently, it was then possible to regulate the photoperiod on the stem tip by fitting the carton into the lid or removing it. The length of the stem which could be dark-

[1] B. S. Moskov, Planta, 23:774-803, 1935.
[2] P. J. Kramer, Plant Physiol., 11:127-137, 1936.
[3] W. W. Garner and H. A. Allard, Jour. Agric. Res., 23:871-920, 1923.

ened was 20 cm. in the elm, 5 cm. in the tulip tree and 17 cm. in the sumac. The number of leaves darkened was about 6 in the tulip tree and 10 to 12 in the other species. Thirteen cartons were used on each species. The experiments were begun on July 10, when the photoperiod including effective twilight was about 15½ hours. On that date the photoperiod was reduced to 15¼ hours, and each successive day the photoperiod was further reduced by 15 minutes. By July 29 the photoperiod had been reduced to 10½ hours and was maintained at this figure until the end of the treatments on August 21. The development of the branches was compared with that of untreated branches, and regular measurements of the amount of growth were made.

No observable significant differences existed between the treated and untreated branches, or between the treated trees and others. Since neither the effects observed by Garner and Allard nor those observed by Kramer were evident it appears that in the species tested localized short photoperiods are ineffective in inducing leaf abscission or dormancy, at least under the conditions of this experiment.

***Rhizoctonia solani* Kühn and the Brownpatch Disease of Grass**—J. L. HEARN, JR., Houston, Texas. The brownpatch disease of grass is caused, not by insect infestation, but by *Rhizoctonia solani* Kühn, a fungus which probably attacks a wider variety of hosts than any other. The grass in the center first turns dark, then gradually light brown, the outer border remaining dark as the infection spreads. One spot may be 20 feet or more in diameter. The disease usually manifests itself between September and January, inclusive. The writer has not observed damage to the roots or stolons in this typical form of the disease, but found a spring and summer grass disease in which the roots died first, followed by the stolons and leaves. Of several fungi isolated only *R. solani* is known to be pathogenic and probably causes the disease.

The optimum pH for *R. solani* is 7.0, but it can develop where the pH of the soil ranges from 6.0 to 8.2. The optimum temperature range is 72° F. to 94° F. High atmospheric and soil moisture favors its development. Excessive nitrogen, particularly in the form of ammonium sulfate, appears to favor the fungus, but balanced fertilizers do not. Other factors which may favor spread of the disease are shade, high organic matter in the soil, and short photoperiods.

Fungicides which may aid in control include mercurial compounds such as Semesan, Uspulan, Corona 620, Corona 640, Germisan, mercuric oxide, mercuric cyanide, mercurous chloride, nitrate and sulfate. Westover and Enlow's formula of two ounces of mercurous chloride and one ounce of mercuric chloride in eight pints of dry sand for 1000 square feet is widely used. Although effective, these mercury compounds are dangerous to use because of their poisonous nature. Bordeaux mixture may be effective on alkaline soils. Tetramethyl thiuram disulfide, available in DuBay 1205 FF, Thiurad, and Tuads, appears to be effective when used at the rate of four ounces per 1000 square feet. Sulfur, tobacco dust, soap powders and other commonly used non-scientific applications are valueless.

Cultural treatments, which may be more effective than fungicides and should be tried first include: 1. As little watering as possible; 2. Cutting grass rather long until late summer and short during the fall and winter; 3. Using balanced fertilizer instead of nitrogen compounds alone; 4. Not adding excessive organic matter.

**The Biogeography of East Texas**—HAL B. PARKS. Stephen F. Austin State Teachers College, Nacodoches. This paper is an attempt to present a geomorphological background for the Biogeography of East Texas. The main part of the paper is devoted to the presentation of an accumulation of geological and ecological facts presented some years ago by C. C. Adams and E. W. Berry. An attempt to correlate the findings of these two scientists in terms of East Texas has been made. Emphasis has been placed on the use of the Wilcox-Sabine Uplift as a possible center or gateway of life into Central East Texas. Key Animals and Plants of the Temperate Deciduous Forest and the Southern Coniferous Forest are given in anticipation that at some later date the faunal and floral surveys can be completed and the evidence used to support the findings of this paper. The value of the paper outside of the foundational evidence is the fact that all data point toward one thing, that is, the majority of Central East Texas Biota is strictly Mississippian or the direct descendants of the life that made up "The moist Southeast Storage Zone" of C. C. Adams.

**Chemical and Bacterial Changes in Culture of Spirogyra**—R. G. UPTON, Professor of Biology, Stephen F. Austin State Teachers College. Fresh specimens of spirogyra were brought into the laboratory and placed in a large fish bowl. Changes took place rapidly. It is customary to say that these are due to change in the amount of dissolved oxygen. The following factors were observed from day to day: (1) Temperature; (2) Hydrogen ion concentration; (3) Dissolved oxygen; (4) Free carbon-dioxide; (5) Bicarbonate as carbon dioxide; (6) Normal carbonate as carbon dioxide; (7) Bacteria per cu. cm.

Summary and Conclusions

1. In specimen jars, spirogyra grow in abundance until the free $CO_2$ is taken out and part of the bicarbonate $CO_2$. Then growth fails.

2. As the growth of spirogyra increases and decreases, the dissolved oxygen correspondingly increases and decreases.

3. After the spirogyra begin to die out, the bacteria increase and the $CO_2$ increases but the growth of the algae does not return.

4. Complete dying out from lack of mineral food matter is improbable—as some was restored daily by additions of pond water to make up for evaporation loss and loss due to analysis.

5. The complete dying out of the spirogyra must be due to toxic products, either bacterial, autolytic, or to some other antagonistic cause.

6. In natural pools the volume and surface of water is relatively greater than in these experiments. Air contact adds enough $CO_2$ to keep the spirogyra growing. In turn, the growth adds oxygen to the water, which

keeps down the anaerobic, parasitic growths. In natural water, much greater dilution of toxic or antagonistic products would prevent injury to the growing spirogyra.

**Interrelation of the Cortical and Medullary Tissue in the Adrenal of *Phrynosoma Cornutum***—H. R. CHANDLER, A. & M. College, College Station, Texas. The adrenal glands of the horned lizard consist of an interlacement of the interrenal and suprarenal tissues which occur in strands of cells intertwining with one another. Even though there is intertwining, the majority of the intermediate strands (suprarenal tissue) is located in the periphery of the adrenal with a relatively smaller number of them located deep within the tissue. The arrangement of the tissue strands of the adrenals of *Phrynosoma* is similar to that found in the higher reptiles and in birds.

Histologically, the adrenal glands of this lizard present a transitional condition between that found in Amphibia and that in Mammals. Amphibia are the first in which the interrenal and suprarenal tissues are found in one body. In more primitive forms, they are isolated separately. In the amphibian, the cortex is composed of suprarenal tissue, and the medulla is composed of interrenal tissue. This relationship is just opposite to that found in mammals, wherein the cortex and medulla are compsed of interrenal and suprarenal tissues, respectively. It seems that this transitional condition, which is begun here in this type of lizard, is continued in birds and the change completed in mammals.

**Speciation in Drosophila**—L. E. ROSENBLAD, University of Houston, Houston, Texas. A general discussion of speciation problems encountered in the animal kingdom as a whole and a consideration of these problems in the light of present-day findings among members of the genus Drosophila and closely related genera. The evidence presented in the fields of cytology, ecology and experimental genetics is interpreted in connection with the reproductive tract characteristics. Internal and external characteristics (both morphological and physiological) are considered as a basis for making taxonomic groupings among the lower categories. An analysis is made of the literature dealing with the isolating mechanisms which operate in the development of distinct species among natural populations.

The following conclusions are made:

1. New species are constantly being produced in nature as a result of gene mutations becoming perpetuated among the members of a group and also by new combinations resulting from chromosome aberrations.
2. Geographical barriers, sexual incompatibility, physiological (mechanical) impediments, and psychological factors act as isolating mechanisms in the formation of distinct populations.
3. Both internal and external characteristics must be studied to determine genetic relationships, but the present findings indicate that the reproductive tract characteristics are more reliable in that they seem to control whole series of other morphological character expressions.

4. Reproductive tract traits in one sex of a species seem to be altered so as to correspond to changes in the other sex; this is noted especially in the ventral receptacle and testes modifications.

**Some Experimental Studies on Pain**—R. M. MOORE AND E. L. PORTER, From the Departments of Surgery and Physiology, The University of Texas Medical Branch, Galveston, Texas. In some nerve injuries, the wound apparently heals completely, but there follows a gradually increasing and often uncontrollable pain lasting weeks or months. The condition is known as causalgia or thermalgia because the pain is spoken of as burning. There is some evidence that this condition is due to, or is at least aggravated by, a reflex disturbance of the blood supply to the limb.

Without causing conscious pain we have imitated this condition and experimented upon it by using the "Spinal Cat", in which the brain is destroyed and the spinal cord alone left. In such an animal, if the toe pad is pricked the leg is drawn up reflexly. A shock to a nerve does the same. To make the study quantitative, we have stimulated the posterior tibial nerve by a measured electric shock every 3 seconds and have recorded the reflex contraction of the tibialis anticus muscle near the threshold While this is being done, a ligature previously placed around the femoral artery is pulled tight, thus shutting off the blood supply to the limb. In about 2 minutes the contractions rise markedly in height. This is due to summation of stimuli, for if the shocks are not given the muscle is perfectly quiet. If the ligature is removed from the artery the contractions usually diminish to their original height after a few minutes. The same summation may be observed if instead of cutting off the blood supply a stimulus is given which would certainly cause pain in the conscious animal, such as application of a few drops of boiling water to the skin of toes or knee.

These experiments suggest the possibility that the pain of causalgia may be a summation phenomenon in which interference with the blood supply of the affected limb may play a part.

**Possibilities in the Utilization of Aquatic Invertebrates**—S. H. HOPKINS, A. & M. College of Texas, College Station. Aquatic invertebrates are important for food, for shell and pearl products, and for vitamins and minerals. Nearly all marine and freshwater invertebrates of sufficient size and abundance are used for food somewhere in the world. In the United States, oysters produce 100 million pounds of meat worth $9,000,000 to the fisherman; shrimp yield 100 million pounds worth at least $3,000,000, and crabs produce 90 million pounds worth over $2,000,000. In addition, some $5,000,000 worth has until now been imported from Japan. Several species of clams and scallops are also important for food, and many other invertebrate species could be utilized. Freshwater clams have yielded shell products worth $6,000,000 annually in addition to pearls formerly worth $300,000; marine shell products have been worth $6,000,000; the most important shell products are buttons and "pearl" novelties, but much shell is also used for poultry feed and agricultural lime. The United States uses annually 3 million gallons of cod-liver oil for human and animal nutrition, of which all but 300,000 gallons has been imported from countries now cut off by war; the vitamins of codliver oil, A and D, can be obtained from sea mussels, snails, and probably other marine invertebrates; more research is needed immediately on invertebrate sources of vitamins and their utilization. Sea foods, particularly invertebrates such as molluscs and crustacea, are the best sources for iodine and some other "mineral" elements needed in human diet. The production of marine invertebrates and their products could undoubtedly be developed to many times the present extent in Texas by scientific methods.

**Fetal Placental Relations at Birth**—JOHN G. SINCLAIR, University of Texas, Medical Branch, Galveston, Texas. Any factor affecting the birth rate and character of the infant at birth is of public health significance. Death during gestation or at birth is due to numerous causes classifiable into genetic and congenital. Control of the former is eugenic and of the latter therapeutic. Both are expressed through mechanisms which are represented both in the fetus and in the placenta and membranes. The normal relation between placenta and fetus leading up to birth was studied in 1200 successive births in Galveston Hospitals in 1939 and 1940. These have been supplemented by study of all unusual groups that could be found since then and from collections made in previous years.

In infants at full term there is an average relationship between the placental weight (minus membranes) and the birth weight under standardized methods of technique so that the ratio P/I is relatively constant in normal uncomplicated births of normal infants. Premature infants show a low ratio of placenta to infant. Multiple births are all premature and fall into the same class. Overweight babies generally have a high ratio and may also show thyroid difficulties. Congenital defectives are generally underweight and have small placentas, but the ratio is high even when they are premature. Certain types of defects involving blood cell production appear in normal weight infants with very large placentas. Therapeutic abortions for hypertension have yielded a number of fetuses with defects of the limbs. Most normally aborted embryos are found to be defective grossly. The most important early defect involves the vascular system.

The proportion of these defects which are genetic compared to those which are congenital and subject to therapy is not known. The indications are that most of them represent incompatible genetic systems. Infants are not genetic images of their mothers and their defects and birth difficulties may be due to factors passing the placenta. In this case therapy may bring some of them to term. The wisdom of this is subject to investigation. A study of the microscopic sections of cords, placentas and fetuses is continuing and experimental work on the causes of simple prematurity is planned.

**The Biologist and the War**—WALTER P. TAYLOR, Texas Cooperative Wildlife Research Unit, College Station, Texas. As Governor-elect Warren of California has said in substance, "Battles are won in the field, wars are won on the home front." Of importance in a balanced war program, on the home front, are: (1) Conservation and wise use of basic natural resources (minerals, soils, waters, vegetation — range forage, crops, forests — wildlife and human life), (2) maintenance of morale, and (3) production and conservation of trained workers, scientists, and leaders.

On the biologist rests an unusual responsibility and opportunity to help, especially in fields such as public health, biological control, conservation of organic resources, land use, human ecology, nutrition, agriculture, recreation, biological research, post-war biological adjustments.

The materials with which the biologist deals are the organic resources. Economic products derived from vegetation apparently are better known than those from animal life. A catalog of some products of the latter indicates their very considerable variety and importance. Some of these animal products are food, vitamins, fertilizer, leather, fur, textile fabrics, felt, pharmaceuticals, ivory, bone, horn, hoof, hair, bristles, wood, gelatine, glue, oils, pigments (for soaps, paints and varnishes), fats, perfumes, coloring materials, chemicals, meals, spermaceti, glycerin, baleen, quills, baskets, eggs, feathers, down, musk, tortoise shell, shagreen, isinglass, ornament, scales, artificial pearls, eel skins, pickled eggs, honey, wax, silk, insect wings, blistering preparations, lac, manna, galls, ink, nacre, shell. The economic relations of animals and plants are various, requiring technical knowledge if man is to keep them properly in hand.

Since all machinery and technical equipment, all food and shelter, come from the basic production resources, all necessary attention should be given to their conservation.

In any sort of biological enterprise it is probably best to follow Nature's ways, to cooperate to the fullest extent practicable with Nature's laws. Furthermore, the integrated ecological approach is the only one adequate to the need for a close-knit, unbeatable organization whether in war or peace.

The States and the Nation have invested time, energy, and millions of dollars in conservation of wildlife. It is important not to permit the resources involved to become depleted by default, even in the present unlimited emergency.

In the interest of conservation of foodstuffs and a variety of materials, increased control efforts are being devoted to the brown rat, most dangerous mammal in the world.

Just as patent laws must be revised in wartime so as not to impede the war program, so legislation dealing with all the natural resources should be re-worked and simplified in the light of available scientific information.

The objectives of land use planning, which aim to suit the crop to the land rather than the land to the crop, and to adapt the land to that use which will benefit the largest number of people over the longest time, were never more important.

Proper recreation is desirable in peace time, vital during wartime. From this angle it is more important than ever to provide for wildlife conservation and the preservation of Nature.

Maintenance of trained technical leadership, an adequate professional group, and an enlightened citizenry is also of first importance in wartime. Thus a realistic education should be emphasized in the present emergency throughout the nation.

For some reason, difficult to explain, the United States has never been fully "sold" on the value of scientific research. Yet our entire industrial civilization is based on research; and in agriculture the economic returns " . . . so far as they can be measured, are very large, now amounting to more each year than the entire expenditure for all the work of the department (U. S. Department of Agriculture) and these colleges (the land grant institutions in each state) from their foundation to the present time." Numerous insistent questions of importance in connection with the wartime conservation and use of fish and game resources continue to press for solution. Biological and other research is believed to be of greater importance at present than at any previous period in the Nation's history.

The difficult period of post-war adjustment will require biological information and cooperation.

While building the Nation's military might, the basic production resources should not be neglected.

**A Comparison of Some Dehydrating Agents on Plant Tissues**—MARTHA B. CAYTON AND JOHN A. YARBROUGH, Baylor University, Waco. Ethyl alcohol-xylene, normal butyl alcohol, tertiary butyl alcohol, and dioxan were used as dehydrating agents of F.A.A. fixed material to determine the best method or methods of dehydration for the leaf of *Elodea canadensis* and the stem of *Petunia hybrida.* Living cells of both tissues were carefully compared with dehydrated ones previous to paraffin infiltration. This could be accomplished by direct observation on leaves of *Elodea* and by use of freehand sections of petunia stem. Material was also infiltrated, embedded, sectioned and stained in the usual manner.

Normal butyl alcohol caused the least amount of shrinkage and cell distortion. Tertiary butyl alcohol gave substantially similar results. Ethyl alcohol-xylene hardened the tissue and caused the most extreme shattering during the sectioning. Dioxan caused more shrinkage and cell distortion than any other reagent. Dioxan obtained from Eastman Kodak Company was slightly superior to that obtained from Carbide and Carbon Chemical Company.

Transverse sections of embedded *Elodea* leaf and petunia stem showed more cell distortion than did the whole mounts or freehand sections. This would indicate that the greatest hazard to the tissue is probably the passage of tissues into the paraffin rather than dehydration. Acceptable fixation by F.A.A. had little effect on the cell wall or cell inclusions.

**An Apparatus for the Continuous Culture of *Chlorella***—JACK MYERS, The University of Texas, Austin, Texas. Recent work on the nature of the photosynthesis reaction has tended toward the selection of the unicellular green algae for experimental material. There are numerous indications that photosynthetic behavior depends upon the conditions under which the algae are cultured. Data presented show that for *Chlorella pyrenoidosa* grown in Knops solution, the pH and nitrate concentration of the medium and the maximum possible rate of photosynthesis per cell undergo marked changes during the growth curve. In order to maintain constant conditions, it is necessary to devise a method of stabilizing growth at some one point on the growth curve. To this end a continuous-culture apparatus has been constructed. By means of a photoelectric nephelometer, relay, and solenoid valve, fresh nutrient solution is automatically added to a growing culture at such a rate that the density of population of the algae remains constant. Growth is thus stabilized at a point or very short segment of the normal growth curve. Data presented show that density of population of an algal suspension in the continuous culture chamber was held constant (within the experimental error of counting with a hemocytometer) over a six-day period.

This project is being conducted in collaboration with Mr. L. B. Clark of the Division of Radiation and Organisms of the Smithsonian Institution.

**The Effect of Gravity on the Electrical Correlation Pattern in the Coleoptile of Avena Sativa**—A. R. SCHRANK, The University of Texas, Austin. This investigation is based on the concept of electrical cell correlation and was carried out to verify the previously observed details of the electric correlation pattern in the *Avena* coleoptile, and to determine how this pattern changes when the position of the coleoptile with respect to the force of gravity is changed. An apparatus that makes possible the manipulation of the electrode contacts over microscopic distances and the changing of the coleoptile from the vertical to the horizontal position, without changing the vertical position of the electrodes, was used.

The experimental results show that the observed changes in E.M.F. originated in the *living* coleoptile and that these changes are not caused by mechanical stimulation of the plant nor by variations in the measuring instrument. The results also indicate that there are specific transverse responses, namely: the under side becomes positive to the upper side when the plants are placed in the horizontal position. Further experiments show that these transverse responses are strongest in the apical region of the coleoptile, and that they are the result of two concurrent, oppositely oriented, radial responses. The longitudinal electrical polarity of the coleoptile in the horizontal position at first decreases and later increases. The results of numerous experiments indicate that the entire correlation pattern of the coleoptile changes as a unified whole when the coleoptile is placed in the horizontal position. These electrical changes take place long before any growth curvatures or differences in hormone concentrations can be detected, and they cannot be described as streaming potentials.

**A Collection of Biology Pictures for the Opaque Projector**—VICTOR A. GREULACH, University of Houston, Houston, Texas. The value of the opaque projector in the biology classroom and laboratory can be increased greatly by making a collection of biology pictures to use with it. This involves considerable work but is the least expensive method of acquiring a comprehensive set of biology pictures for projection. Our collection of some 3,000 pictures at the University of Houston has cost about $45, practically all of this being for mounting cards. The pictures cover every phase of pure and applied botany and zoology and include almost every topic we might wish to illustrate, at least in our general courses.

The pictures were cut from old magazines, textbooks, laboratory manuals, government publications, and biological supply catalogs, the best sources being the National Geographic Magazine, Life, freshman biology texts, and the Turtox, Triarch, and Ward catalogs. Colored pictures published by the U. S. Department of Agriculture and original drawings and photographs completed the collection. The collection of photographs for sale by Turtox is another possible source of pictures.

After classification and elimination of duplicates, the pictures were mounted on 8½" x 11" cards cut from dull black cover stock thick enough so the heat of the lantern would not cause it to buckle. Ordinary good library paste and mucilage are satisfactory adhesives but must be applied to the entire surface of the picture. The dull black surface of the cards reduces the reflection of unnecessary light to a minimum, and the cards are large enough to mount any pictures suitable for projection. The pictures are filed in steel filing cabinets by subject.

Such a collection of pictures is valuable, not only for projection, but also for direct examination or study and for bulletin board display. Samples of the pictures were projected at the meeting of the Biological Sciences Section.

**Vitamin A Potency of Commercial Butter Sold in Texas**—A. R. KEMMERER, Texas Agriculture Experiment Station, College Station, Texas. Thirty-two commercial butters collected at different seasons of the year were analyzed for carotene and spectro vitamin A and the vitamin A potency calculated in International units. The average vitamin A potency was 38.7 International units per gram, and the variation between samples was from 20.7 units to 52.6 units. The season of year had no effect on the average vitamin A potency of the butter sold. The annual per capita consumption of 17.6 lbs. of butter affords 850 International units of vitamin A potency daily for each person in the United States or one-sixth of the daily requirement.

**Relative Value of Carotene in Different Foods for Storage of Vitamin A in Livers of Rats**—W. W. MEINKE AND G. S. FRAPS. The carotene and vitamin A in the 10 foods studied had widely varying relative values for storage of vitamin A in livers of white rats. Using the quantity of spectro vitamin A stored in liver from carotene dissolved in oil as 100, raw beef liver had a value of 163, butter fat a value of 140, turnip greens 8, dried apricots 10, baked sweet potatoes 11. Canned pumpkin and raw carrots had equal values (19). Cooked carrots and boiled dried apricots had good values of 27 and 49. The addition of oil to the basal ration and also its addition to the supplement before feeding caused an increase in the utilization of the carotene for liver storage. There was an increase in liver storage with an increase of oil in the basal ration up to 10% of oil. Addition of 20% of oil to the basal ration failed to increase the value above that of 10% of oil. Oil, when added to the baked sweet potatoes before feeding, gave values of 16.6 for 0.1 cc and 23.4 for 0.2 cc compared with 10.3 when no oil was added.

**The Crab Fishery, with Suggestions for Its Improvement in Texas**—SEWELL H. HOPKINS, A. & M. College of Texas, College Station, Texas. The crab industry based on the blue crab, *Callinectes sapidus,* produces about 90 million pounds annually, two thirds of which comes from the Chesapeake Bay region, while the Texas production is only a fraction of one per cent. of the total. In the Chesapeake Bay, the crab fishery is divided into two rather distinct parts, the hard crab industry and the soft crab industry. Hard crabs are caught by several different gears: hand dip nets, crab pounds or traps made of chicken wire, crab pots, dredges, hand trot lines, and trot lines operated with "patent rigs." Hard crabs are mostly cooked in steam pressure cookers in packing houses, where the meat is picked out and packed in cans. Soft crabs are caught by hand, by dip nets, and by crab scrapes towed over shallow grassy bottoms by small boats. "Peelers," hard crabs about to shed, are bought by crab shedders and kept in large floats until they shed; the newly-shed soft crabs are shipped alive, packed in wet eel grass. It is probable that if improved methods of catching and handling crabs were adopted, Texas might develop a crab industry comparable to that of the Chesapeake Bay region.

**Forest Conservation Education in the Public Schools**—PAUL W. SCHOEN, Chief, Division of Forest Management, Texas Forest Service, A. & M. College, College Station, Texas. Forest conservation education is not a new subject in the public school curriculum of Texas. The textbooks in current use throughout the state contain a great deal of material not only on forestry but on all phases of conservation of natural resources. Any weakness in the educational program has been in the emphasis placed on the subject more than in a lack of teaching material.

State Superintendent of Schools Dr. L. A Woods always has fully supported conservation work and has favored a more effective program of instruction. Therefore, realizing that sufficient progress was not being made, especially in view of the present war emergency period, Dr. Woods selected "Conservation" as the theme of his annual conference of administrators and executives which was held during January, 1942. A number of committees was appointed, each to prepare a three-point presentation. The points to be covered were, first, to furnish specific facts on that field of conservation to which the committee was assigned; second, to work out emergency education plans; and third, to point the way to a constructive program of education in that phase of conservation and the better use of that particular natural resource.

Among the committees appointed was one on forest conservation headed by Dr. A. W. Birdwell, who recently retired as president of Stephen F. Austin State Teachers College. This committee, like the others, prepared and presented a program that was well received by the conference group. In order to make use of the suggestions presented, Dr. Woods requested the committees to continue to function in preparing a definite teaching plan for practical use in the public schools of Texas.

Speaking especially for the forestry committee, this assignment was accepted as a serious challenge to make a worthwhile contribution to conservation education. Meetings of the committee were held, methods of work were adopted and specific assignments were made to committee members.

Without detailing each step in the preparation of the outline for teaching forest conservation which has grown out of the work of the committee, it is significant to note the policies followed by the committee. First of these was that the teaching outline should not be presented as a separate subject but should be correlated to the subjects now forming a part of the curriculum. Using this as the basic approach, it was further decided that forest conservation should be integrated with all subjects, in all grades, and should be usable throughout the entire state. The final policy was to make the teaching as easy as possible by furnishing page references to material found in texts adopted for state use and to supply a series of sample lessons in different subjects and on each grade level.

As the teaching outline took form, the question of its use came to the front. The decision made on this point was in favor of the experimental use of the course in approximately one hundred schools distributed over the entire state and with a more comprehensive test by using all of the schools in one or two selected counties. In general, the cooperating schools were located in the vicinity of a teachers training institution so that they might have the assistance of that institution as well as that of a deputy state superintendent of schools. Also, it was decided to use four distinct types of schools in each test area, namely: the city school system, the consolidated system, the rural school and the one or two teacher school.

With the teaching outline compiled and the mechanics of operation set up, the 1942-43 school term was the signal for starting the actual test of the material prepared by the forest conservation committee. While to the present time only favorable comment has been received, no conclusions will be formed until the end of the school year. Then, it is planned to draw from the experiences of the teachers that used the course those constructive criticisms which will permit a revision of the teaching outline on a more permanent basis for use in all the schools of the state.

Looking into the future, this course is only the starting point. For example, the vocational agriculture classes need a semi-technical forestry course as compared to this academic course. Such a course has been outlined for East Texas but needs expanding to include work for other sections of the state. Also, in training new teachers in our colleges a conservation course is needed as preliminary to better teaching of the subject.

Thus, while it is believed that although the forest conservation teaching outline as now being used experimentally is a real step forward toward the adoption of conservation as an essential in the educational program of the public schools, it is only one phase of the activity. The final step will be the adoption and general use of a unified teaching program of conservation in which neither forestry, soil, water nor wildlife will dominate, but each will be presented in relation to the other, and each will be emphasized in relation to its local importance and significance.

**A Review of the Revision of the Subgenus Pycreus in North and South America**—SISTER MARY LUCY CORCORAN, Incarnate Word College, San Antonio, Texas. The work done at the Catholic University of America on the genus Cyperus was briefly outlined and the method and a few of the results of a detailed study of the subgenus Pycreus discussed. The study was based on the examination of over 10,000 representative specimens borrowed from forty-two institutions. The complete revision of Pycreus has been published and is No. 37 in the list of Contributions from the Biological Laboratory of the Catholic University of America.

**A Proposed Manual of the Woody Plants of Texas**—ROBERT A. VINES, Houston, Texas. The great size of Texas, together with its diverse soil and climatic conditions, promote the growth of a rich and varied flora. Because of the large number of species of plants in the state, no complete botanical manual has yet been published. The enormous amount of field work and research necessary for the preparation of such a project could not be adequately accomplished by any one person but should be a work fostered and promoted by some group of persons or some institution.

However, it is conceivable that one person could undertake to publish a volume on some distinct part of the vegetation, such as the woody plants of the state which comprise approximately six hundred and twenty-five species. This project has, in fact, been undertaken by the writer. Such a work is meant to include all of the species of trees, shrubs, and woody vines native to Texas. It was estimated at the beginning that the task of collecting, describing and having illustrations prepared for this number of plants would require about eight years of work. This estimate has been correct thus far, because after three years of effort the writer has the task about one-third completed.

In the preparation of the manual many difficulties have been encountered. First, it was found that existing notations and descriptions concerning the Texas species are many times incomplete and unreliable. Some books were even found to be contradictory, and many records are found in old botanical journals which are difficult to obtain.

Secondly, confusing differences in nomenclature are always present in this type of research work. The International Rules of Botanical Nomenclature are being followed, and the occurrence of the species is based on the known distribution of the plants of Texas as recorded in "Catalogue of the Flora of Texas" Bulletin No. 550; A. & M. College of Texas. In some cases, the number of species in the genera is not complete. Typical examples of incomplete and confusing genera are *Crataegus* and *Quercus*. Estimates on the number of haws in Texas run all the way from thirty to fifty species, and the information on the oaks is far from satisfactory. It is hoped that the manual will clarify some of these botanical enigmas.

A third problem consists in the separation and inclusion in the manual of plants which are barely woody. The inclusion of plants which are suffrutescent, or suffruticose, presents an ecological problem. Some plants are barely woody in the northern areas of their distribution but become truly fruticose toward the south. To insure completeness of the manual, a number of these border line species has been included.

In order to ascertain the quality and utility of the illustrations being prepared for the manual, a number of lectures were given, and several hundred of the drawings were put on exhibition. Everyone who saw the drawings expressed admiration for their scientific accurateness and authenticity.

It is hoped that the preparation of this complete manual of the woody plants of Texas will be supported by all the patrons of botanical science in Texas, and that the manual will fill an urgent need and encounter a popular reception when it is completed.

**A Fisheries Program for the Texas Coast**—GORDON GUNTER, Game, Fish and Oyster Commission, Rockport, Texas. The commercial salt water fisheries of Texas produce between 17 and 22 million pounds of seafoods a year. The edible catch of sport fishermen is probably about 3 to 5 million pounds. Marine resources are subject to depletion and there must be administrative control of salt water fisheries. In Texas, this control is in the hands of the Game, Fish and Oyster Commission. Fishery administration in this state is not as effective as it should be. A long-range program must be put into operation.

The coastal environment should be maintained in the natural state. All pollution should be stopped. The activities of mudshell dredges in the bays should be supervised. The problem is connected with erosion and drainage of the hinterland. Rapid silting of inner bays is taking place, which damages oysters and other marine life and lowers general fertility of the bays. Drainage districts have brought about quick run-off, so that today it has more of a seasonal aspect than usual, coming largely in the spring. This situation has had a great deal to do with a decline of Texas' oyster production since the peak year, 1904. Permits to cut channels and canals and put up docks and other constructions are granted only on a basis of their effect on navigation. The possible deleterious effects of these changes on currents and other characteristics of coastal waters should be examined. These uncoordinated activities must be coordinated. The only alternative is to accept with complacency the progressive decline of the natural environment of the Texas Coast.

Effective control of fisheries is based on enforcement of various laws. Education is helpful, but not all people are morally responsible, and for that group strict law enforcement is the only answer. Law enforcement can only be misdirected energy if the laws are inadequate. Therefore, a rather complete biological knowledge of marine life is a necessity.

Marine fishes cannot be artificially raised and the matter must be approached from the aspect of a wildlife crop. We must attain that stage of knowledge whereby we can reap an average yearly production, which is all the traffic will bear, but not more.

The general hydrographic features of Texas coastal waters must be known. Mr. Albert Collier has conducted a hydrographical study of the Aransas Bay area, which is typical of the Texas Coast, and his work will serve as a basis for future biological research. The writer's work in the same area is a second step. It has been a monthly ecological survey of the fishes and crustaceans carried on by fishery methods, including total length measurements. Thirty-one stations were visited over a salinity gradient from near fresh water to pure sea water of the Gulf. The fish population was sampled by every available means. The hydrographic and ecological study will serve as a background for intensive life history study on the more important species. The life history studies will comprise the third step in this program. Here we come to the place where the work can no longer be done by one biologist in any reasonable length of time. The third step merges with the fourth and final step, which is gathering of rather complete information of the size and composition of the population of important species and their variations from time to time. It is possible, by knowing the amount of fish present following the success of various spawning seasons and by knowing the rate of growth, to predict how much will be available in the future. When this point is reached, we shall have adequate knowledge and all work done can serve only as an approach to it. This is the goal of fishery research. Until we reach it, fishery administration will not be adequate on the Texas Coast. Coastal fisheries yield wealth to this state. An adequate fraction of this money should be ploughed back into the industry in the form of a research program which will show how to care for and insure continuation of Texas coastal fisheries at the highest possible levels.

**The Physiology of the Rumen Protozoa**—R. E. HUNGATE, The University of Texas. Four species of *Diplodinium* from the cow's rumen have been grown *in vitro* in a culture medium containing grass and cellulose. Three of the species, *Eudiplodinium neglectum, E. maggii,* and *Polyplastron multivesciculatum* have been obtained in sufficient numbers to permit preparation of an extract which could be tested for cellulolytic activity. A cellulase was found present in each. *Anoplodinium denticulatum* has been cultured in the laboratory but has not been present in sufficient numbers to allow direct tests for a cellulase. However, microscopic observations and cultural data are in agreement with the hypothesis that it also digests cellulose.

Since a cellulase appears in all the *Diplodinium* species tested and since the food habits of the other species are similar it is probable that all *Diplodinium* species digest cellulose. They therefore aid their host by breaking down this material.

*Entodinium caudatum* has also been grown in laboratory cultures. Tests for a cellulase are negative. This protozoan can be grown on a medium containing grass and finely ground wheat. Cellulose is not required. It seems probable that most species of *Entodinium* are unable to digest cellulose.

Microscopic observations of the numerous *Isotricha* in the rumen show that plant parts are not ingested by them. It is improbable that they digest cellulose. On the basis of these studies it seems doubtful whether *Entodinium and Isotricha* are of any aid to their host, whereas *Diplodinium* is definitely a symbiont.

**Spawning of the Shovelhead Catfish—*Pilodictis Olivaris***—PIERRE A. FONTAINE, Director, City of Dallas Aquarium and Fish Hatchery. Spawning of the Shovelhead Catfish, *Pilodictis olivaris,* was observed in the Dallas Aquarium and notes taken. This fish can be successfully spawned and the fry reared to a size to justify the effort of stocking lakes and ponds to replenish food supply and maintain a stock of sufficient size for the fisherman.

The tank in which these fish were spawned was 12 x 8 x 4 feet. The interior was prepared in a manner to simulate the natural habitat as near as was possible. Sand and gravel covered the bottom, rock ledges were arranged across the rear and old trees and tree stumps placed throughout the tank. The attempts to spawn the fish the first two years were unsuccessful as the female crushed the eggs soon after spawning was completed. After the eggs were laid the third year, the female was removed from the tank and the male hatched and reared the fry through the egg sac stage. The young were then moved to a rearing pond in the hatchery and raised to about eight inches in length; forty fingerlings weighed one pound.

The spawning behaviour of the shovelhead catfish is similar in many respects to the channel catfish, *Ictalurus lacustris punctatus,* and the brown bull head, *Ameiurus nebulosus,* which have both spawned in the Dallas Aquarium.

**Formation of Disclimaxes in the Alpine Tundra by *Thomomys Fossor***—JOHN J. SPERRY, A. & M. College, College Station, Texas. *Thomomys Fossor* is the principal agent for bringing about a disturbance in the natural vegetation in the alpine tundra on the slopes of Pikes Peak, Colorado. The climax vegetation consists of a consociation of *Elyna bellardi* and the subclimax consists of a consocies of *Carex rupestris.* The diggings of gophers begin near the timberline and may be found as high as 13,000 feet, which is roughly the limit of the large boulder fields. The areas in which the gophers dig give rise to three types of disclimax dominants. The woody dominants are *Salix sp.* and *Potentilla fruticosa.* The non-woody forb dominants include *Cirsium eriocephalus, Geum turbinatum, Potentilla rubricaulis, Campanula rotundifolia, Senecio biglovi, Potenstemon halli, Polygonum bistorta,* and *Polemonium confertum.* The non-woody grass-form dominants include *Agropyrum scribneri, Agropyrum sub-secundum, Calamagrostis canadensis, Trisetum spicatum, Poa rupicola, Poa alpina, Deschampsia caespitosa, and Carex atrata. Salix sp.* of the woody dominants and all of the non-woody grass form dominants represent an advancement in type of vegetation for that area and for the most part consist of species that seem to be palatable to herbivorous game animals. The non-woody form dominants may serve to some extent as protection for wild fowl and other small wild animals. The changes in the vegetation follow a definite sequence and revert to the climax condition when the gophers have abandoned the area.

**The Anatomy of the Inflorescence of *Polygonum Viviparum* L.***—JOHN J. SPERRY, A. & M. College, College Station, Texas. *Polygonum viviparum* produces an inflorescence containing either flowers or bulbils or both. The bulbils develop early and are followed by flowers.

The flower is perigynous, quincuncial, and diplostemonous. It has a paracarpous gynoecium with central placentation. The nectary lobes may be modified stamens. There is an abscission layer at the base of the receptacle. The vascular traces to all organs arise independently. The apiral origin of tepal traces and partially spiral origin of other traces are primitive conditions. The three dorsal traces passing through the ovary wall supply the stylodia. The vascular supply to the ovule is interpreted as the result of the fusion of the ventral traces with the ovular trace.

The bulbil is a modified stem bearing four or five leaves. The stem of the bulbil is covered with a periderm and contains much food storage tissue. The roots arise in the pericyclic region near the apical meristem. Leaves develop from a meristematic ridge which surrounds the vegetative point. The growing point is interpreted as consisting of two germ layers, a single-layered tunica and a several-layered corpus. The vascular system of the bulbil is characterized by the formation of a cylindrical collar at the vascular nodes. From this, varying numbers of traces arise. The traces increase in number in accordance with the complexity of the organ supplied.

The peduncle is a modified areal stem. It differs from the bulbil and rhizome in that it contains much schlerenchyma, cambium, secondary xylem, and a marked endodermis. An unbroken vascular cylinder is formed below the multi-lacunar leaf nodes. Emerging from this, one trace supplies the bract, two a bulbil or a flower. The normal two traces may fork to supply two flowers.

Bulbils are probably the chief means of reproduction in *Polygonum viviparum L.* Reproduction by seeds may occur to a lesser extent. There is no anatomical evidence present to indicate that a bulbil is a modified flower or the reverse, except that both structures are modified stem branches.

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## Development of Fish Culture and Fisheries in the Southwest

GEORGE E. POTTER, Department of Biology, A. & M. College of Texas, College Station.

Until recently, much of the effort spent on developing inland fishery resources in Texas has been promoted by the sportsmen. This means that our Game, Fish, and Oyster Commission, which receives most of its income and support from the sportsman, has been interested in developing fish largely for game purposes. This is as it should be under these conditions. On this account, most inland inhabitants of the state have come to think of fish and fishing as being in the realm of recreation alone. With the present need for utilization and conservation of all natural resources, as well as the completion of many ponds by the AAA and Soil Conservation Division, it becomes extremely important and timely that the land operators be made aware of the possibilities for food production by pond fish culture.

It is estimated that there are at least between 50,000 and 60,000 farm ponds in Texas which maintain water permanently and are capable of supporting fish. Few of these are provided with drains or otherwise planned for fish production ponds but, nevertheless, most of them are capable of producing some fish. With these as a beginning, it should be possible to establish the practice of raising fish as a crop to supply the family table with meat, both fresh and preserved.

Perhaps the first question arising is "would it be economical practice?" With modern methods of culture, it is fair to answer this question in the affirmative. Swingle and Smith at Alabama Agricultural Experiment Station in 1939 have shown that in ponds fertilized with 100 pounds of 6N-8P-4K commercial fertilizer, it is possible to harvest between 500 and 600 pounds of black bass and bluegill combination per acre per season. The cost of fertilizer, as used by them, was from three to six cents per pound of fish produced. The cost of labor for applying the fertilizer, transferring and catching the fish is about the only other cost, if the pond has already been constructed for water conservation purposes. This labor cost would average about three to four cents per pound of fish. Thus the total cost would range between six and ten cents per pound. Since most of the labor used in such a project would be spare time work, this cost could be eliminated in most cases. By comparison, the three to six cents per pound paid for this meat would be as cheap as any furnished by the farm.

Other fish combinations, including crappie and bullhead catfish, are likewise useful in combinations and for certain conditions. Such species as Buffalo or even carp might be used if the meat is to be canned.

In a farm-pond fish production program, provision should be made for preservation of the harvested fish. Part of the flesh can, of course, be eaten or sold fresh, but much of it should be stored. If frozen locker space is available, it is suitable for keeping most pond fish. However, cooking bony fish like Buffalo in a pressure cooker and then canning causes the disintegration of most of the bones so the flesh can be eaten readily. Several practical methods of canning fish have been published by the Fisheries

Division of the U. S. Fish and Wildlife Service under the title "Home Canning of Fish" and written by Norman D. Jarvis, and Francis P. Griffiths. The use of an ordinary pressure cooker and pint glass jars or number 2 tin cans is essential for fish canning. Salt cured fish (even gar), smoked fish, and pickled fish are being tried with success.

Selective breeding has become well established as a method of improvement of other farm live stock and it should have a place on the fish program. Selection of quality characters and size in fish has been done to some extent in goldfish but, so far as the writer knows, this has not been practised among any other fish. From the meager knowledge we have on the matter of selective breeding in fish, it seems that it may be possible to develop special, desirable breeds for different economic uses.

In the marine phase of our fisheries, the potentialities for development are even greater so far as fish proper are concerned. (The shrimp fishery which is the leading field seems to be producing about the volume to be expected at present.) The utilization of such species as mullet, Spanish mackerel and perhaps others must be brought into practice. These are valuable fish, but tradition and prejudice have kept them off the markets. Much more must be learned concerning the habits and life histories of these species.

Millions of pounds of "trash" fish are hauled in by shrimpers and fishermen and destroyed. With a little enterprise, it should be possible to establish a fish-meal and fertilizer manufacturing industry in which all of the trash fish and scraps produced in processing the marketable products of fishery could be utilized. The fish-meal which is used on all Texas poultry farms has been shipped from California. There is as much raw material for this type of product along the Texas Gulf coast as in California.

## Relative Cost of Energy, Protein, Vitamin C and Carotene in Human Foods

G. S. FRAPS, Texas Agricultural Experiment Station, College Station.

Human foods, like other foods, supply energy for bodily activities and for work, protein for muscular tissue, body secretions and other constituents, minerals and vitamins. In times like these, it is desirable to secure food which will provide the greatest efficiency, at the lowest cost.

Energy is supplied by sugars, starches and fats as well as by protein and a number of other compounds of less importance, such as organic acids. Protein is supplied by proteids, some of which are not as good as others because they are more or less deficient in some of the structural amino acids.

The prices of animal feeds are to a large extent related to their feeding values, but this is not the case with human foods. Foods which sell at high prices may have little food value. Foods of high nutritive value may be comparatively inexpensive. Personal preference, scarcity, advertising, costs of securing, transporting and processing human foods have greater influences upon the prices for which they sell than the food values.

Approximate estimates of the relative cost of energy, protein, and other food values may be secured by calculating the cost at which they can be purchased, disregarding the food values other than the one being considered.

Table A. Cost of 3000 calories of energy when protein etc. is disregarded and 70 grams of protein when energy is disregarded.

| | Price per pound | 3000 calories in cents | Cost of 70 grams protein cents |
|---|---|---|---|
| Corn meal | 4.2 | 7.6 | 7.1 |
| Lard | 14.8 | 10.5 | — |
| White flour | 5.8 | 10.6 | 7.9 |
| Sugar | 8.0 | 12.9 | — |
| Wheat farina | 8.0 | 14.2 | 11.2 |
| Dried beans | 8.0 | 15.0 | 5.5 |
| Oatmeal | 9.6 | 15.5 | 9.2 |
| Vegetable shortening | 22.3 | 15.8 | — |
| Macaroni | 9.0 | 16.2 | 10.6 |
| Barley (pearled) | 10.0 | 18.2 | 18.2 |
| Peas, dried | 10.1 | 18.3 | 6.4 |
| Rice | 10.5 | 19.3 | 20.3 |
| Prunes, dried | 8.0 | 20.2 | 68.6 |
| Bread, white | 8.0 | 20.2 | 12.9 |
| Bread, whole wheat | 10.0 | 26.3 | 15.9 |
| Butter | 32.0 | 26.6 | — |
| Crackers | 19.0 | 29.6 | 29.9 |
| Potatoes, sweet | 4.6 | 30.0 | 50.7 |
| Wheat, shredded | 17.6 | 31.3 | 25.9 |
| Cheese, Cheddar | 22.5 | 31.5 | 12.5 |
| Bacon, rind off | 32.0 | 34.2 | 54.3 |
| Honey | 20.0 | 39.4 | — |
| Peanuts, shelled | 27.2 | 42.2 | 21.5 |
| Beef heart | 20.0 | 45.4 | 20.9 |
| Potatoes, white | 5.8 | 56.1 | 49.7 |
| Milk | 5.5 | 50.8 | 25.9 |
| Eggs | 20.0 | 94.4 | 25.9 |

The Committee on Food and Nutrition of the National Research Council recommends a daily allowance of 3000 calories of energy, 70 grams of protein, 5000 units of vitamin A and 75 milligrams of ascorbic acid for a man at moderate work. Energy requirements are greater for men at hard work, and less for women and children.

Table A shows the cost of 3000 calories in various foods at prices prevailing in Bryan and College Station on February 10, 1942, if only the energy is considered, arranged in order of the cost of energy, and also the cost of 70 grams of protein, if only the protein is considered. Where the approximate cost of protein is less than that of energy, the quantity of food which provides 3000 calories of energy supplies more than the needed 70 grams of protein at the same time. The cheapest source of energy is corn meal, and the cheapest source of protein is dried beans. It is to be noted that many of the foods which supply energy also furnish protein. The quantity of corn meal which provides 3000 calories of energy also supplies over 70 grams of protein. This also applies to wheat flour, farina, barley, crackers, bread, and rice. Some of the foods supply energy but little or no protein. These include lard, vegetable shortening, butter, sugar, honey, sugar candy. Some, while supplying protein, do not furnish sufficient amounts. These include prunes, sweet potatoes, marmalade, bacon, apple pie and white potatoes. On the other hand, peas, beans, oatmeal, macaroni, cheese, milk, eggs and meat in general, supply more protein than is needed in proportion to the energy, and may be used to balance the foods low in protein and high in energy.

From a combined energy and protein standpoint, those foods are most economical which furnish both energy and protein at a moderate price. Those which require supplements of protein-rich food are less economical.

The price of food depends upon the size of the package in which it is purchased. Bread may be bought for 8 cents a pound in 1½ pound loaves and 12 cents a pound in 1 pound loaves. The same kind of flour may cost

Table B. Approximate cost of carotene in cents per 3000 micrograms.

| | Dec. 1941 (Fresh) | July 1942 (Fresh) | March 1942 (Canned) | October 1942 (Fresh) |
|---|---|---|---|---|
| Mustard greens | 0.59 | 1.57 | 2.5 | 1.10 |
| Kale | — | — | — | .74 |
| Pumpkin | — | .55 | 1.2 | — |
| Turnip greens | .65 | 2.12 | 2.3 | 1.66 |
| Sweet potatoes | .67 | .81 | — | .94 |
| Collards | — | 1.10 | — | — |
| Carrots | .99 | 1.26 | 1.4 | 1.80 |
| Carrot juice | — | — | 3.5 | — |
| Canteloupe | — | 1.47 | — | — |
| Spinach | 1.87 | 5.92 | 2.0 | — |
| Swiss Chard | — | 2.22 | — | — |
| Beet tops | 3.79 | 7.58 | — | 38.78 |
| Watermelon | — | 4.35 | — | — |
| Apricots, dried | 4.95 | 5.03 | — | 5.67 |
| Apricots, fresh | — | 20.88 | 11.6 | — |
| Squash, yellow | 10.35 | — | — | 16.50 |
| Butter | 11.30 | 12.10 | — | 14.10 |
| Tomatoes | 12.50 | 5.66 | 33.3 | 13.08 |
| Tomato juice | — | — | 16.6 | — |
| Peppers, bell | 22.73 | — | — | 35.75 |
| Peas, English | — | — | 33.3 | — |
| String beans (green) | 24.50 | 27.05 | 53.2 | 29.40 |
| Lettuce | 40.00 | 73.75 | — | 81.25 |
| Peaches | 41.66 | 83.30 | — | — |
| Cabbage | — | — | — | 122.50 |

6.7 cents a pound in 3 pound packages and 4.1 cents a pound in 48 pound packages. Corn meal may cost 4.6 cents a pound in 5 pound packages and 3.2 cents a pound in 20 pound packages. Pinto beans sold for 10 cents a pound in 1 pound packages and 5.9 cents a pound in 10 pound packages, oat flakes 12.0 cents a pound in 1 pound packages and 8.3 in 3 pound packages.

The foods which provide energy and protein also supply some minerals and some vitamin $B_1$ and riboflavin, but few of them furnish vitamin A or carotene. Butter, milk, eggs and yellow sweet potatoes furnish vitamin A while sweet potatoes, white potatoes, and milk provide vitamin C. Vegetables supply practically all the vitamin C in a diet and most of the vitamin A potency or carotene.

Fraps and Meinke have made a survey of the cost of carotene and vitamin C, as published in Progress reports 764, 785, 791, 810. The results are summarized in Table B and Table C. The tables show the approximate cost of 3000 micrograms of carotene and 75 miligrams of vitamin C, which are the quantities recommended for an average man by the Committee on Food and Nutrition of the National Research Council.

Table C. Cost of Vitamin C in October 1942.

| | Cost cents per pound | Cost of 75 milligrams Vitamin C cents |
|---|---|---|
| Cabbage, raw | 4.9 | .74 |
| Kale, cooked | 3.4 | .82 |
| Turnip greens, cooked | 4.3 | .90 |
| Mustard greens, cooked | 4.7 | .99 |
| Cabbage, cooked | 4.9 | 1.37 |
| Peppers, green Bell, raw | 11.8 | 2.12 |
| Turnip roots, cooked | 3.8 | 2.51 |
| Grapefruit | 9.0 | 4.68 |
| Sweet potatoes, cooked | 5.6 | 6.61 |
| Tomatoes, raw | 15.7 | 6.75 |
| Oranges | 7.5 | 7.28 |
| Pineapple juice, canned | 10.7 | 8.88 |
| Potatoes, white, cooked | 6.8 | 14.01 |
| Onions, mature, raw | 7.1 | 14.20 |
| Sauerkraut (canned) | 8.9 | 14.24 |
| Beans, green snap, cooked | 15.0 | 14.55 |
| Lettuce, raw | 13.0 | 18.85 |
| Lemons | 8.7 | 19.66 |
| Bananas, raw | 10.0 | 25.40 |
| Beet roots, cooked | 8.5 | 40.89 |
| Carrots, cooked | 9.7 | 48.50 |
| Limes | 17.5 | 61.60 |
| Cowpeas, green in pod, cooked | 12.5 | 73.75 |

Low priced sources of carotene are mustard greens, kale, pumpkin, turnip greens, sweet potatoes, collards, carrots, spinach and swiss chard.

Tomatoes, lettuce, cabbage, peas and beans are somewhat expensive sources. It is to be noted that, at times, canned foods are more economical sources of carotene than the fresh vegetables.

The most economical sources of vitamin C are raw cabbage, kale, turnip greens, mustard greens, cooked cabbage, turnip roots, grapefruit and sweet potatoes, in the order named. Vitamin C is lost to some extent in cooking and is soluble in water, so that part of it is also lost if the cooking water is poured off.

It is evident from the data presented that the proper selection of food can result in both an efficient and an economical diet.

## Poisonous Marine Animals in the Gulf of Mexico

MALCOLM COLBY, JR., The University of Texas School of Medicine, Galveston.

Poisonous marine animals may be divided into two large groups: first, those which poison by being ingested and, secondly, those which poison by contact, either stinging, biting or simple contact. In the first large group, those which poison by being ingested, there are several sub-groups which will be considered in the following order.

1. *Decomposed Fish or Bacterial Food Poisoning.* Any type of food which remains warm for several hours serves as an excellent medium for bacterial culture, fish being no exception. Until fairly recently, many considered that food poisoning was due to the action of ptomaines, which are supposedly products of protein disintegration, and the clinical condition was termed "ptomaine poisoning." Actually it is a question whether there is such a substance as a ptomaine. Authorities insist that the term should be abandoned, for not only is it inaccurate but in some cases much more serious and often fatal conditions have been overlooked until too late by having the label of "ptomaine poisoning" too readily placed on them. A few conditions which were established at autopsy on some of these cases are appendicitis, ruptured ectopic pregnancy, peritonitis, meningitis, encephalitis, carbon monoxide and metallic poisoning, abortion, diphtheria, bacillary dysentery, coronary disease and pneumonia. The most common bacteria which cause this disease are members of the Salmonella group. The commonest offenders are *Bacillus enteritidis,* and *B. aertrycke.* Symptoms generally appear in from two to six hours after the fish or seafood is eaten. The picture is that of an acute gastro-enteritis. First there is nausea, abdominal discomfort, vomiting, headache, and later diarrhea. There is usually a moderate degree of fever. In most cases the acute symptoms subside in 12 to 24 hours and are followed by a few days of weakness, anorexia, and mild abdominal discomfort. Rarely, the infection may become generalized and proceed to a fatal termination. As a rule the treatment is to replace fluid and electrolyte loss by intravenous Ringer's solution and to withhold food until about one day after the acute symptoms have subsided. After vomiting has ceased one may give kaolin, or bismuth sub-carbonate.

2. *Ichthiotoxismus.* Cases of poisoning from eating fish have occurred in which there was no doubt of the fact that the fish was fresh and the cause was attributed to bacteria. Such cases have been called ichthiotoxismus. It has been thought that these cases may be connected with epidemic diseases among fishes (16). Bacterial organisms have been isolated in some cases and certain workers attribute the poisoning to the effect of toxins elaborated by the bacteria. Members of the Colon and Proteus groups of bacteria are those which have been most often incriminated.

Botulism-like poisonings have been reported from eating uncooked salted fish (16). Botulism is a peculiar type of food poisoning produced by the toxins of *Clostridium botulinum* and *Cl. parabotulinum.* It differs greatly from other forms of food poisoning, in that the symptoms are not so much those of an acute gastro-enteritis as of an acute encephalitis with paralysis of the ocular and pharyngeal muscles. Another peculiarity is the late onset of symptoms; they seldom occur before 18 to 36 hours after the ingestion of the toxic food. If these cases are true cases of botulism, then the prognosis is quite bad. The mortality rate of botulism in the U. S. A. is about 66%. Treatment consists of rest, morphine for pain, use of the specific antiserum (which should be given early to be of any value), tube feeding, and the use of the artificial respirator.

3. *Animal Parasites.* There are only two animal parasites of any importance which man obtains by the ingestion of fish; these are the fish tape worm, *Diphyllobothrium latum,* and the fluke, *Clonorchis sinensis.* As far as I know, these parasites occur only in fresh water fish.

4. *Fish Whose Meat is Poison.* No bacterial element involved. (3, 9, 10, 11, 13, 16.)

a. The Tetraodontidae, the puffer family.

The two most common puffers seen in the Gulf of Mexico are the *Sphoeroides marmoratus* and *Lagocephalus loevigatus.* The latter is the only one that ever gets large enough to eat but is never eaten in Texas (10). Most of the original work upon these fish was done by the Japanese who call the puffer the fugu fish. The illness produced by the puffer has hence come to be called fuguismus. It has been found that the poisonous principle, which is probably an alkaloid, is a neurotoxin, and has a physiological action similar to curare. It is thermostable. The poisonous substance is confined largely to the ovaries and testes. The eating of a single roe has caused death within a few hours. It has been stated that if the organs of the genital and alimentary tracts are carefully removed, these fish may be eaten without harm. Macht and Spencer (13) in their work on fish muscle extracts were impressed by the similarity between the poison principle in the puffers and certain snake venoms. They are now making a special study of this matter and promise to report their results in the near future.

b. Diodontidae—porcupine fish.

The porcupine fish, *Chilomycterus schoepfi,* and the closely related filefish, and trigger fish are considered poisonous. It is well known that certain of these fish are poisonous at one time and not at another. It has been noted that the poisonous effects occur predominantly at the time of spawning. These fish are closely related to the puffers. There is a disease called Ciguatera which has been ascribed to eating the filefish, puffers, and porcupine fish. This disease was first described around the Caribbean ports (9, 16). Ciguatera manifests itself in two rather different forms. The first and most frequent form is the gastro-intestinal type, which is characterized by epigastric pain, headaches, cramps, tenesmus, nausea, vomiting, diarrhea, cold extremities, syncope, erythrism, and desquamation. The second and more severe form is the algid type which is characterized by alternate paralyses, and convulsions, cyanosis, coma, and often death. Gudger (9) is of the opinion that the first type may be nothing more than a case of food poisoning.

c. Barracuda.

The two barracudas which are found in the Gulf of Mexico are the *Sphyraena guachancho* and the *Sphyraena barracuda* (11). Strong (16) has found that usually one may eat the barracuda with impunity; however there are undeniable cases of poisoning from eating the barracuda. It has been noted by fishermen that the larger barracudas are more likely to be poisonous than the small ones. The clinical picture which results is that of an acute gastro-enteritis. The source of the poison is disputed; however, three prominent theories are as follows: (1) Some observers feel that the barracuda are poisonous because of feeding on certain poisonous medusae and corals; according to Gunter (10), this theory is probably erroneous for the barracuda is a rapacious carnivore, (2) others look upon the poison as arising from within, through some disturbance in metabolism which occurs at spawning season, (3) the last theory suggests that the poison is due to commencing putrefaction. These observers believe that the barracuda is subject to more rapid decomposition at certain times of life than at others. Strong favors the last theory; however, the correct answer is not known as yet.

d. *Melleta* or certain of the herrings—have been reported to be poisonous. *M. venenosa,* occurring at New Caledonia, are reported to cause cramps, dyspnea, cyanosis, cold sweats, dilated pupils and at times death. *M. theissa* has been reported from the West Indies to be a very poisonous fish also. Fish of this genus have not been reported from the Gulf of Mexico.

e. Gars.

Coker (3), in his bulletin on the common fishes of the Mississippi, discusses caviar made from gar eggs. This substance is poisonous. The Mississippi gar, *Atractosteus spatula,* is found throughout the larger streams, brackish waters, and coastal waters of the South Atlantic and Gulf States. The Cuban alligator gar *(Lepisosteus tristoechus* or *Atractosteus tristoechus)* is also very commonly found in the bays and coastal waters of the Gulf.

The treatment for all of these toxic states caused by eating fish whose meat is poisonous is essentially the same. The fish should of course be eliminated from the diet; gastric lavage and purgation with one of the saline laxatives should follow immediately. The rest of the treatment is purely symptomatic; morphine may be given for pain, and if shock occurs it should be treated in the usual manner.

f. The Molluscs.

(1) Oysters—Two species of oysters occur along the Gulf Coast. The only species that has been developed for food is the *Ostrea virginica.* The other species is *Ostrea equestris,* a very small and uncomon species. Typhoid fever has been contracted from eating oysters which have been grown in beds contaminated with sewage. Contamination also occurs while the oysters are stored if the water in which they are stored becomes contaminated with *Bacterium typhosum.* Oysters are now "floated" or stored in chlorinated sea water. If they are floated for 2 or 3 weeks in this water, they are rid of the typhoid organisms and made safe for food. As far as I know, no typhoid cases have developed from eating Gulf Coast oysters.

(2) Mussels and Clams—In Science News Letters, June 6, 1942, several fatal cases are described which occured in California from eating mussels and clams infected with a marine micro-organism called *Goniaulax catenellia.* No other cases have been reported.

In the second large group of poisonous marine animals to be considered are those which poison by stinging, biting, or simple contact.

1. *Genus Muraena.* Stitt's Textbook of Tropical Medicine says that these fish have a poison sac which is in such relation to the teeth of the fish that when one is bitten by this fish the venom pours into the wound from the poison sac. Gudger (9) says that it is not true that these fish have a distinct poison gland but suggests that the poisoning may be due to a combination of infection, foreign blood serum, and secretions from the palatine mucosa. Some species of this genus occur in the deeper waters of the Gulf around coral reefs.

2. *The Dasyatidae or Sting Rays.* The rays most commonly encountered by fishermen in the Gulf are *Dasyatis sabina, D. americana,* and *Pteroplatea micrura,* the butterfly ray. *Stoasodon narinari,* the eagle ray or whipperee is also present. Only *D. sabina* is common. These rays are all flat, disk-shaped animals that live on or near the bottom. Because of their color they are difficult to see, as they lie half covered with mud and debris. On their long, whip-like tails they bear a slender, flat, bony spine several inches long, with backward projecting barbs on each side. When the animals are disturbed, this spine is driven into anything within range, and it inflicts an ugly, jagged wound which is at the same time likely to become badly infected from bacteria on the spine and in the mud. They do not inject any kind of poison except the slime that is always on the body and seems to be an active irritant (14). The question whether or not rays have poison glands and inject an active poison is rather controversial. Gudger in his article on poisonous fishes (9) refers to an article by Phisalix purporting to have shown that rays possess definite poison glands. It has been reported that Dr. Gudger is now preparing a paper, soon to be published, entitled, "Is the sting-ray's sting poisonous?" One of the physicians on the faculty of the University of Texas School of Medicine was recently struck on the ankle by the spine of a stingaree. He first noted rather severe localized

pain at the site of the injury; this was followed in about 30 minutes by the development of a gradually ascending paralysis, which within an hour involved the lower extremity completely. Certain general systemic symptoms occurred also; he became hot, flushed, nervous and tremulous. Vertigo, tinnitus, and an extreme tachycardia were noted. Harvey Bassler (1) reports a case of an attack by the sting-ray upon his native orderly, while in the Amazon Basin in the year 1925. This native was struck on the sole of the foot while wading in shallow water. The outstanding symptom noted was excruciating pain which brought tears to the man's eyes and made him writhe in agony. Bassler had heard that the Brazilian proprietary medicine called "Balsamo Divino" was considered the most effective manner of treatment. Bassler cleaned and bathed the wound with this substance and dressed it, leaving a saturated pad of this drug over the wound. This substance contains carbolic acid to which one may probably safely attribute its efficacy. The pain subsided in a few hours and the wound healed with no evidence of undue inflammation or secondary infection. Bayley's treatment for scorpion fish stings, which will be described shortly, has as far as I know never been tried in stings caused by the sting-ray; however, it would be interesting to try this treatment and to observe the results. The Galveston physician, whose case has been described, was treated by the local injection of Novocaine and 1:1000 adrenalin solution, but only incidentally as an anaesthetic to allow incision and irrigation of the wound. He obtained marked relief within 30 minutes, but the degree of benefit solely from the anaesthetic solution cannot, of course, be evaluated.

3. *The Scorpion Fishes.* Several species of these poisonous fishes are found in the Gulf. They are, *Scorpaena atlantica, Scorpaena ginsburgi,* and *Scorpaena brasiliensis.* Evans in 1921 (6) claimed the discovery of definite poison glands in the scorpion fish; however Bayley, in an article written in 1940 (2), says that he has examined several species which occur around Barbodos Island but has never found anything resembling a poison gland. Bayley describes the dorsal spine of the *Scorpaena plumieri* as being covered with a thick mucous membrane composed of a layer of stratified epithelium, next a layer composed of large darkly pigmented cells and below this many microscopic mucous glands. He believes that these microscopic glands may secrete a poison. It is probable that some species may have definite poison glands while others do not. This question has been an even more hotly debated one than that concerning the stingaree, and as far as I am able to determine is not even yet settled to the satisfaction of all concerned. Stitt's textbook gives the following symptoms for the species *Scorpaena scropha:* stabbing pain in affected part, a sense of suffocation, delirium and finally collapse and death may ensue. At the site of the wound there appears an erythematous lesion, which later becomes black and gangrenous. Since the poison rapidly enters the general circulation, Strong (16) advises that the wound should be treated by incision and suction just as if it were a snake bite. Evans recommends that these wounds be treated by the local injection of several minims of 5% $KMnO_4$. The symptoms which are produced by the *Scorpaena plumieri* are described as a severe

agonizing pain comparable to renal colic, pallor, dyspnea, extreme tachycardia, vomiting, and diarrhea. After 24 hours a rash appears. In 1940 Bayley published a paper in which he described a new treatment which he has found to be quite successful for injuries caused by this species. He had been using Evans' treatment, but one day he tried simple local infiltration with procaine hydrochloride and 1:1000 adrenalin solution. The local pain was relieved immediately and no symptoms or signs developed at all. Since that time he has used this method in all of his cases with consistent success.

4. *Catfish.* Gowanloch (8) states that the pain produced by the spines of the hardhead catfish, *Galeichthys felis* and the Gafftopsail catfish, *Bagre marina,* is so intense that it leads him to believe that there must be some poisonous substance present. Gunter (10) says that he is inclined to agree with him.

It should be mentioned that in all cases of injury by marine animals in which the skin is penetrated there is always the danger of inoculating the tetanus bacillus.

5. *The Torpedinidae or Electric Rays.* These rays carry a positive charge on the dorsal surface of the body and a negative charge on the ventral surface. If one touches these rays in two places he receives a shock which may be severe enough to cause temporary paralysis of an extremity. The two rays found in the Gulf waters are the torpedo or numbfish, *Tetranarce occidentalis* and the small electric ray, *Narcine brasiliensis.*

6. *The Echinoderms.* Earle has written an article (5) in which he describes the pathological effects of two Echinoderms occurring in the West Indies. The effects are local ones due to punctures of the spines which remain in place and set up local irritation and inflammation, and general allergic reactions due to ingestion of certain echinoderm ova which give rise to gastro-intestinal upsets and urticarial rashes. There are 15 or 20 diffierent echinoderms in the Gulf; the sea urchins possess spines which are larger and more useful than most of the other forms. There is also a smaller species, *Eucidaria tribuloides,* which is covered with strong thorny spines.

7. *Poisonous Coelenterates.* The sea anemones occurring in the Mediterranean produce a disease in the sponge fishermen of that area called "la maladie des plongeurs." It is due to stinging by the anemone and is characterized by itching, burning, erythema and possible ulceration. Other polyps have been said to cause nausea and vomiting in addition to the above. The treatment recommended for this condition is local application of vinegar in olive oil.

Perhaps the most widely known of all poisonous marine animals are the jellyfish or sea-jellies. The most familiar sea jelly is the cabbage head, *Stomolophus meleagris.* "The cabbage head may be found in the spring and early summer in great numbers in the clear Gulf waters on warm sunny days, but not in the form in which it is generally recognized, for it is then a tiny, white, almost invisibly transparent hemisphere as big as a buckshot or perhaps an English pea. It grows rapidly and by fall is as large as an orange; the next spring finds it as large as a grapefruit, and the summer bathers see it this year as large as a medium sized head of cabbage" (14). There are many other sea jellies which occur in the Gulf of Mexico. As Reed says, "all these sea jellies, in fact all members of the Coelenterata, possess tiny stinging nettle cells (nematocysts), by means of which they defend themselves and paralyze their prey. The nettles are of several types, yet all on the same fundamental plan of structure and action. Large cells, cnidoblasts, in the outer (ectodermal) layer of the body, produce at their outer ends little pear-shaped or ampoule-shaped bladders called nematocysts, and a tiny spine or trigger, the cnidocil, which projects outward above the surface. The nematocysts are hollow and have a long thread-like, smooth or barbed tube coiled within them. When it is mature and the cnidocil is touched, the coiled-tube dart is forcibly discharged and will penetrate even the hard shells of some Crustacea. Of course, like the bee's sting, the nettledart (nematocyst) is pulled out of the nettle cell (cnidoblast) or thread cell and its poison, called hypnotoxin, is injected into the victim. The cell proceeds to build another nettle with which to reload this hypodermic harpoon for the next victim. Like the venom of serpents, hypnotoxin is a powerful digestive enzyme." Dr. Meyer Bodansky has found that hypnotoxin is precipitated by alcohol, is non-dialyzable, and is destroyed by heat. It is similar to the toxin produced by the Portuguese Man o' War. The symptoms which have been recorded from jellyfish stings are very numerous; some of them are local rash, weeping eczema, laryngitis, urticaria, shock, dyspnea, muscle pains, tachycardia, cough, coryzal signs, weakness, restlessness, lachrymation, and a vesicular dermatitis. Another coelenterate of the class Hydrozoa is the Portuguese Man O'War, *Physalia pelagica.* What appears to be a single animal is really whole colonies of several hundred hydra-like individuals growing so close together that they simulate a single organism. The Portuguese Man O'War is frequently seen floating near the beach. Its pearly bluish purple float or pneumatophore expands in the sun and is readily recognized. There are long tentacles which trail beneath the water; these are the dangerous part of the Physalia and they vary in length from several inches to 30 or 40 feet. Crutchfield (14) has written an excellent article describing the dermatitis produced by this animal. The tentacles produce an acute dermatitis when they contact the skin. This dermatitis varies from an urticarial line to a linear coagulation necrosis. The lesions heal and leave a hematogenous pigment which is slowly absorbed. Rarely, a permanent scar may result. The nature of the poison was investigated by Dr. Meyer Bodansky and he recorded the following facts: (1) Injection of the extracts from the tentacles into pigeons causes coma, respiratory paralysis and death, (2) the extracts caused a local dermatitis like that of the fresh tentacle and if this was severe enough fever resulted, (3) the dried extract remained active for as long as two years, (4) the poison is easily destroyed by heat or tryspin, which indicates that it is a protein-like substance. The acute symptoms of this dermatitis are relieved by local antacids. Morphine is often given in large doses since the pain is extremely excruciating.

8. *Erysipeloid.* Dr. Earl Ritchie has recently written an excellent paper on this subject (15) which will here be reproduced practically

verbatim. "Erysipeloid, first described by Rosenbach in 1884, is an acute cellulitis caused by the bacillus of swine erysipelas. Gilchrist (7), and Klauder and his associates (12) in this country have called attention to the prevalence of this infection and have published classical papers worthy of close study.

"The organism, *Erysipelothrix rhusiopathiae,* order of Actinomycetales, occurs in three strains—human, swine, and mouse. The organisms occur in cultures as gram-positive short bacilli. The infection has an incubation period of from one to five days, although Light has reported a case with twelve days incubation. It follows the handling of fresh slimy fish, shrimp, crabs, decayed vegetable or animal matter. It has also been reported in laboratory workers through bites from laboratory animals. An injury, even of the most trivial sort, affords entrance of the organism to the skin.

"The cellulitis has definite clinical characteristics which lead to a diagnosis. These are: a bluish-red advancing border; second, the spontaneous clearing of central areas without exfoliation; third, the migrating tendencies; fourth, involvement in most cases of the hands only. Most cases are seen only during the warm summer months, from May to September. The severity of erysipeloid varies from a migrating cellulitis, to a cellulitis accompanied by symptoms of arthritis and finally a severe septicemic form with complications of endocarditis. The infection in swine, swine erysipelas, is a systemic disease, commonly called 'diamond disease' because of quadrangular areas (diamond-shaped) of cellulitis in the skin accompanied by polyarthritis and endocarditis.

"The frequency of erysipeloid, especially among commercial fishermen along the Atlantic seaboard, as reported by Klauder, would lead one to suspect that the coastal regions along the Gulf of Mexico should be likewise affected. The writer believes that many cases of erysipeloid are diagnosed as ordinary pyogenic cellulitis. Erysipeloid, as a disease of varying intensity, is definitely an industrial dermatosis. It is commonly called 'fish poisoning' among commercial fishermen and even mild cases may mean partial or complete incapacitation for a period of from two to three weeks. The treatment in addition to immobilization of the part should consist of hot, wet dressings of magnesium sulfate, boric acid, or potassium permanganate, and the administration of sulfanilamide. A specific serum has been used with success, injections either intramuscularly in dosages of 25 c.c. in mild cases, or by local injection into the active portions of the cellulitis. Spontaneous cure in mild cases will occur in from three to five weeks."

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## A Comparative Study of Grazed and Ungrazed Quadrats on Two Forest Types in Southeastern Texas

S. R. WARNER, Sam Houston State Teachers College, Huntsville.

There are about 6,000,000 acres of open range forest in southeastern Texas. Nearly a million acres of this forest have been acquired by the United States for a national forest. The controversial issue in this region is whether forest should be grazed or protected from grazing. To arrive at a solution of the problem the Texas office of the U. S. National Forest Service initiated this study in 1937 to run for a period of ten years. The area chosen for the experiment is a 73,000-acre block in the western part of the Sam Houston National Forest, located 60 miles north of Houston and several miles west of New Waverly. A check of the quadrats has been made each year in April, for spring flora, and in September, for all other vegetation, to determine the plant species present and the percentage of ground cover (density) occupied by each species. Five plots, each one acre square, were established and fenced. Three one-acre plots wre designated for controls. Ten mil-acre (1/1000) quadrats were established by the diagonal method on each of the one-acre plots.

Three of the fenced plots were placed on the shortleaf-loblolly-hardwood forest type on a site considered fairly typical of 83% of the Sam

Houston National Forest. The site had been cut over about 18 years ago for all merchantable pine above 8 inches in diameter. A "slash" fire followed about 4 years later but did not destroy the undersized, suppressed pines or the hardwoods. All pine reproduction has started since this fire.

There exists today a stand of scattered pines, 14 inches in diameter or less, enough to give a volume of 1,000 board feet to the acre, and about 200 sapling pines per acre, 8 to 12 years of age. There were about as many hardwoods as pines left following cutting. These are inferior in quality and would yield about four cords of fuel wood per acre. There exists today a considerable number of hardwood sprouts and saplings. The hardwood species are principally post oak, red oak, sweet gum, and black hickory. The shrubs are mainly Callicarpa, Ascyrum, Rhus, and Myrica.

Three types of forestry practices were instituted on the shortleaf-loblolly-hardwood type, as follows: One acre was burned in January each year, one acre had all non-merchantable hardwoods girdled according to T. S. I. rules, and another acre was studied only for the effects of the release of grazing. No report is to be made at this time on the results of winter burning.

The most apparent effect brought about by the release of grazing on this pine-oak upland type is an increase in the tall grasses, specifically, the andropogons, and a decrease in the short grasses such as aristidas, the basal leaved panicums, Eragratis, carpet grass, and Bermuda grass. This was also accompanied by a decrease in annuals.

The grazed quadrats showed at the beginning for Andropogon scoparius a frequency of 50% and a ground cover density of 2%; after five years, a frequency of 50% and a density of 1.1%. Andropogon virginianus started with a frequency of 60% and a density of 2% and ended with a frequency of 50% and a density of 1.2%, thus showing that neither species was holding its own against grazing and the advancing stage of the forest. However, on the fenced, ungrazed quadrats there was considerable increase of tall grasses in spite of the advancing stage in forest succession. Andropogon scoparius advanced from a frequency of 40% and a density of 1.2% to a frequency of 60% and a density of 3%, Andropogon virginianus, from a frequency of 70% and a density of 3% to a frequency of 90% and a density of 8%, whereas short grasses were reduced as follows: aristidas, from 3.7% density to 1.2%, carpet grass, from 11% density to .2%; basal leaf panicums, from 4% density to 2.6%. The short grasses remain nearly constant on the grazed quadrats.

Five years after starting this experiment, the results on pine reproduction are not as conclusive as they should be at the end of the experiment in 1947. Also, there are greater site and timber stand differences in the quadrats than are desirable. Results indicate that the acre on which the non-merchantable hardwoods were girdled has the best reproduction and height growth of pine, also the best growth of tall grasses. However, it does not follow that the best reproduction of pine is accompanied by tall grasses (Andropogon). A grouping of the 30 ungrazed mill-acre quadrats on the three unfenced acres in ten sunniest, ten shadiest, and ten half-shaded, i.e. about 33% to 66% shade, revealed that the partially shaded quadrats gave the best results, the sunny, the second best results, and the shady, the poorest or inadequate reproduction, the plants being small, depauperated individuals. The density stated in number of young pines per mil-acre and grasses in percent of ground cover is as follows:

| | *Pines* | Tall grasses | Short grasses | Woods grasses | Total grasses |
|---|---|---|---|---|---|
| Sunny quadrats ........ | 6.2 plants | 19.4% | 15% | 4.8% | 39.2% |
| Half-shaded quadrats .. | 10.5 plants | 11.1% | 9.7% | 13% | 22.1% |
| Shaded quadrats ....... | 2.2 plants | 4.7% | 10.3% | 2% | 17% |

These figures indicate that the sunny quadrats show the best growth of grasses, but the best reproduction of pine occurs on the partially shaded areas where the grass cover is about half that of the sunny stations.

There was little evidence of young pine being browsed by cattle as is often the case where supply of evergreen browse is limited. The young pines are cropped off with the grass only where grass is as much as 80% of the ground cover. In an attempt to overcome site difference in comparing grazed and ungrazed areas, adjacent 1/10 acre strips were taken inside and outside the fence. The average number of two to five year pines per acre on the grazed was 510 plants, and on the ungrazed, 540 plants. The average height on the grazed area was 14 inches, and on the ungrazed, 22 inches. Apparently deferred or light grazing in years of good pine reproduction, and on the year following, is desirable to establish a good stand. No grazing for a period of five years results in greatly increased fire hazard by the accumulation of dead grass, increase of Andropogons and in the suppression of carpet grass. The latter, because of its green succulent nature, is a deterrent of winter and spring fires. Also, it is the best woodland pasturage on sites that are not too dry.

A range management program for open woodland, which is too dry for carpet grass, should encourage growth of little blue stem (Andropogon scoparius) by not grazing it in late summer. Much woods pasturage could be obtained by this practice for a period of about 15 years following timber cutting. Two shade tolerant grasses, spike grass (Uniola laxa) and beaked panic grass (Panicum anceps), and common broom sedge (Andropogon virginicus) supply much forage when moderately grazed. In general, it may be said that the pasturage ,rental and the benefits to the upland forest would not justify the expenses of a range management program except for the fifteen years following timber cutting.

The two sites chosen on the elm-oak forest type of the bottom land which contains 12%, or 8,760 acres, of the block, were located in the Caney Creek and San Jacinto River bottoms, a fenced and unfenced acre in each. The Caney Creek site is a clay loam levee type of soil with mixed hardwoods, 80 trees per acre, of which 54% are cedar elm, 32% hackberry, 8% water oak and willow oak, 4% water pecan, 1% American elm, and 1% ash. The shrub society is dominated by switch cane, wild privet, hawthorn, dwarf palmetto, smilax, and blackberry. Palmetto is not abundant in the Caney Creek bottom, only about 40 plants per acre as compared to 2,000 palms to the acre on the San Jacinto River bottom site where it is the worst weed species.

The San Jacinto site is a moist, heavy, black clay basin suited to cedar elm (Ulmus crassifolia) and willow oak. A heavy shade produced by a 90% canopy has 185 trees per acre and is 84% cedar elm, 9% hackberry, 5% willow and water oak, and 2% ash. The shrub society is almost entirely of dwarf palmetto which shades out most of the herbaceous vegetation. A few colonies of switch cane occur on this site. The Caney Creek site, however, gives a good opportunity to study switch cane.

By the early residents of southeastern Texas, switch cane (Arundinaria tecta) was regarded as the most valuable winter browse for cattle. Most of the bottom lands are believed to have been fully occupied by dense cane brakes tall enough to conceal deer. Tall cane brakes exist in southeastern Texas today only in isolated fragment areas. However, there is a rather general occurrence of small colonies of suppressed, browsed plants on all bottom woodland, especially along the natural stream levees and on alluvial ridges. The fenced acre quadrat on Caney Creek has produced the following results in five years: An increase from an average density of 9 plants per mil-acre to 20 plants per mil-acre and an increase of height from an average of 30 inches, numerous canes being more than 7 feet tall. Few people in recent years have seen switch cane in flower or fruit. Considerable flowering was observed in April 1939 on fenced plots but few, if any, seed matured. No flowering was in evidence in other years. Reproduction of switch cane is mainly by rhizomes some of which extend as much as 20 feet from the parent plant.

The critical period of browsing damage to switch cane is the spring and early summer. When the succulent young canes shoot up in late March and April, they are diligently sought by cattle which prefer them to other browse. If protected from cattle at this time and until they have leaved out and toughened, cattle will pass them by for other more succulent vegetation. During the period of winter scarcity, cattle largely confine their browsing of switch cane to the leaves, the canes being unpalatable. Good new growth can follow winter browsing since the plant has had time to store food in its rhizomes and canes for the new growth of spring. Range management program for switch cane would permit late summer and winter use.

The most valuable bottom land hardwood of Texas is the American ash (Fraxinus americana). The merchantable ash trees of southeastern Texas bottom lands have been largely depleted. There is little reproduction of this species in the open range woodland. There exists only about an average of one mature ash per acre in the area of this study, and these have been left because of some defect affecting their marketability. A census of two fenced acres gave a count of 226 young plants on the Caney Creek acre and 130 plants on the San Jacinto River acre. These young plants are largely the five year old survivals of the 1937 seedlings. Census of two adjacent grazed acres showed no ash reproduction although there are three mature ash trees present.

Release from grazing also brought about an increase of red mulberry (Morus rubra) which showed respectively 41 plants, and 14 plants, two to five years of age, on the ungrazed acres and no young plants on the two adjacent grazed acres. The principal source of fence posts in this region is red mulberry.

Most woody species showed an increase in reproduction on the ungrazed quadrats, notably such wildlife food plants as water oak which keeps green leaves most of the winter and is therefore very subject to browsing, hawthorn, smilax, wild privet (Foresteria pubescens), and hackberry. Elm showed the best survival of any woody species on the grazed areas.

The principal herbaceous ground cover of bottom land hardwood elm-oak forest type is Carex with a 100% frequency, occurring on all mil-acre quadrats. The density of ground covered by Carex on ungrazed quadrats averaged 13%. This density increased after fencing for four years as follows: 14%, 22%, 26% and 28% but declined slightly to 26% in 1941 due to being reduced by switch cane. Carex foliage is green and palatable all winter and fruits in the spring. It is the most important grazing under present conditions. Its food value is increased in winter by greater sunlight resulting from defoliation of the forest canopy. Carex represents the second stage in the succession, following ruderals, and continues until it is overshadowed by switch cane, palmetto, and the woody members of the community. Nimble-will (Muhlenbergia schreberi) is the most common grass but is of little volume. Most of the annual species increase the first year after fencing but decrease each year thereafter.

A forestry, range, and wildlife management program for the bottom land hardwood type based on this progress report would suggest that grazing be permitted only in the late fall and winter months when Carex and switch cane are matured and would yield the best return. It would also suggest that bottom woodland be fenced separately from the pine-oak uplands as the optimum grazing season is the reverse of that of the upland. This separation would further permit a deferment of grazing in those years when there is a good catch of ash reproduction. Wildlife food plants and shelter would be increased, and the recreation facilities would be improved by freeing the area in summer of cattle and cattle ticks.

## SUMMARY

The results of fencing the bottom land elm-oak forest type would indicate an increase of the more valuable hardwoods and winter grazing, but would produce a thicket-like understory if not winter grazed. The release of grazing on the upland pine-oak forest shows increase of the tall grasses and a decrease in carpet grass. This would result in a greater fire hazard. Pine reproduction is favored by partial shade and light grass density. Grazing has only a slight influence on pine reproduction where the grass cover is of low density.

## A New Variety of *Rhus Toxicodendron* from Harris County, Texas

ROBERT A. VINES, Houston.

While collecting plants for herbarium specimens on the banks of Bray's Bayou in the Houston, Texas, area, a woody, climbing plant was noticed which resembled poison ivy in many respects but yet was sufficiently different to warrant a closer and more detailed examination. The plant bore five leaflets, instead of the usual three of poison ivy (Fig. 1). The specimen was collected, but no particular research was done at the time because the writer considered this single plant to be an unstable variation of *Rhus toxicodendron* L. However, fully two years later, while again collecting in this particular area, fifteen separate plants were found which bore the five distinct leaflets, and four separate plants were found which bore both three and five leaflets. The fact that the great majority of these plants bore five leaflets, and were reproducing themselves true to form indicated a stability within the five leaflet plants. But, the presence, in the same vicinity, of the plants bearing both three and five leaflets, put in doubt the possibility that the five leaflet plants were a new species.

Undoubtedly this plant has a very local distribution. Besides the limited area mentioned above, one plant with five leaflets was observed on the banks of the San Jacinto River near Highlands, Texas. More field work will have to be done to determine the exact distribution of the new variety.

After careful examination of all the material, it was finally decided that the new plant should warrant the status of a new variety. It is therefore suggested that it henceforth be known as *Rhus toxicodendron* L. var. *multifolia* R. A. Vines. The type specimen was deposited in the private herbarium of the writer, and may be examined upon request. The following detailed description is presented:

A vine climbing by rootlets, or a shrub, up to 3 meters high, the woody stem from 1-2 cm. in diameter; leaves 2-3 dm. long, pinnately compound of five distinct, pubescent leaflets; leaflets ovate to lanceolate, entire or coarsely few-toothed, acuminate at the apex, rounded, or oblique, at the base, petioles 2-3 mm. long; flowers in slender axillary panicles, polygamous, calyx five-lobed, petals five, stamens five, ovary one-celled; fruit a globular, dry, drupe 4-5 mm. in diameter, dull white or tan colored; entire plant poisonous to the touch; habitat in loose sand soil of stream banks.

## The Preparation and Use of Colloidal Clay-Sand Culture in Plant Research

H. E. HAMPTON, Associate Professor, Department of Agronomy, Agricultural and Mechanical College of Texas, College Station.

Of the several types of cultural media available to the investigator, aqueous solutions and sand cultures have been the mostly widely used. A number of workers have suggested either that soil media were more pro-

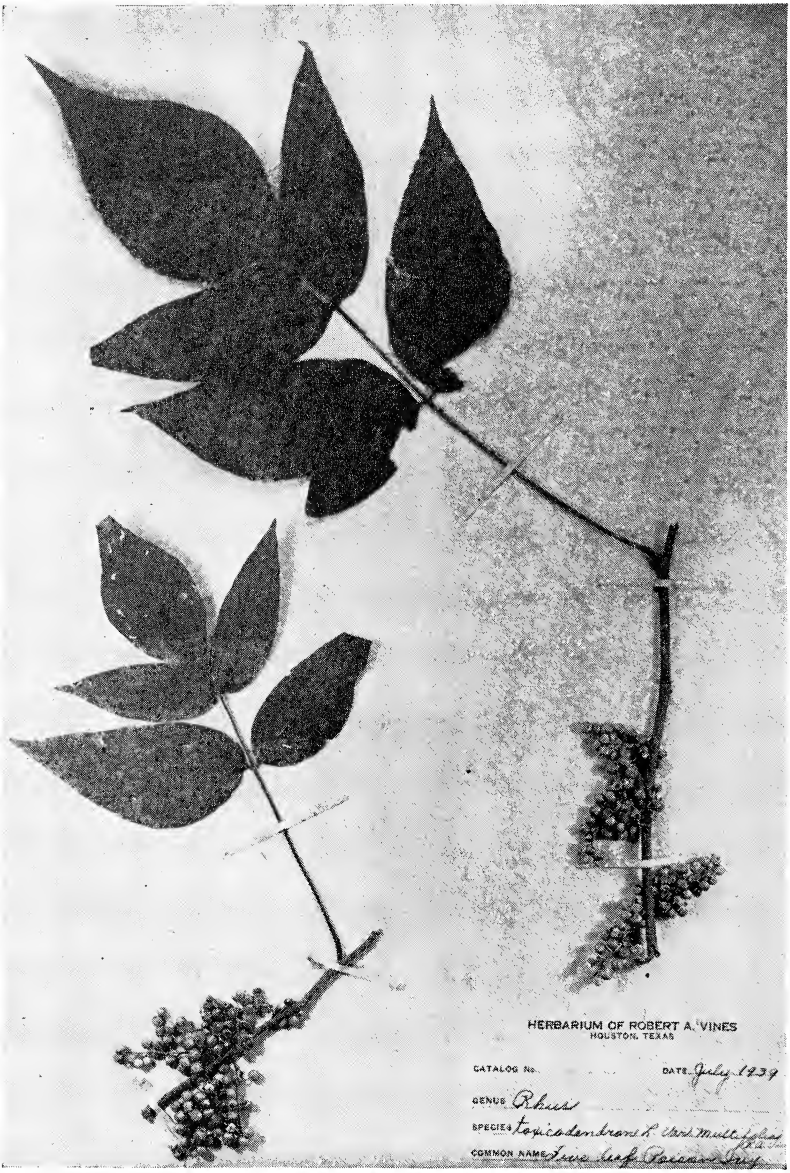


Fig. 1.—Type specimen of *Rhus toxicodendron* L. var. *multifolia* R. A. Vines, new variety. This specimen is in the herbarium of R. A. Vines, Houston, Texas.

ductive than aqueous solutions (Hoagland and Martin (6), Jones and Pember (9), or that the addition of certain solid substances to a solution culture may result in the adsorption of toxic substances (McCall, 10). Jennings (7) observed that the addition of colloidal silica brought about increased growth. For proper phosphate nutrition of plants, Parker and Pierre (11) concluded that "root-soil contact is necessary."

A better understanding of the properties and behavior of colloidal clay (4) has made it possible to use this fraction of the soil in plant nutrition studies. Colloidal clay is that part of the clay fraction of the soil having an effective diameter of less than 0.2 micron. It may be composed of a single clay mineral or a mixture of several. Clay minerals are alumino-silicates, crystalline in character, and usually plate-shaped. Surface activity for the adsorption of mineral nutrients and their delivery to the plant by ionic exchange (Jenny and Cowan, 8) is a property of colloidal clay. The up-take of nutrients from the adsorption complex by plants is related in quantities to the supply which is determined either by the total clay or by the degree of saturation of the clay with the respective nutrient ions.

Recent experimental studies with colloidal clay have suggested a variety of uses of this material in several lines of research. W. A. Albrecht and his associates at the University of Missouri (1, 2, 3) have developed the use of colloidal clay-sand cultures and have shown that they can serve as media for both the soil micro-organisms that bring about nitrification, and for those which fix atmospheric nitrogen either in a free or symbiotic state, as well as for the regular growth processes of plants.

In the work at the University of Missouri, the clay subsoil of the Putnam silt loam is used. A 5-gallon rotating stone-ware churn is filled about one-third full with the clay, about a handful of sodium hydroxide pellets is added, and the churn is filled about two-thirds full of water. It is necessary to rotate the churn about twelve hours to disperse the clay completely. After the material has settled for another twelve hours, the top suspension is drawn off into carboys, from which it is transferred by syphon into a Sharples (ultra) centrifuge. Operating at approximately 30,000 r.p.m., the centrifuge separates the clay particles having a diameter of less than 0.2 micron from the coarser particles.

The suspension is then fed into a dialysis cell and dialyzed by means of an electric current. It is necessary, of course, to use direct current in this process to secure the removal of ions, which requires two or three days for completion. Since potassium is the least mobile of the ions that are apt to be adsorbed on the clay, the test for the completion of the process involves simply a qualitative test for this element in the cathole chamber.

Because the clay particles are negatively charged, they will accumulate on the wall of the cell nearest the positive electrode. Electro-endosmosis will cause the water in the system to flow toward the cathode chamber, where a syphon is provided for its removal. The water level in the apparatus is maintained by means of a self-regulating feed from an elevated supply. The positively charged ions will, of course, migrate to the cathode chamber and will be carried away with the waste water. The anions, however, will collect in the anode chamber from which they must be removed by a periodic changing of the water in the chamber.

The hydrogen clay is removed from the dialysis cells in the form of a thick paste. It is mixed with sufficient water and stirred until a suspension of approximately 5% by volume is obtained. The concentration of the suspension and the exchange capacity of the clay are determined, and the amount of suspension required to adsorb the desired amount of cations is measured out on a volume basis into two-liter wide-mouthed bottles.

The removal of ions by electro-dialysis is surprisingly complete. When completely dialyzed, the clay will have a pH of only about 3.5 in a 5% suspension. Trials at the University of Missouri (2) have shown that any cations retained by the clay following this treatment cannot be removed by ordinary plants.

As the pH of the suspension indicates, the colloidal clay after dialysis constitutes a hydrogen system. In fact, it has been established by Bradfield (3) that colloidal clay behaves not unlike a polybasic weak acid.

The ions desired in the culture are added in a regular order. The ions that are supplied in constant amounts to all cultures are added first, beginning with the least soluble. Sufficient time is allowed, with frequent stirring, for the ions to be adsorbed on the clay. This usually requires 2-4 days depending upon solubility. When possible the ions are added in the form of the hydroxide. Next the variable nutrient ions are added, also in the order of increasing solubility, allowing time after each addition for the system to come to equilibrium.

Sufficient white quartz sand to give the culture a good physical condition is treated with commercial hydrochloric acid, and then washed free of chlorides with distilled water. In general, 20-30 grams of sand to each gram of clay will give a desirable physical condition. The sand is placed in convenient-sized containers with water-tight bottoms (two-quart enamelware pans are used at Missouri). The clay suspension into which the the nutrient ions have been titrated is added. The water is allowed to evaporate with frequent and thorough mixing until an optimum moisture condition is attained.

In this manner a cultural medium is prepared which approximates a soil in its physical constitution, chemical composition, and physico-chemical behavior.

The most serious criticism of colloidal clay-sand cultures is the cost of preparing the dialyzed clay, which at the University of Missouri has been estimated at 5 cents a gram. The cost necessarily prohibits the use of this type of culture except where reproducible quantitative results are required. However, 30-50 grams of colloidal clay, having an adsorptive capacity of 60-70 milligram equivalents per 100 grams, will provide sufficient mineral nutrients for three crops of fifty soybean plants, each crop grown for a period of six weeks.

Several modifications of this technique are possible. A simplification has been used successfully by R. A. Schroeder of the Department of Horticulture at Missouri (3). The clay subsoil of the Putnam silt loam is dispersed by churning in distilled water alone, and the clay suspension used without fractionation or dialysis. Chemical analysis gives the amount of nutrient elements present in the suspension, and enough more are added, in the manner described above, to give the desired nutrient level. The clay is then mixed with sufficient washed sand to give a good physical condition. Schroeder has used this type of culture in the study of the oxalic acid content of spinach and for investigating the influence of mineral elements on potato scab. This modified culture is much more economical and apparently gives quite satisfactory results in many research problems, although with some loss of refinement.

The perfect medium upon which to grow plants would have the potential ability of providing a large total supply of nutrient elements without effecting any great change in the osmotic pressure of the medium. It would contain a large portion of the elements in an available form. It would permit the striking of a "balance-sheet," or the determination of the percentage of the available supply of nutrients which are taken by the plants. The pH would remain constant while the amount of nutrients present would vary widely, or, on the other hand, the nutrient supply would remain unchanged while the pH is altered.

Colloidal clay-sand cultures more nearly fulfill the conception of a perfect medium than any other type of culture.

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## Some Economic Aspects of Texas Marine Fisheries Development

G. W. SCHLESSELMAN, Department of Agricultural Economics, A. & M. College of Texas, College Station.

To the casual observer the sea appears more or less as a barren waste valued chiefly for transportation and a source of rainfall and occasionally recreation, yet it is literally teeming with both plant and animal life. Much of this life is readily accessible. Nowhere else can such large quantities of excellent food be obtained for such little effort.

The Gulf Coastal waters have been neglected for production probably more than any other in the United States. Few people realize the enormous potential value of marine life in this body of water.

*Importance of Marine Products in History.* Marine products have been utilized since prehistoric times. Amber, coral, salt, fish, and shellfish were among the first articles to be bartered by savage man. Strings of shell beads (wampum) served as money among many tribes of North American Indians.

Salt water fishing is generally considered the cause that led man to ocean sailing. The development of navigation in northwestern Europe and the rest of the world had its beginning with fishing in various seas. The early settlers on the rockbound New England coast had great difficulty in obtaining sufficient food and might have starved, had it not been for the discovery of the rich fishing grounds close at hand. The proximity of the Banks encouraged the building of vessels and so the New Englanders became the pioneer seamen of America.

Perhaps the impetus of war on food conservation will force Gulf Coastal people to make use of an enormous storehouse of food heretofore not touched or slightly used, thus making another great step in the importance of the sea in America. Japan and northwestern Europe have long realized the importance of the sea as a source of food.

*Relative Importance of Marine Products.* Fishery products constitute less than three percent. of the world's food. However, in certain places, namely northwestern Europe, Japan, Newfoundland, and Labrador, the fish is a much more important food factor and may make up ten percent. of the food. Except for shrimp, the Gulf Coastal waters have not played an important role as a source of food.

*Variety of Products.* The Gulf Coastal area has as great a variety of marine products as any water in the world. Lying, as it does, partly in the tropics and partly in the middle latitudes, varieties of both regions abound.

*Fish.* There are more than 19,000 different species of fish. Thousands of species exist whose names are known only to the systematist. Some species are very numerous, as the menhaden, the herring, etc., of which about a billion are caught each year.

When the enormous number of fish is considered, one wonders where they obtain food to satisfy their voracious appetites. However, when sea water is examined under a microscope, it is seen that the ocean is literally alive with countless millions of minute organisms.

Fish are utilized principally as food for man. In addition to being eaten fresh, they are preserved by freezing, canning, salting, pickling, smoking, and even fermenting. Non-edible fish are made into oil, fertilizer, and meal. By-products of fish find many commercial applications, namely: oils for medicines, and soap; swim bladders of certain fish for isinglass; skins for glue manufacture; some skins for leather; some scales of fish for pearl essence manufacture; etc.

According to the Texas Almanac in 1940, the total commercial catch of fish on the Texas Coast was slightly more than 3,000,000 pounds, not including shrimps, oysters and crabs. Yet the Texas Coast has a large number of species, some 130, that are important commercial fish in other waters, namely, trout, flounder, red fish, drum, whiting, mackerel, red snapper, pompano, etc. From the standpoint of commercial production the Texas Coast fishing industry is still in its infancy and offers great possibilities.

All fish are of some value. If not for food, they can be used for fertilizer or in industry. With the great variety and number of fishes in the Gulf waters, it would seem that the time is here to develop some of these potentially important enterprises.

*Shell Fish.* Mollusks are utilized to an extent scarcely appreciated by many people. In America, the annual production of these fisheries constitutes approximately one-third of the total value of all the fisheries. The oyster production, for food alone, is about $15,000,000 annually. In addition, there are several millions of dollars worth of poultry grit, lime and fertilizer.

Oysters are distributed over the southern and eastern coast of the United States from Mexico to southern Canada. They do not live in the open ocean where the water is salty, but back in the bays and bayous where fresh water is mixed with sea water. In addition to large areas for oyster production, the Gulf Region has a long breeding season, extending from early spring to late fall. Oysters are ready to spawn when the water reaches a temperature of about 70° F. The long, warm period also results in rapid growth of oysters in Gulf waters. The natural factors greatly favor oyster production on the Texas Coast and Texas produces an excellent oyster; yet the annual production is under 1,000,000 pounds. This is less than half the production of 2,000,000 pounds produced in 1904, the peak year of production.

The clam and scallop industries are also large, but not on the Texas Coast. An industry greater than the oyster industry might be developed if Americans would eat the shellfish as the Europeans do.

*Crustacea.* Shrimp, lobsters, and crabs are now universally esteemed food. Yet, fifty years ago, the common blue crab was almost unknown as an article of food. The lobster catch is so great that their numbers have been seriously diminished. In the past few years, canned shrimp has become very popular in America. Because of this fact, the Gulf Coastal shrimp industry has undergone a sudden expansion and is now the largest fishery on the Texas Coast. The annual production for the past few years has been between eleven and twelve million pounds and brings an income of approximately $370,000 a year to the shrimp fishermen. From the beginning of the present century to 1941 the annual shrimp catch on the Texas Coast has increased from less than a quarter million pounds to almost 12,000,000 pounds. The rapid rise in this industry is truly phenomenal and may well be used to illustrate the possibilities of other fisheries of the Texas Coast. Shortly after World War I the introduction of otter trawl, a long funnel-shaped net with wings extending out from the open end on both sides and pulled behind power boats, and the canning and quick freezing of shrimp for market were largely responsible for the rapid rise in shrimp production. Louisiana, Florida and Texas, in that order, are by far the largest producers of shrimp in America.

There is much waste, about 40%, after the edible parts of these animals have been taken. Perhaps this waste could be used for fertilizer or some other commercial product. It is estimated that millions of pounds of this potential fertilizer are available annually. The percentage of waste material from crabs is probably greater, and this waste is also a potential source of fertilizer.

From a commercial point of view, crab production on the Texas Coast is practically negligible. In 1940 only 12,500 pounds were taken. Conditions for breeding, feeding and production in general are very good, yet little has been done about making the crab industry a worth-while undertaking on the Texas Coast.

The Cheasapeake Bay region produces about 60 million pounds of crab meat per year according to Gordon Gunter, Marine Biologist of the Texas Game, Fish and Oyster Commission. Mr. Gunter also points out that a biologist who studied the blue crab in the Chesapeake area has said that general observation has led him to believe that blue crabs are as abundant in Texas waters as in the Chesapeake Bay region. There is apparently no reason for the lack of development of a big crab industry on the Texas Coast.

*Other Products.* Whales, sharks, sponges, coral, minerals, vegetable products are important sources of income from the sea. The recent development of shark liver oil production has resulted from increases in the price of shark's liver. As much as $9.00 per pound has been paid by manufacturing concerns making capsules containing fish liver oils. Many other large sea animals, as the dolphin, porpoise and black fish, furnish valuable oils and leather, yet are of little commercial importance in the Gulf Region at present.

The Key West-Nassau region is of major importance for sponge production. Sponges can be cultivated and, if more interest were given to the fishery, an industry of great commercial value might be developed.

Coral fisheries from Japanese and Italian waters dominate this industry; the Gulf Coastal waters produce some and could greatly increase their production.

In addition to fisheries, the sea is a great source of common salt, potassium, magnesium and calcium salts iodine and bromine and perhaps other minerals. At present at Freeport, Texas, we have two huge chemical plants extracting magnesium and other elements from sea water.

The sea is also a great potential source of valuable vegetable matter. These marine plants, however, are utilized scarcely at all. The kelp burners of Scotland, France, Norway and Japan produce about a third of the world's iodine and tons of potash. Some sea weed is used for fertilizer, for feed and for food. Japan uses seaweed more extensively than any other country. If it were harvested in similiar quantities in other parts of the world, the annual production would reach a very high figure.

*Summary.* From the standpoint of commercial production, the marine resources of the Gulf Coastal waters have been barely touched. With a little encouragement, large industries could be developed.

## Soils, Vegetation and Ecological Succession in Walker County, Texas, as Related to Wildlife

S. R. WARNER, Head, Department of Biology, Sam Houston State Teachers College, Huntsville.

Some knowledge of the geology, soils and vegetational types of an area is essential to wise land use and especially to successful wildlife, range and forestry management. Perhaps of greatest advantage is information on the future possibilities afforded from data on the different stages of vegetation which appear and succeed each other in an orderly manner on the ground. The process by which these stages of vegetation grow and replace each other is known as ecological succession, and the final stage is considered the climax. The various stages of this replacement can be known through indicator species of vegetation which are more or less characteristic of the different stages. Through familiarity with these indicator plants, the farmer, the forester, or the wildlife manager can handle the lands under his control so as to afford the maximum economic return by anticipating the changes that are to be to his advantage or disadvantage. With this in mind, the writer has attempted to supply some data on Walker County, Texas, which are applicable with little change to Polk, Trinity, San Jacinto counties and apply in their generalizations to most of the counties of eastern Texas having similar soils and vegetations.

The present paper was written as part of a comprehensive wildlife survey of Walker and neighboring counties sponsored by the Texas Cooperative Wildlife Research Unit in close association with the Sam Houston State Teachers College, Huntsville. Some of the results of this survey have already appeared in print or in mimeographed form (see Taylor, 1937, Lay, 1940, Goodrum, 1940, and Warner, 1940).

*Geology and Soils.* From southwest to northeast, Walker County is traversed by four geological formations. According to age and position from north to south, these are the Jackson (Eocene), Catahoula (sometimes called the Corrigan formation, Oligocene), Lagarto clay (Miocene), and Lissie sand (sometimes called Willis sand of Lissie group, Pliocene-Pleistocene).

Lissie sand is the youngest formation geologically, although it is the oldest on the basis of soil maturity because it is the most leached and stabilized. It supports the best pine-woodland type, and the southern evergreen forest extends farthest westward on soils of this formation. In the southeastern part of the county the Lissie sand forms a continuous belt; elsewhere this soil occupies large areas superimposed upon the Lagarto clay and upon the Catahoula to form sandy ridges.

The Lagarto clay is virtually an eastward extension of the blackland prairie into the forested region of eastern Texas. The parent material of the Lagarto is a heavy, calcareous clay. Three soils are developed on this formation, the Houston black clay (see Carter, 1931, pp. 58 and following), the Wilson clay loam, and the Crockett clay loam, which are named inversely with the amount of leaching of calcium carbonate.

In their soil structure and degree of leaching, the Catahoula and Jackson are intermediate between the heavy, calcareous Lagarto clay and the friable, leached soils of the Lissie sand. In fact, the transitional zone produced by an intermingling of the Houston black clay of the Lagarto and the Susquehanna fine sand of the Lissie is strikingly similar, both in its plant composition and in its surface soil features, to that of the Catahoula and Jackson geological formations. The surface soils are silty, fine sandy loams; the subsoils, sticky, poorly aerated, plastic clays. The most characteristic vegetational features are scrub oaks and hawthorns.

*Vegetational Types in Relation to the Soil Groups.* The distribution of the four vegetational types represented in Walker County in relation to the soil groups may be indicated as follows:

I. Pine Woodlands—Susquehanna, Ruston and Segno soil series, 195,400 acres.

II. Post Oak Woodland—Lufkin, Crockett soil series, 184,900 acres.

III. Blackland Prairie—Houston, Wilson soil series, 83,800 acres.

IV. Bottomland Hardwoods—Ochlockonee, Trinity, and Bibb soil series, 54,900 acres.

A general description follows of each soil group, and of the final stage reached in Walker County by each vegetational type whether this be climax or sub-climax in character. Successional changes in the vegetation following cultivation are considered and lists of indicator species and species important to wildlife given for each stage of succession.

*Pine Woodland.* This vegetation occupies about 195,400 acres of the uplands of Walker County. These light colored sandy soils with yellow and reddish friable sub-soils are developed from the Lissie geological formation and belong to the Segno, Ruston, and the sandy types of the Susquehanna series. Two climax forest types constitute the pine woodland.

One of these climaxes, the loblolly-hardwood forest type, characterized by a luxuriant growth of loblolly pine, tall hardwoods and evergreen shrubs, dominates the more fertile and better watered phases of this soil group. This type extends southeastward into San Jacinto and Polk counties to form the "Big Thicket" (see Baird and others, 1936) of Texas and should be preserved as a wildlife refuge and a forest and water-conservation area.

The porous, friable nature of its sub-soils favors storage of underground water, a point of considerable significance to the cities to the southward; the numerous springs and clear spring branches are favorable to animal life; and the luxuriant evergreen shrubs and vines supply excellent concealment cover and winter browse for deer. A list of these climax evergreens clearly indicates their importance.

The food supplied by tree mast (acorns and seed from the oaks and pines) is considerable. Fruits of the forest include muscadine grape, *Berchemia,* holly, dogwood, hawthorn, blueberry, huckleberry, partridge berry, French mulberry, black gum, witherod, red bay, sassafras, and smilax *(Smilax bona-nox and pumila).*

The other climax, the shortleaf-loblolly forest type, dominates the less fertile drier phases of the pine woodland soil group. The pines are accompanied by scattered red oaks and post oaks, black and white hickory, and poor quality sweet and black gums. The most characteristic feature of this forest type is an understory of French mulberry *(Callicarpa)* which is ever present and as abundant as the two species of pine. Most of the fruiting shrubs listed for the loblolly hardwood forest type occur here, but less abundantly, except in case of French mulberry, the sumacs, *Vitis lineacomii* and dewberries which are more abundant. This type affords rather poor conditions for game species except for a period of about 15 years following lumbering. After 15 years, the second growth timber shades out many of the species that constitute acceptable food and cover plants for wildlife.

Plant Succession on Pine Woodland Soils:

(1) Early weed stage following cultivation, mostly annual weeds.

Indicator species:

Diodia teres (button weed), Heterotheca subaxillaris (camphor weed), Plantago virginica (plantain), Rumex hastatulus (sheep sorrel), Festuca octoflora (fescuegrass), Apolpappus divaricatus.

Other plants, some of them importnat to wildlife:

Croton capitatus (dove weed), Ambrosia artemisiifolia (common ragweed), Geranium carolinianum (wild geranium), Lepidium apetalum (pepper grass), Oenothesa lacinata (pigweed), Richardia scabra (poor Richard), Digitaria sanguinale (crabgrass), Serinia oppositifolia (dwarf dandelion), Medicago hispida (bur clover), Strophostyles helvola (trailing wild bean), Cynodon dactylon (Bermuda grass).

(2) Late weed and low grass stage, mostly perennials.

Indicator species:

Aristida longespica (three-awned grass), Axonopus compressus (carpet grass), Cerastium viscosum (mouse-eared chickweed), Paspalum pubescens, Paspalum ciliatifolium, Trifolium carolinianum (Carolina clover), Lespedeza striata (Japan clover), Vicia ludoviciana (Blue vetch).

Other plants, some of them important to wildlife:

Cynodon dactylon (Bermuda grass), Polygonum punctata (smart weed), Panicum dichotomiflorum (fall panicum), Panicum brachyanthum, Digitaria villosum (tall crabgrass), Desmodium rigidum (beggarweed), Desmodium sessilifolium (beggarweed).

(3) Tall grass stage, principally perennial grasses, and perennial weeds.
Indicator species:

Andropogon virginicus (broomsedge), Andropogon scoparius (little bluestem), Eupatorium compositifolium (perennial ragweed), Cnidoscolus texanus (bull nettle).

Other plants, some of them important to wildlife:

Panicum anceps (beaked panic grass), Rubus trivialis (dewberry), Linum striatum (yellow flax), Verbena xutha (vervain).

(4) Open woodland stage, principally a sub-climax resulting from lumbering.

Indicator species:

Galactia regularis (milk pea), Rhynchosia latifolia (wild bean), Lespedeza hirta (bush clover), Desmodium obtusum (beggarweed), Schrankia angustata (sensitive briar), Panicum anceps (beaked panic grass), Panicum ciliatum, Scleria triglomerata (nut sedge), Commelina erecta (day flower), Acalypha virginica (three-seeded mercury), Crotonopsis linearis, Liatris elegans (blazing star).

Other species, some of them important to wildlife:

Strophostyles leiosperma (trailing wild bean), Centrosema virginianum (butterfly pea), Cassia nicitans (small partridge pea), Desmodium dilleni (beggarweed), Euphorbia corollata (flowering spurge), Croton glandulosus, Croton capitatus (dove weed), Tragia nepetaefolia (nettle spurge).

(5) The climax forest is of two types.

(a) Loblolly hardwoods, on the more fertile and less dry soils, characterized by *Pinus taeda* and by tall hardwoods.

Indicator species:

Pinus taeda (loblolly pine), Quercus alba (white oak), Quercus nigra (water oak), Liquid-ambar styraciflua (sweet gum), Nyssa sylvatica (black gum), Cornus florida (flowering dogwood), Morus rubra (red mulberry), Hicoria alba (white hickory), Viburnum rufidulum (black haw), Ostrya virginiana (ironwood).

Characteristic evergreens of the climax, most of them important as winter browse for wildlife:

Ilex vomitoria (yaupon), Ilex opaca (American holly), Symplocos tinctoria (sweet leaf), Myrica cerifera (wax myrtle), Persea borbonia (red bay), Magnolia grandiflora (magnolia), Smilax pumila (dwarf smilax), Smilax laurifolia (southern smilax) Smilax lanceolata (swamp smilax) Rubus argutus (blackberry, semi-evergreen), Gelsemium sempervirens (yellow jasmine), Mitchella repens (partridge berry).

(b) Shortleaf loblolly type on the poorer, drier soils.

Dominant indicators:

Pinus echimata (shortleaf pine), Quercus rubra (southern red oak).

Understory indicator species:

Callicarpa americana (French mulberry, very abundant), Quercus stellata (post oak), Quercus marilandica (blackjack oak), Rhus canadensis (fragrant sumac).

*Post Oak Woodland.* The post oak woodland vegetational type, about 184,900 acres within Walker County, includes a post oak-blackjack association or scrub hardwood forest in the western part of the area; a scrub hardwood-shortleaf pine forest type in central Walker County; and a longleaf pine forest type accompanied by scrub hardwood farther eastward in Trinity, Polk and San Jacinto counties.

The soils of this group of types are developed from the Jackson and Catahoula geologic formations, most characteristically belonging to the Lufkin series. Other soils present are the Crockett and heavier phases of the Susquehanna. All of the soils possess shallow, fine sandy loam surfaces and sub-soils of silty, plastic clay. These soils are droughty in dry seasons and wet and poorly aerated in wet seasons.

Each of the forest types found in the post oak vegetational group is an open woods and possesses more abundant herbaceous ground cover of weeds and grasses than is present in the pine woodland. The shrub understory is less characterized by French mulberry than in the pine woodland but contains a greater number of other fruiting shrubs such as hawthorns (*Crataegus*), possum haw (*Ilex decidua*), wild privet (*Forestiera pubescens*), yaupon (*Ilex vomitoria*), coral berry (*Symphoricarpos orbiculatus*), dewberry (*Rubus trivialis*), and tree huckleberry (*Vaccinium arboreum*).

Plant Succession on Post Oak Soils and the Transitional Zone Between Prairies and Pineland:

(1) Early weed stage following cultivation, mostly annual grasses and weeds.

Indicator species:

Brachiaria extensa (joint grass), Iva angustifolia (narrow leaf marsh elder), Plantago aristata (bracted plantain).

Other species, some of them important to wildlife:

Digitaria sanguinalis (crabgrass), Diodia teres (buttonweed), Cassia fasciculta (partridge pea), Sesban macrocarpa (sesban), Strophostyles helvola (trailing wild bean), Croton capitatus (dove weed), Medicago denticulta (bur clover), Valerianella stenocarpa (lamb's lettuce), Serinia wrightii (dwarf dandelion).

(2) Late weed and low grass stage.

Indicator species:

Strophostyles leiosperma (trailing wild bean), Stylosanthes biflora (pencil pea), Ptilimnium nuttallii (bishop's weed), Arenaria nuttallii (flowering chickweed), Chrysopsis pilosa (golden aster), Callirrhoe involucrata (wine cup), Rubus trivialis (dewberry), Aristida oligantha (three-awned grass), Paspalum plicatulum (honey grass), Paspalum distichum (knot grass), Lespedeza procumbens (bush clover).

Other species, some of them important to wildlife:

Trifolium carolinianum (Carolina clover), Trifolium bejarienese, Trifolium amphianthum (pink clover), Vicia ludoviciana (blue vetch), Cerastium viscosum (mouse-eared chickweed), Ambrosia psilostachya (perennial ragweed), Aristida purpurascens (arrow feather), Paspalum dilatatum (dallis grass), Sporobolus poiretii (smut grass), Cynodon dactylon (Bermuda grass).

(3) Tall grass stage, mostly tall perennial grasses and perennial weeds.

Andropogon ternarius (silver plume), Liatris pycnostachya (blazing star), Lespedeza stuvii (bush clover).

Other species, some of them important to wildlife:

Andropogon virginicus (broomsedge), Andropogon scoparius (little bluestem), Andropogon furcatus (big bluestem), Paspalum floridanum (large paspalum), Lespedeza frutescens (bush clover), Desmodium obtusum (beggarweed).

(4) Climax stage, an open woods.

Woody plants, indicators:

Quercus stellata (post oak), Quercus marilandica (blackjack oak), Hicoria buckleyi (black hickory), Pinus echinata (shortleaf pine), Pinus palustris (eastward) (longleaf pine), Crataegus spathulata (spathulate haw), Crataegus marshallii (parsley haw), Forestiera pubescens (wild privet), Vaccinium arboreum (tree huckleberry), Rubus trivialis (dewberry).

Other woody plants, some of them important to wildlife:

Quercus rubra (red oak), Ulmus alata (winged elm), Pinus taeda (loblolly pine), Ilex decidua (possum haw), Ilex vomitoria (yaupon), Symphoricarpos orbiculatus (coral berry), Simlax bona-nox (greenbriar), Vitis candicans (mustang grape).

Herbaceous plants, indicators:

Baptisia leucophaea (wild indigo), Stililingia sylvatica (queen's delight), Acalypha gracilens (three-seeded mercury), Lithospermum incisum (puccoon), Phlox tenuis (dwarf phlox), Lechea villosa (pinweed), Iva angustifolia (narrow leaf ragweed), Callirrhoe involucrata (wine cup).

Other herbaceous species, some of them important to wildlife:

Schrankia nuttallii (sensitive briar), Tephrosia onobrychoides (goat's rue), Triodia flava (purple top), Euphorbia corollata (flowering spurge), Scleria triglomerata (nutrush).

*Blackland Prairie.* The blackland prairie type comprises about 83,800 acres in Walker County, most of which is in cultivation except where erosion has caused abandonment. Prairie vegetation is characteristic of the Lagarto clay and smaller areas scattered throughout the Catahoula and Jackson formations. The black to dark grey, heavy clays belong to the Houston and Wilson soil series. Both surface and subsoil of the Houston black clay are calcareous. The Wilson clay loam is a blackish grey soil possessing free carbonate in the subsoil but not in the surface soil.

The final stage of vegetation on the blackland prairie (see Warner, 1926, p. 361) is an association of *Stipa, Sporobolus,* and *Andropogon* except under conditions of heavy grazing when these are replaced by dallis, Bermuda, Texas grama, three-awned, and buffalo grasses. The "worn out" and eroded old fields are occupied by a subclimax of *Aristida* and *Andropogon* grasses, together with the herbaceous perennials listed in the third stage of succession on blacklands.

Plant Succession on Blackland Prairie Soils:

(1) Early weed stage following cultivation, mostly annual weeds.

Indicator species:

Croton monanthogynus (prairie doveweed), Euphorbia nutans, Euphorbia bicolor (snow-on-the mountain), Plantago occidentalis (tallow weed), Pyrrhopappus multicaulis (tall dandelion), Centaurea americana (star thistle), Lindheimera texana (prairie star).

Other species, some of them important to wildlife:

Euphorbia arkansanus (wart fruited spurge), Plantago rhodosperma (tallow weed), Ambrosia trifida (giant ragweed), Iva ciliata (rough marsh elder, Ipomoea trifida (tie vine), Helianthus annuus (sun flower), Sorghum halepense (Johnson grass), Panicum texanum (Texas millet), Panicum fasciculatum (brown top).

(2) Late weed stage and low grasses.

Indicator species:

Rhynchosia minima (wild bean), Bifora americana (lace flower), Gutierrezia dracunculoides (broomweed), Chaerophyllum texanum (chervil), Galium virgatum (bedstraw), Heliotropium tenellum (wild heliotrope), Hordeum pusillum (wild barley), Bromus catharticus (rescue grass), Panicum spaerocarpum (panic grass), Eustoma russellianum (Texas bluebell), Monarda citriodora (prairie horsemint).

Other species, some of them important to wildlife:

Vicia texana (Texas vetch), Vicia leavenworthii (blue vetch), Lathyrus pusillus (vetchling), Melilotus alba (white sweet clover), Medicago lupulina (black medic), Setaria lutescens (foxtail grass), Sisyrinchium pruinosum (blue-eyed grass), Paspalum dilatatum (dallis grass).

(3) Climax stage, tall, mostly perennial grasses and perennial herbs.

Indicator species:

Andropogon saccharoides (prairie beard grass), Andropogon furcatus (big bluestem), Sporobolus asper (prairie dropseed), Stipa leucotricha (Texas needle grass), Petalostemon purpureus (prairie clover), Petalostemon multiflorus (prairie clover), Desmanthus illinoensis (acacia), Desmanthus leptolobus (acacia), Phaneotaenia nuttallii (prairie parsley), Cacalia tuberosa (Indian plantain), Helianthus maximiliani (prairie sunflower), Onosmodium molle (gromwell), Kuhnia gutinosa (prairie boneset).

(4) Woody plants found associated with climax stage of blackland prairies where irregularities in topography permit their appearance.

Prunus angustifolia (chickasaw plum), Prunus mexicana (Mexican plum), Celtis laevigata (southern hackberry), Maclura pomifera (bois d'arc), Gleditsia triacanthos (honey locust), Bumelia lanuginosa (buckthorn), Juniperus virginiana (red cedar), Cornus asperifolia (rough leaf dogwood), Prosopis glandulosa (mesquite), Vitis candicans (mustang grape), Crataegus viridis (green hawthorn), Cercis canadensis (redbud), Morus rubra (red mulberry), Quercus stellata (post oak), Quercus shumardii (Shumard's oak).

*Bottom Land Hardwoods.* The bottom land hardwoods occupy about 54,900 acres in Walker County. This vegetation has not been subdivided because of the difficulty in plotting. It represents two types, (1) the elm-oak hardwoods on the clay soils of the larger stream valleys which usually are referable to the Trinity or Bibb soil series, and (2) the loblolly pine-tall hardwoods of the sandy smaller stream valleys which belong to the Ochlockonee soil series. The vegetation on Ochlockonee soils is much the same as the adjacent loblolly-hardwood forest type of the pine woodland, except that it has richer flora of vines, shrubs, and evergreens and is better suited to woodland animals.

The vegetation in the larger bottoms, where the soils are mostly heavy clays of the Trinity and Bibb series, contains most species of the vines and tall hardwoods of eastern Texas. These supply the best habitat for the gray squirrel and the raccoon. Many shrubs occur as undergrowth, the most conspicuous of which is dwarf palm *(Sabal minor)*. Originally, the undergrowth was largely switch cane *(Arundinaria tecta)* which has been for the most part suppressed by overbrowsing. The principal herbaceous ground cover is made of several species of *Carex,* which constitutes the principal winter and spring grazing of the shaded woodland. Plant succession on bottomland hardwood resembles that on the better upland soils, although certain species show preference for this habitat.

Plant Succession on Bottom Land Hardwood Soils:

(1) Early weed stage following cultivation, mostly annual weeds and grasses.

Indicator species:

Sesbania macrocarpa (sesban), Ambrosia trifida (giant ragweed), Iva ciliata (rough leaf elder), Echinochloa colonum (jungle rice), Sida spinosa (sida), Xanthium speciosum (clotbur), Ipomoea cairiea (morning glory), Panicum dichotomiflorum (fall panic grass).

Other species, some of them important to wildlife:

Amarantus palmeri (careless weed), Amaranthus retroflexus (redroot), Sorghum halepense (Johnson grass), Ipomoea trifida (tie vine).

(2) Late weed stage and low grasses.

Indicator species:

Leptochloa filiformis (sprangletop), Paspalum dilatatum (dallis grass), Paspalum pubiflorum (water grass), Setaria verticillata (foxtail), Eryngium hookeri (eryngio), Passiflora incarnata (maypop), Desmodium paniculata (beggarweed).

Other species, some of them important to wildlife:

Bromus catharticus (rescue grass), Axonopus compressus (carpet grass), Medicago denticulata (bur clover), Lespedeza striata (Japan clover).

(3) Tall grass stage, perennial grasses and weeds.

Indicator species:

Andropogon glomeratus (bushy beard grass), Panicum virgatum (switch grass), Arundinaria tecta (switch cane), Tripsacum dactyloides (gama grass).

Other species, sometimes important to wildlife:

Andropogon virginicus (broom sedge), Paspalum uvillei (Vasey grass).

(4) Woodland stage, usually an open woodland subclimax condition resulting from partial lumbering.

Indicator species:

Muhlenbergia schreberi (nimbleweed), Elymus canadensis (wild rye), Poa autumnalis (woods-bluegrass), Carex laxiflora (carex), Carex oxlepis (carex), Cynosciadium pinnatum (dog parsley), Sanicula canadensis (snakeroot), Ranunculus repens (creeping buttercup), Dianthera lanceolata (water willow), Ptilimnium capillaceum (bishop's weed).

Other species, some of them important to wildlife:

Carex lupulina (carex), Carex cherokeensis (carex), Carex crus-corvi (carex), Trepocarpus aethusae, Hydrocotyle verticillata (pennywort).

Woody plants:

Arundinaria tecta (switch cane), Sebastiana ligustrina, Vitis cinerea (downy grape), Brunnichia cirrhosa (buckwheat vine), Sambucus canadensis (black elder), Crataegus viridis (green haw), Forestiera acuminata (wild privet), Cephalanthus occidentalis (buttonbush), Sabal minor (dwarf palmetto).

Other species, some of them important to wildlife:

Rubus argutus (blackberry), Vitis candicans (mustang grape), Vitis cordifolia (frost grape), Vitis rotundifolia (muscadine), Berchemia scandens (rattan supplejack), Cissus arborea (pepper vine), Cissus ampelopsis, Simlax bona-nox (green briar), Parthenocissus quinquefolia (Virginia creeper), Crataegus marshallia (parsley haw), Prunus mexicana (Mexican plum), Forestiera pubescens (wild privet), Cercis canadensis (redbud).

(5) The elm-oak association is the climax stage of the bottom land hardwoods where a close stand exists. Elsewhere most members of stage (4) occur together with the following tall hardwoods.

Indicator species:

Ulmus crassifolia (cedar elm), Ulmus americana (American elm), Quercus lyrata (overcup oak), Quercus phellos (willow oak), Quercus shumardii (Shumard's oak), Quercus rubra leucophylla (cherrybark oak), Hicoria pecan (pecan), Hicoria aquatica (water hickory), Tilia caroliniana (Basswood), Sophora affinis (pink sophora), Diospyros virginiana (persimmon), Gleditsia aquatica (water locust), Planera aquatica (planer tree), Fraxinus caroliniana (water ash).

Other trees, some of them important to wildlife:

Liquidambar styraciflua (sweet gum), Nyssa sylvatica (black gum), Quercus nigra (water oak), Quercus stellata (post oak), Quercus prinus (swamp chestnut oak), Celtis laevigata (hackberry), Fraxinus americana (white ash), Fraxinus pennsylvanica (green ash).

*Plant Succession Following Timber Cutting.* A careful study of the changes in the vegetation in Walker County on cutover land has been made by Lay (1940, pp. 14 to 19) who states, "Plant succession in cutover pine woodland shows a number of differences from that in abandoned fields. The differences in the two are the result of the different degrees of disturbance initiating the successions. In general the cutover pine woodland has been disturbed less than the cultivated fields. Where logging is conservative, the plant community may be set back only one or two stages; annual weeds may never appear in great numbers. The presence in fresh cutover of many woody shrubs and rootstocks, and some uncut trees, accounts for much of the apparent difference in the two successions. Along the trams and side lanes, succession is set back more than it is in cutover where only the larger trees have been removed. The pine woodland succession may be considered in four stages: (1) sprouts, (2) early intermediate, (3) late intermediate, and (4) near-mature pine.

"Long before a woodland reaches the climax, it may be termed nearly mature, as far as its effects upon occupation by quail are concerned. Most of the woody species are then of fruiting age and few herbaceous annuals remain; the grasses present are all shade-tolerant species."

The mature second growth stand of woods following timber cutting contains more hardwoods than are found in the forest developing upon abandoned cultivated land. The latter is almost a pure stand of pine, whereas the cutover woods goes through an oak-gum stage prior to being overtopped by the pines, which suppress much of the hardwood, especially the blackjack oak. The more shade-tolerant hardwoods become a part of the climax stage. Cutover woods, if not overgrazed, afford good conditions for deer and turkey up to about the 15th year and longer where woods remain open.

*Grazing.* Seventy-five percent. of the area of Walker, San Jacinto, Trinity, and Polk counties is open woodland and forest pasture, and is grazed twelve months in the year. During the winter months, farmland areas under fence are also grazed. It is not customary in this section of Texas to feed cattle during the seasons of forage shortage in winter and in drought periods of late summer. This results in overgrazing and severe browse damage. Some effects of cattle on food and shelter for wildlife, and some changes produced by overgrazing on forest and grassland succession are discussed in the following paragraphs.

Influence on food supply: The food value of all palatable plants, excepting certain unusually tolerant low-growing plants, is greatly lessened by the grazing and browsing of catte. Examples of plants unusually tolerant of grazing are Japan clover, bur clover, Carolina clover, violets, wood sorrels, day flower, plantains, carpet grass, crab grass, and the shorter panic grasses. Some plants of unpalatable foliage yield important seed foods, notably members of the spurge family such as doveweed and other crotons, snow-on-the-mountain, bullnettle, stillingias, euphorbias, tragias and other than spurges, the various ivas, buttonweed, buttercups, pinweeds, smartweeds, mints, broomweeds, and several umbellifers.

Influence on cover: The obvious effect of overgrazing is lack of adequate concealment cover in pastures. This is particularly true where pastures are mowed for weeds. The best weed cover on the blackland prairie soils is made up of broomweed, small croton, and snow-on-the-mountain; that on the sandy soils comprises doveweed, thoroughworts, and low branching young pines; that on the post oak soil type is composed of *Iva angustifolia,* doveweed, pinweed, and hawthorn, and that on bottoms is dwarf palmetto, smilax, and blackberry.

The browsing of cattle reduces suitable concealment of deer in winter because it damages evergreens such as sweetleaf, wax myrtle, holly and switch cane. Yaupon and red bay withstand browsing and supply good cover. The trampling effect of cattle is most disturbing to birds that nest on the ground, and to the beds of certain small mammals. Strips adjacent to pastures and small ungrazed areas should be established as runways and nesting sites if wildlife is to be maintained on heavily grazed areas.

Influence on forest and forest succession: The forest is kept more open because of grazing. Many valuable tree species such as magnolia, ash, mulberry, sassafras, wateroak, maple, and red cedar are suppressed and largely prevented from reproducing by livestock grazing. Grazing tends to develop a forest of pine, oak, hickory, and gum. Obviously grazing is of some benefit to open forest through lessening the danger of fire. Tall grasses and bramble thickets which result from release of grazing constitute an important fire hazard. Grazing and the associated reduction in severity of fire is in part responsible for the character of the present forest of Walker and adjoining counties, in that it favors oaks and gums.

Influence on grassland succession: On ungrazed better phases of blackland, the climax vegetation is a *Stipa-Sporobolus* association, while on the poorer phases of the blackland, on the transitional soils from blackland to sandy loam, and on soils of the post oak type, the climax vegetation is an open woods of scrub oaks and andropogons. Due to heavy grazing, however, these various grasses are very little in evidence and their place is occupied by the short grasses, mostly such introduced species as Bermuda, carpet, and dallis grasses.

*Burning.* Burning tends to set back the vegetation to an earlier stage of succession. This is accompanied by certain disadvantages and advantages.

First, consider the disadvantages. While winter burning does not seriously affect the perennial legumes, it does destroy all the winter annuals, such as clovers, vetches, plantagos, serinias, chickweeds, and rescue grass, the seeds of which are important foods for quail and doves and supply pasturage for deer and cattle. Burning destroys both the winter seed germination of longleaf pine and seedlings under two years of age. The seedlings and saplings under six years of age of the shortleaf and loblolly pines are also intolerant of fire. It destroys cover for wildlife at the critical season of exposure to predators and bad weather. This is particularly bad practice along stream banks, gully edges, fence rows, and the margins of fields and woods. It is also a factor in increasing run-off and soil erosion. Burning decreases the humus and prevents the development of the more favorable mesophytic conditions for a forest.

Late March burnings in pastures destroy early spring seedlings of Japan clover *(Lespedeza),* and such winter annuals as clovers, vetches, and many other wildlife food plants, as well as reproduction of pine for that particular spring.

Late summer burning is the worst and hardest to control. It is destructive to both small and large trees, and lessens fruits, mast, and young game. It eliminates the late maturing quail foods and does serious damage to the bottom land switch cane. It tends to be more destructive to hardwood trees than to the larger pines, hence over long periods of time an occasional fire, fifteen to twenty years apart, tends to develop a pine forest instead of a hardwood forest.

On the other hand, winter burning possesses some advantages. For example, winter burning lessens the hazard of devastating summer fire which often occurs in dry summers in spite of all efforts at prevention. Winter fires are easier to control than at other times, and increase the quantity and quality of browse vegetation. Such burning encourages the sprout stage for such palatable plants as smilax, blackberry, red haw *(Crataegus),* yaupon (Illex), elm, water oak, and sweet gum. Winter burning does not have a detrimental effect on perennial grasses and perennial legumes. Carefully controlled slow fires during the winter may help to remove excessive roughs of unpalatable grasses such as broomsedge. The propriety even of slow, controlled fires may be debated in the pine-oak-hickory type of Walker County, but in the longleaf pine belt of southeastern Texas fire of the slow singeing type during the late fall or early winter helps to maintain palatable forage grasses and valuable herbaceous plants such as partridge pea, vetch, beggarweed, bush lespedezas, and other legumes. From a forestry production standpoint the use of controlled fire may sometimes be defensible on the basis of preventing the accumulation of a serious hot-fire hazard and enabling better germination of pine seedlings by exposing some of the mineral soil.

Many herbaceous perennials, such as beggarweed, bush clovers, *Stylosanthes* and *Stillingia* seem to improve under late fall and winter burning. The seeds are more accessible to birds, and conditions are less favorable to rodents. While, as Lay has pointed out (see Lay 1940), burns have considerable value for quail after the surrounding forest crowds the birds out, since the burned areas remain open longer and are the last haven for quail in forest succession following lumbering, nevertheless Lay considers conditions superior for quail in the early stages of succession in the unburned, rather than the burned areas.

The most favorable time for partial or spot burning of limited areas is from October to December when the weather conditions are favorable to easily controlled, slow-burning fires. The partial removal of excess old grass cover and pine needles seems to be favorable to some winter annuals which germinate with the cool rains of late November and December, also to short grasses. Burning also helps to control cotton rats by the destruction of old grass mats.

It goes without saying that any burning should be done with the greatest care, when the air is still, and when the lower layer of leaf litter is moist so as to permit rigid control. Fire lanes at intervals are a desirable precaution. Care should be taken that the burning is not done so late in the winter that the winter annuals would be killed by the burning, or so late in the spring that early spring and summer plants would be destroyed. It is especially important to avoid all burning whatsoever after the nesting season has begun for ground birds such as bobwhite quail.

*Summary.* There are four principal vegetational types in Walker County, Texas. They are: I. Pine woodland (on Susquehanna, Ruston, and Segno soils); II. Post oak woodland (on Lufkin and Crockett soils); III. Blackland prairie (on Houston and Wilson soils; IV. Bottom land hardwoods (on Ochlockonee, Trinity, and Bibb soils).

The pine woodland soil occupies about 195,400 acres of Walker County uplands and is made up of two climax forest types: loblolly-hardwood in the more fertile, better watered places and shortleaf-loblolly in the less fertile, drier areas. The key indicator species: (a) for the loblolly-hardwood are loblolly pine, water oak, white oak, sweet gum, flowering dogwood, American holly, yellow jasmine, muscadine grape, and wax myrtle, (b) for the shortleaf-hardwood type are shortleaf pine, French mulberry, red, post, and blackjack oak, fragrant sumac, St. Andrews Cross, and post oak grape.

The loblolly-hardwood type is excellently suited for deer because of the winter browse and shelter offered by numerous evergreen shrubs. It is also a good habitat for squirrel and fur bearers because of accessibility of water and large hardwoods supplying hollows for shelter. The shortleaf-loblolly is the poorest wildlife vegetational type because of its uniformity and limited variety of food species. This condition is accentuated by the open range practice of overgrazing, and of forest burning. But it is quite favorable for quail for a period of about fifteen years following timber cutting or following cultivation.

The post oak woodland vegetational type of soil occupies about 184,900 acres and is made up of three forest types, namely: (1) the scrub hardwoods type in the northwestern part of the county, (2) the shortleaf pine-scrub hardwood type of the northeastern part of Walker County, and (3) the longleaf-scrub hardwood in the adjoining counties eastward. Decrease in moisture and leaching effects account for the differences westward in these three types. All types are grassy woodlands of savanna character, possessing a large variety of herbaceous quail food species and abundance of fruit bearing shrubs. Indicator species are post oak, blackjack, black hickory, hawthorn, tree huckleberry, coral berry, wild privet, *Iva augustifolia, Baptisia leucophaea,* flowering chickweed, bishops weed, wine cup, dwarf phlox, and queen's delight. The post oak woodland vegetational type is fairly well suited to quail, fox squirrel and turkey.

The blackland prairie type of soil comprises about 83,800 acres in Walker County and supports a vegetation similar to that of the counties in the blackland prairie belt of Texas. The indicator species are prairie doveweed, star thistle, broomweed, snow-on-the-mountain, Texas bluebell, prairie beard grass, Texas needle grass, prairie clover, rough leaf dogwood,

chickasaw plum, and bois d' arc. This vegetational type is largely under cultivation except where erosion has caused it to be abandoned. The transitional zone between this and the adjoining types supports a greater abundance of legumes and a larger number of plant species than any one of the upland vegetational types of the county, therefore furnishing excellent food and shelter for wildlife animals.

The soils of the bottom land hardwood type occupy about 54,900 acres in Walker County. There are two forest sub-types in the bottoms: the elm-oak type on the heavy soils of the larger streams, and the hardwood-loblolly type on the sandy loams of the small stream valleys. The indicator species of elm-oak type are cedar elm, willow oak, switch cane, dwarf palmetto, sesban, rough leaf elder, bushy beard grass, gama grass, nimblewill grass, and several species of carex. This type is the best habitat for gray squirrel, raccoon, mink, and water birds. Conditions are also favorable for deer and turkey.

This survey classifies the land of Walker County into four climax vegetational types on the theory that these were the original vegetational types prevailing in the county. The trend today is to return to this original climax type whenever cultivation or lumbering is discontinued. Good game and wildlife conditions can be restored throughout the county by intelligent game management practice which gives thought to the successional stages of the vegetation and to the desirable native food and shelter plants which can be increased for each stage of each vegetational type.

At present the greater part of Walker County is an overgrazed open range which is used by livestock twelve months in the year, and although it contains many wildlife food plants, the lack of suitable shelter areas and protection from the tramping of cattle is detrimental to best wildlife conditions. Limited grazing seems desirable at certain seasons to keep down fire hazard from tall grasses.

Burning has had both advantages and disadvantages to wildlife. To be desirable, burning should occur in late fall and early winter after fall rains, but before the germination of winter legumes, and then only on limited areas. Some controlled burning would lessen the hazard of extensive fires that often occur in dry weather. Spring burning has the disadvantage of destroying all germination of Japan clover, partridge pea and black berries, and does much damage to other valued wildlife food plants.

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## Some Wild Flowers of Red River County and Adjoining Territory

DELPHINE CROOK, Detroit, Texas.

Red River County is located in the northeastern part of Texas. It is bounded on the north by Red River, on the south by Sulfur River, on the east by Bowie County and on the west by Lamar County. The soil is of 39 types, mainly of various sandy and clayey loams with an outcropping of Houston Chalk near the center. The northern half of the county is mainly in native timber, second-growth, and cut-over lands. The central and southern parts are largely prairies with timber along the Sulfur River bottoms. The altitude is about 450 feet, the average annual rainfall is 41 inches, and the mean annual temperature is 65.1 degrees.

Quite likely, there is something in bloom every day in the year, but the spectacular bloom that everyone notices is in full glory by March and continues unabated until the arrival of a killing frost which occurs usually in late November.

In spring, the prairies are resplendent with the flower that might well have been chosen the State flower had the Bluebonnet not won that place. It is the Oenothera speciosa, also called Hartmania speciosa. This plant is to be found throughout the state. The color ranges from pure white through the various shades of pink. It is characteristic of this one oenothera that is *not* yellow to throw, occasionally, a yellow sport. It has been the writer's rare good fortune to observe this phenomenon twice. No other yellow primrose has the ethereal beauty of the yellow sport.

Other vivid prairie flowers are the wild Sweet William, Phlox pilosa, Verbena canadensis and Verbena bipinnatifida. Vying with these will be the Sisyrinchium in many species but all called "Blue-eyed grass," even those that are white with a yellow eye.

Achillea millefolium varies its natural white with pink now and then, but the color recedes when the pink plants are transplanted.

The Pentstemon is the most interesting group to study. The P. digitalis is the most common one, but there are P. tubaeflora, P. albidius, P. accuminatus, P. gracillis and others. In Lamar County, near Hinkly, is a patch of Pentstemons that are a variation of Texas' most gorgeous one, P. cobaea. The writer has not found plants like these elsewhere. They vary from the type in several respects, but they could probably not be classified as another species.

Indian Cress is the local name for Linaria texana and for L. canadensis. It seems to be more pleasing than the name "bule toadflax" that designates that plant elsewhere.

Agave maculosa, sometimes called Manfreda, is a plant that wins mention here because it is queer. The flowers resemble a Preying Mantis. It has a pleasing fragrance which compensates for its lack of beauty. The foliage, too, is queer. On most of the plants the leaves are flecked with red, so that they look for all the world as if they had been spattered with fresh blood. It is one of the plants called "rattle snake master." A poultice of the leaves is supposed to cure snake bite.

Hymenocallis occidentalis and H. orientalis are two beautiful and unusual flowers that have many features of interest. The former is spring flowering. The foliage and leaves appear together. The writer gives preference to the summer or fall flowering one, because the white is more intense and the flowers are less fragile. The foliage of H. occidentalis is a brighter green than is the foliage of H. orientalis. Neither of these is the same as the Hymenocallis that grows in the vicinity of Houston.

Cooperia drummondii is known as the "White Rain Lily" and grows on the hard-packed meadows. After every summer rain, the lovely, fragrant flower bursts into bloom like magic. The bloom lasts only a day or two, and unless the flowers set seed there will be nothing to indicate where they grew until the next shower brings them to bloom again. The foliage appears in late fall and is rather conspicuous in the dormant grasses during the winter.

The writer has found, but rarely, the plants of Herbertia drummondii. This lovely flower is sold under the name of "blue Tigridia" by a certain northern firm. The Nemastylis coelestina is more abundant, and the color is much bluer, although the flower is smaller and its life brief. However, a fresh one replaces the old one every day for many days.

Dodecatheon is said to be a rare flower in Texas, but it occurs in groups of thousands. It may be D. media but this has not been proved. Another so-called rare flower is Calopogon pulchellus. In April, the post oak woods are roseate with them. Efforts to grow them under cultivation are usually foiled by field mice, who relish the tubers, and nothing seems to give adequate protection to the orchids. One wonders where the belief that these plants are delicate came from when one sees them in such profusion and knows that in midsummer the soil in those woods will be as dry as ashes, and that fire will sweep the carpet of leaves from them sometime in winter. There are several other types of orchid but except for the Spiranthes none has been identified.

A flower that Texans seem to overlook is Rhexia. Two kinds of these have been found. They tally in some respects with R. mariana and R. virginica, but they may not be either of those species.

Hydrolea ovata and H. affinis are both to be found in moist soils or in the edges of ponds. The intense blue of the flower tempts people to pluck it, but the long needle-like thorns under the leaves give it all the protection it needs. The foliage of H. affinis is more attractive than that of H. ovata, but the flower is somewhat paler in color. Aureolaria surrata is one of the most beautiful flowers to be found there. However, it may never attain the popularity of many less attractive flowers, because the flowers turn brown if bruised slightly and it cannot be transplanted. It is said that this plant is partly saprophytic on the roots of post oak trees. It appears to grow only under post oak trees.

Another attractive flower to be admired only in the wild is Impatiens biflora. The plant requires dense shade and plenty of moisture. The rather odd-shaped flower is the color of Nasturtiums and, as it sways on its rather thread-like stem, it resembles a small colorful bird. The seed pods of this plant are even more quick to burst at the slightest touch than are its relatives that are called "touch-me-nots."

Lobelia cardinalis and L. spicata bear little resemblance to each other to the casual observer. The former is too well known to need description; the latter is a dainty little spring flower either white or pale blue in color. In the wild, Salvia aurea is a ragged thing, but if cultivated and pruned vigorously it becomes spectacular. Salvia lyrata is another native plant that is gaining popularity in northern gardens. A vast number of other labiateae is to be found throughout the area.

Ruellia ciliosa, R. penduculata, and R. strepens all make splendid garden subjects but have no value as cut flowers.

The only yellow violet the writer has found is Viola eriocarpa, but a large yellow violet has been reported in Sulfur bottoms. The violet species to be found is legion, among them the so-called "Dogtooth violet," erythronium albidium.

The many and varied vines are due some mention. A more beautiful vine than the Trumpet Creeper, Campsis radicans, would be difficult to find. Yet it is a troublesome weed in places. Clematis texensis and C. crispa are two vines better known and apreciated out of their habitat than they are at home. Since the seed pods are quite as attractive as flowers and never fail to attract attention, one wonders why they are not popular. Dioscorea villosa is one of the medicinal plants. The local name for it is "wild hops." It grows in rich, moist, shady places. A vine in full fruit is interesting and attractive. The Moon-seed Vine, Coculus carolina, with the clusters of ruby-red berries all along the stem, is eagerly sought in winter for holiday decorations. Every Southerner is familiar with the May-pop, Passiflora incarnata, a vine that is prized as a pot plant in the north. But P. lutea seems to be known only to botanists. True, it is not as colorful as the May-pop, but the foliage is unusual, and the fruit makes a lasting purple dye—if one is patient enough to gather it. Birds relish the berry. A most unusual colored flower is the Vincetoxicum biflorum. It is a chocolate-brown that is often called "black." This vine belongs to the milkweeds as will be noted when the seed pod is seen.

This gives only a sample of the flora of this county, and hundreds of others are as pretty as those described. The trees and shrubs, the ferns, the mushrooms, all offer plenty of material for further work.

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## Biology for Defense; A Course of Study in Biology for the Secondary Schools of Today

EMILY BARRY WALKER, Assistant Professor of Biology, East Texas State Teachers College, Commerce.

This course of study is designed with a view to curriculum improvement in our secondary schools in agreement with the national defense plans. Its purpose is to enable the student to recognize his place in the present-day scheme of things and to accept his responsibility to future generations. He must be trained to realize that the unbalanced condition of everything around us is the result of failure to understand or obey the laws of nature.

This course of study cuts across the well-worn outlines of the classification of living things, to the subjects whose major importance in the world today is their relation to the maintenance of life and liberty.

General objectives:

A. To foster an understanding of the need for wartime economic health regulations.

B. To teach students how to live in this present war crisis.

C. To maintain standards through an understanding of man's place in the present scheme of things.

Subject objectives:

1. To gain a true conception of the living world.
2. To understand the similarities and differences between plants and animals.

3. To understand the relationship and interdependence of the various forms of life.
4. To gain an understanding of the best ways in which to safeguard personal and public health.
5. To obtain a general understanding of the parts and uses of the human body.
6. To learn something of the values of various types of food.
7. To understand food from the viewpoint of conservation.
8. To study medicinal plants and the use of simple remedies.
9. To study the why and wherefore of first-aid principles.
10. To learn the use and misuse of stimulants.

The course of study is arranged in sections which are in turn divided into teaching subject-matter units:

Section I:
Unit 1. The processes necessary to the maintenance of life.
Unit 2. Keeping alive; food and food stuff.
Unit 3. Human anatomy or law of the body.

Section II:
Unit 4. Microscope study, and microscopic animals and plants.
Unit 5. Protozoa, common and pathogenic.
Unit 6. Bacteria and bacterial diseases.

Section III:
Unit 7. Insects and insect control.
Unit 8. Insects as disease carriers.
Unit 9. Vertebrate animals.

Section IV:
Unit 10. Simple plant forms.
Unit 11. Higher plants.
Unit 12. Common plants used for food.
Unit 13. Local herbs useful as medicine.

Section V:
Unit 14. Harmful action of chemicals and gases on the body.
Unit 15. Remedies and first-aid treatment.
Unit 16. Use and misuse of stimulants.

The students were instructed in the subject matter suggested in the units; in addition to the formal (involving the use of the microscope and training in dissection) laboratory work, many activities in the form of projects were carried out. These projects served to interrelate the principles and subjects studied. Some of them were carried on by the students individually and the others by groups.

Partial list of projects: The Aquarium; Plant Collections; Victory Gardens; First-Aid and First-Aid Kits; Field Trips.

*Summary.* The subject matter was chosen to fulfill suggestions for work in biology in cooperation with the war effort. The state course of study was kept well in mind. The only difference between this course and the courses generally followed by curriculum builders resides in the approach, and in the particular topics stressed. It is hoped that this work may prove helpful in executing the important program in which so large a portion of the world is united.

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**Other papers listed on the programs of meetings**

1. Unusual Hypertrophies in the Zygnemataceae. Floyd F. Davidson, Stephen F. Austin State Teachers College, Nacogdoches.
2. Karyological Investigations on the Hepatic *Pallavicinia*. G. B. Wolcott, Southwestern University, Georgetown.
3. Acanthocephalan Life Cycles. Donald V. Moore, The Rice Institute, Houston.
4. The Serranid Fishes of Texas and Related Genera. J. L. Baughman, The Rice Institute, Houston.
5. Bird Migrations in the Galveston Bay Region. George G. Williams, The Rice Institute, Houston.
6. Biology Interests of College Students in Relation to Value Estimates by Adults. Victor A. Greulach, University of Houston, Houston.
7. Further Researches in Food Specificity of Grasshoppers. F. B. Isely, Trinity University, San Antonio.
8. Factors Limiting Bobwhite Reproduction in South Texas. Valgene Lehmann, Texas Game, Fish and Oyster Commission, Hebbronville.
9. A Study of the Food of Fishes of the Bosque River System. Gray W. Waldorf and Leo T. Murray, Baylor University, Waco.
10. Some Unutilized Resources of Texas. J. L. Baughman, Houston.
11. The Physiology of the Protozoa of Cattle. R. E. Hungate, The University of Texas, Austin.
12. Some Common Errors in Names of Gulf Invertebrates. Willis G. Hewatt, Texas Christian University, Fort Worth.
13. Oat Variety Studies for Winter Pasture. I. P. Trotter, A. & M. College, College Station.

# SECTION III: SOCIAL SCIENCES

MRS. DON O. BAIRD, Chairman. Served after the resignation of Mr. T. H. Etheridge.

Mrs. Don O. Baird was elected chairman for 1943.

## ABSTRACTS

**The American Heritage and the World of Tomorrow**—S. R. GAMMON, Head of History Department, A. & M. College, College Station, Texas. The single word which best expresses the meaning of "American heritage" is *Individualism.* It denotes the individual's freedom *to do, to be, to become*—limited only by its possessor's respecting a similar freedom for others. A main function of American history is to inform Americans as to the nature, source and scope of this heritage.

A national tendency to take things for granted has resulted in the false assumption that our educational system is adequately imparting this heritage to our high school and college students. A comprehensive survey of 690 American colleges and universities reveals that 72% of them require no U. S. history for entrance and 82% require none at all as a condition of graduation. Of over half a million college students, fewer than 10% are taking courses in their country's history. It is difficult to see how a college graduate can function intelligently either as voter or leader unless he has a sufficient background of the culture and heritage of his own land.

Some remedial and corrective measures are being undertaken in several institutions; namely, the Universities of Oklahoma and Texas, in the Texas system of Teachers Colleges, in Barnard College, New York, and in several others.

The American people's knowledge of their heritage has suffered from the nation's history being taught on a basis too narrowly national thus encouraging isolationism and an attitude of national self-sufficiency in a world which has become too small for such an attitude to be aught but dangerous to a nation which follows it.

This isolationism in the present century was responsible for America's colossal blunder in rejecting the opportunity at the end of the last war to project her heritage of freedom, individualism, and peace upon a world scale. Apparently nothing whatever was learned from World War I by a large part of the nation as to the futility of isolation and as to the wisdom of national readiness amid such isolation to meet aggressive attack.

About one half of the world's total population, located in southeastern Asia and in the western Pacific, is interested in the American heritage's influence as manifested in that nation's policy. This is due to the relative fairness with which America has dealt with those peoples and also to the practical example before their eyes of the United States' application of it in the Philippine Islands.

When the agggressors and oppressors shall have been crushed in the current war, it seems probable that America will again, at the council table of peace, have before her the opportunity for world leadership through paths of peace into a heritage like her own.

**Lay Opinions About Eugenics**—VICTOR A. GREULACH, University of Houston, Houston. In an effort to secure some information as to what opinions selected residents of Houston held in regard to eugenics, four of the students[1] from my eugenics class prepared a questionnaire and submitted it by personal interview to 100 residents of Houston. This group included 5 clergymen; 11 unskilled laborers; 13 housewives; 9 each of lawyers, college students and miscellaneous professional men; 8 each of clerical and skilled laborers; and seven each of business men, physicians, college teachers, and public school teachers. There were 60 Protestants, 23 Catholics, and 17 Jews. Half were under 35 years of age and half were 35 or over, while 35 were single, 35 married with two or fewer children, and 30 had over two children. Tabulations of responses were made for each of these sub-groups, as well as for the group as a whole. Despite the smallness of the sample the results were mostly so clear-cut as to be worth while presenting.

Before the nature of the interview was revealed each person was asked what he considered the most important problem facing this country as it planned for the future. Only three mentioned eugenic problems, and even they probably would not have done so after Pearl Harbor. Only 22 believed that heredity played no part in determining whether a person would be a success, although the fact that there was even as large a number as this is perhaps significant. Ninety-three felt that an attempt should be made to improve human heredity, and 90 that a program to reverse the present differential birth rate was necessary.

Eighty-five or more believed that if hereditary potentialities for feeble-mindedness, blindness, deaf-mutism, degeneration of the upper spinal cord, lobster claw, muscular atrophy, lack of hands and feet or epilepsy were present in a family no children should be permitted. Seventy-nine believed that people should not have children if there were a possibility of haemophilia, 72 if there would be a possibility of hair and teeth failing to develop, and only 36 and 35 respectively if there were tendencies toward tuberculosis or diabetes. Approximately the same number stated they would be willing to refrain from having children if genes for each of the defects were present in their families.

Twenty were opposed to birth control, 33 to sterilization, 27 to segregation, 24 to stricter limitation of marriage, 12 to further control of immigration, and only 5 to increasing standards of living. Four were opposed to eugenic education, 30 to adjustment of family size to income, 43 to responsibility of grandparents in helping financially with their grandchildren, 11 to further efforts to eliminate economic insecurity, 8 to free nursery schools and day nurseries, and 8 to greater income tax exemptions for children.

Although the sub-groups were too small to give very reliable data it appears evident that the Catholics were definitely more opposed to eugenics

[1] Jane Artusy, Louise Kost, Margaret Pryzent, George Weinle.

than the group as a whole, while the Protestants were more favorable, with the Jews in an intermediate position. The three groups of laborers and perhaps the business men seemed to be less eugenically minded than the average, while the public school teachers and clergymen were above the average. Age, marital condition, and the number of children in the family seemed to have little influence on eugenic opinions.

**The Socialized Community High School**—J. C. McElhannon, Baylor University, Waco. Efficient understanding of American life must be the objective of public secondary education in this country. We are discovering that the community setting for such learning furnishes the best environment. Education is the product of the environment according to the interaction hypothesis to which we hold. In it the pupil not only learns the item assigned, but also the setting. In fact, the setting is generally by far more significant for living than the item itself.

An individual can function only through a medium of useful experiences. His acquired cultures will be largely through, and of, community cultures. He may ultimately understand ancient and foreign cultures, but his emotionalized understandings: attitudes, ideals, insights and appreciations will be the product of present cultures. The purpose of the school is to short-circuit the getting of experiences. If the youth is to be made able to think for himself, he must have abundant worth while experiences from and applicable to American life as it is now and may be tomorrow. Thinking cannot take place in a vacuum, nor in most instances does it take place in a textbook environment alone. Generally marks, grades, and notices of promotion are not symbols of understanding. Such knowledges soon vanish.

The community is the fundamental unit of American life. Almost all of man's intellectual, social and emotional functioning takes place in a community. The home, the church, and that part of the state which man can understand—the tax district, the political unit, expression of the suffrage rights, the various co-operative activities, language growth, scientific beginnings and social intercourse and provisions—all these find their expression and understanding here.

Extra-curricular activities, the activity movement, practical studies of various kinds arise out of the pupil's environment because of his search for understanding. The Junior High School and the Junior College, C.C.C., N.Y.A. project method, unit organization of the curriculum, the various core curricula and thousands of "promising practices" have been tried out in answer to the need of the individual student. They succeeded and are succeeding because they are based in the environment of high school pupils. They proclaim the emergence of the whole school from 12 to 21 based in a community for the education of the whole child.

The "ivory tower" concept of secondary education, resulting from the older disciplinary-transfer school of thought, which attained its results through handed-down-in-advance contents is seldom able to discover its outcomes to be other than marks or grades. The boys and girls, after four years in the so-called Liberal High School, seldom transfer themselves into American life situations. They did not have such an environment in which to learn American life. For the 90% who will never attend college and, possibly, for the less than 10% who will, the community secondary school appears to offer the best setting for making American citizens.

**The Texas State Nutrition Committee**—LAURA LANE, Extension Editor and Chairman Public Relations, Texas State Nutrition Committee, College Station. In the summer of 1940, when Americans were beginning to talk about national defense, presidents of the Land Grant Colleges in each of the 48 states appointed State Nutrition Committees. These were to be the advisory agencies to handle problems and materials on nutrition within the states. Miss Mildred Horton of College Station was then appointed chairman of the Texas committee and still serves in that capacity.

Since the state committee held its first meeting to make plans for helping Texans solve their nutritional problems, it has grown from 16 to approximately 85 members. The colleges and schools, governmental agencies, the medical profession, lay and professional organizations are represented.

On a national level, the state committee receives guidance from the Nutrition and Food Conservation Branch, Food Distribution Administration, U. S. Department of Agriculture. It maintains liason with the National Defense Committee for Texas, headed by the Governor, at the state level. Locally, it functions through 107 county and 65 municipal food nutrition committees appointed by Office of Civilian Defense coordinators. The state committee has no funds and works only in an advisory capacity.

Since its organization, the committee has formulated a guide to a good daily diet called the Texas Food Standard. More than half a million copies of this standard have been distributed to people of the state. Through professional workers the committee has distributed scientific information on moderate and low-cost meals, sugar savers, preparation of variety meats, and numerous other subjects. It has assisted with the setting up of a State Nutrition Committee for Negroes and has cooperated with the American Red Cross in the training of 15,000 volunteers in nutrition courses.

The committee also promotes wider use of Texas food products and keeps its food standard in line with new research; in the last six months it has distributed nearly half a million copies of educational literature on good nutrition.

## The Farmer's Obligation in Wartime

TYRUS R. TIMM, Economist in Farm Management, Texas A. & M. College Extension Service, College Station.

In beginning, before examining the farmer's wartime obligations, it is desired to emphasize that although these remarks may indicate that farm families are making tremendous contributions towards winning the war—which they are—the reader should guard against the interpretation that they are working harder, both physically and mentally, and are more patriotic, than other groups. It is assumed at all times that all occupational groups are doing their rightful share. Obviously, some contributions are easier to measure than others. Take ourselves—our patriotism and war work cannot be measured in guns rolled off the assembly line or in pounds of beef produced in the feedlots. As usual, it is difficult to measure educational processes, but those working in Social Science feel individually and collectively that their efforts, sincerity, and faith are on a par with other groups.

Today, farmers, laborers, capitalists, professors, workers in government agencies, and all other groups and individuals have one supreme obligation. This is to make their resources, and their mental and physical strength, available for total war against, and complete victory over, the enemies. Farmers, in general, can contribute and are contributing in three ways toward successful completion of this overall obligation.

*First,* they can produce and are producing great quantities of needed food, fiber, and timber. *Secondly,* they can furnish and are furnishing vital manpower to the armed services and to industrial war plants. *Thirdly,* they can make and are making democracy work better than ever before.

Let us examine how well farm people are handling this *first job*—of producing adequate food, fiber, and timber. By checking a few figures one can easily note that farmers are not getting ready to produce. They have produced. Also, we can truthfully say that it does not necessarily take higher prices to make farmers produce. For example, total farm production in this country in 1932 was only 5% under the 1924-29 average.

Moreover, when the Japanese attacked Pearl Harbor, the farm people's readiness was measurable with facts like these—greatest supply of food in history on hand in this country—record livestock numbers—tremendous supplies of fiber ready for army supplies and equipment—feed grain and hay supply largest in 20 years.

When the war began in Europe in 1939, housewives in this country made "runs" on stores similar to those made on banks in 1933. However, the fundamental difference this time was that they found the goods available. As a result, these food and fiber "runs" were soon of historical insignificance.

Today, this commendable production job is showing still greater results —even with the present farm economy of producing more and more with less and less—meaning with less insecticides, equipment, labor, etc. Seventy to 100 hours in the field each week is but one way the job is being done.

Furthermore, recent figures indicate that individual commodity and livestock goals set by the Department of Agriculture for 1942 will either be met or exceeded by Texas farmers this year.

The goal for peanuts is the most interesting. Here, too, we have a change-over on the farm which possibly comes nearest in agriculture to the plant conversion principle used in industry. Prior to Germany's invasion of Poland, this spreading, hairy, annual herb of the order leguminosae was known to most people, especially farmers, as just "goobers." Many farmers in Texas did not know how they should be cultivated for commercial use. But, suddenly, the government required a fantastic increase in peanuts for oil. Texas farmers answered the call immediately. Most farmers did not know where to get the seed, what kind of seed to plant, how many times the crop should be cultivated, the type of weather needed for harvesting, where the peanuts were to be stored, whether there would be a sufficient number of threshers, and whether or not labor would be available. Many of them had to substitute for cotton, not knowing which of the two crops would be more profitable. In 1939, the peanut acreage in Texas approximated 318,000. At the present, a span of three war years, it exceeds 1,150,000 acres or an increase of 250% over peacetime 1939.

We must not lose sight of the fact that Texas farmers have a wide place in the production line of our country. One out of every eight of the Nation's farms is in Texas; 10% of the beef cattle, 1/5 of the sheep; one out of 3 of the acres planted to rice and cotton; and one out of each three grapefruit eaten comes from the Rio Grande Valley of Texas.

Now let us check how well farm people are handling this *second job*—of furnishing manpower to the armed services and to industrial war plants. Already, one-third of the farm labor supply, involving family laborers and hired hands, has either left or been taken from farms. Two-thirds of this decrease has been in family labor. This is possibly one reason why the government has decided to stabilize the supply of manpower engaged in dairy, livestock and poultry production.

Nevertheless, if the war continues through 1944, U. S. Department of Agriculture economists estimate that two million men, or 1/3 of those engaged in agriculture before the war in 1939, will be off the farm. The National Selective Service Board and the Manpower Commission will no doubt cushion the farm labor shock, but farmers can probably not expect much government assistance as long as production continues high. Looking at it one way, farm families may actually be penalized for this tremendous production which they are providing through 70 to 100 hours of work each week and through other sacrifices.

And now the *third task*—that of making our principles of democracy, for which we fight, work better than ever before. Rural people are not only "going all out" for victory with their resources and with their physical strength, but they are doing an equally impressive job with their mental strength.

Professional agricultural workers marvel how farmers are cooperating in their daily tasks; how well they understand national economic policies; their interest in these policies, and their unfaltering faith in democratic principles. Now, when a County Agent is running terrace lines, the farmer usually riddles him with questions and opinions about the public debt, war expenditures, proposed taxation, and similar subjects. Rural people are extremely interested in these subjects. They want to find ways and means of cushioning the ill effects of these problems upon our national economy. They want to make democracy work—and work better.

An outstanding example among rural people, of fine cooperation and seriousness of purpose, is the set-up of Agricultural Victory Leaders; *55,000 rural people are serving today as Victory Leaders for the 400,000 rural families in Texas.*

Each county has an Agricultural Victory Council. This Council has divided the county into Communities and has designated a man and a woman as Community Agricultural Victory Leaders. These two Community Leaders have in turn divided their Community into Neighborhoods and have selected a man and a woman as Neighborhood Leaders who serve for all families in their neighborhood. In some instances, neighborhoods are comprised of only five families, while in other cases they total as many as thirty-five. The predominant basis upon which these neighborhoods were delineated was ease of personal contact in case of serious wartime emergencies. Through this human chain which has been established by the Texas A. & M. College Extension Service with the fine assistance and cooperation of other agencies, approximately one out of each eight farm families in the state is receiving vital educational material, and when the occasion presents itself—emergency duties.

These leaders are transmitting messages to families in their neighborhood through whatever methods available, which probably means all the way from telephone calls to "hollering across the creek."

Mr. Wickard, Secretary of Agriculture, feels that every farm family should and must have an opportunity to participate in the war effort; this arrangement paves the way for total rural participation. If necessary, all rural families in Texas can be notified within six or seven hours.

These Victory Leaders are proud of their assignment and are taking hold of the neighborhood reins in a fine manner. They realize more than ever that our national problem is also a personal problem. They feel a growing sense of personal responsibility for winning this war.

All of this means that today rural people in Texas are more conscious of the close relation between our public problems and agriculture, and even their individual farms. One pronounced example is their interest in the dangers of inflation. They feel that the greatest battle to be fought on American soil will be the Battle Against Inflation. They want the facts about this problem in order that they may individually and collectively help in formulating a workable solution. They are buying all the war bonds they can, thus helping to reach the goal asked for by our President—that of having everybody help finance the war—the real democratic process.

Thus we observe that farmers are fighting today not only for our present way of life but also for the right to improve it. *Too many persons now on the farm, as we know, have very little stake in democracy. The proper way to strengthen democracy is to have every citizen have a stake* *in it.* We must remember that economic opportunity plays a large part in helping citizens realize that they are a part. And we must remember, too, that defense of America is not defense of a geographical entity alone. It is a defense of people, their way of life, institutions and aspirations. *These economic and social problems must be solved more equitably during and after this war than they were during and after the last war.* Farm people, as indicated by the manner in which they have handled their obligations, have confidence that such solutions will be achieved.

As technical specialists, we face our greatest challenge. Agricultural, labor, and management wartime problems challenge not only our courage, but likewise our ability to keep our feet on the ground, to advise people with whom we work in clear and understandable terms, and to suffer hardships and disappointments. Let us honestly hope that, from our efforts in and out of the classroom, all mankind will gain experience today in wartime that will build a non-depreciating foundation for universal peace tomorrow.

## Is the Income Tax the Best Form of Taxation

F. B. CLARK, Professor and Head of the Department of Emonomics, A. & M. College of Texas, College Station.

The income tax is a product of the first of Adam Smith's famous maxims or canons of taxation. It also conforms, superficially at least, fairly well to the third of these maxims. We are likely to forget, however, that there were in fact four of these canons or maxims of taxation. For any tax to measure up to standards of fairness as visualized by Adam Smith it has to conform to all four. In fact, Smith seemed to attach more importance to the two to which the income tax law does not conform than to the ones to which it does.

Another fact that we are likely to overlook is that a mere statement of the principles of taxation set out by Smith is not enough. The development of each maxim contains some of the most pertinent observations made by Adam Smith. I shall therefore quote in full the ones that bear with special emphasis on the subject which I have to discuss.

The fourth maxim reads as follows:

Every tax ought to be so contrived as both to take out and to keep out of the pockets of the people as little as possible, over and above what it brings into the public treasury of the state. A tax may either take out or keep out of the pockets of the people a great deal more than it brings into the public treasury, in the four following ways. First, the levying of it may require a great number of officers, whose salaries may eat up the greater part of the produce of the tax, and whose perquisites may impose another additional tax upon the people. Secondly, it may obstruct the industry of the people, and discourage them from applying to certain branches of business which might give maintenance and employment to great multitudes. While it obliges the people to pay, it may thus diminish, or perhaps destroy, some of the funds which might enable them more easily to do so. Thirdly, by the forfeitures and other penalties which those unfortunate individuals incur who attempt unsuccessfully to evade the tax, it may frequently ruin them, and thereby put an end to the benefit which the community might have received from the employment of their capitals. An injudicious tax offers a great temptation to smuggling. But the penalties of smuggling may rise in proportion to the temptation. The law, contrary to all the ordinary principles of justice, first creates the temptation, and then punishes those who yield to it, and it commonly enhances the punishment, too, in proportion to the very circumstances which ought certainly to alleviate it, the temptation to commit the crime. Fourthly, by subjecting the people to the frequent visits and the odious examination of the tax-gatherers, it may expose them to much unnecessary trouble, vexation, and oppression; and though vexation is not strictly speaking, expence, it is certainly equivalent to the expence at which every man would willingly redeem himself from it." (Adam Smith's Wealth of Nations, Book V, Chap. II, Pt. II).

There are two suggestions here that I wish to emphasize. The actual expense associated with the collection of the income tax in this country is something terrific. During 1940, the amount spent to collect internal revenue was $60,700,000. The cost of operation of the Bureau of Internal Revenue was $103,485,200. The anticipated cost for next year is $80,908,940, and for the whole Bureau, $141,413,940.

Although the above figures are impressive, they do not by any means represent a fair measure of the cost of the income tax as we are operating it in this country. It appears that the job is hardly more than 25% done. If, therefore, the job were done according to a plan of efficiency comparable to other taxes, a fair estimate for the cost of administration of the income tax on the 1940 basis would probably be not less than $250,000,000.

This, however, is not the only social cost that has to be counted if we apply Smith's fourth canon. In 1941 there were 7,642,000 separate returns made. It is not unreasonable to assume that each return required one half day's time. Nor is it unreasonable to calculate an average loss on each of these half days of $2.50. In round numbers this gives us an additional cost of $20,000,000 making a grand total of $270,000,000 as a fair estimate for efficient administration of the tax on the 1940 or 1941 basis.

With these figures, however, we are only beginning to count the cost. If we substitute the phrase *hair-splitting distinctions* for Smith's term *smuggling* we have a fair delineation of the way income tax reports take form. The only possible way to discover allowable deductions is to find out what the law allows. In many instances the tax collecting officials cannot themselves answer the question. As a consequence, controveries in courts develop. We can only imagine the financial burden associated with these controversies. They could well be as much as all other costs put together.

But even yet we have not arrived at the most burdensome effect of the income tax on business endeavor. Reference is to "fourthly" in Smith's fourth canon. Let's quote that again: "By subjecting the people to the frequent visits and odious examination of the tax gatherers, it may expose them to much unnecessary trouble, vexation, and oppression; and though vexation is not strictly speaking, expence, it is certainly equivalent to the expence at which every man would redeem himself from it."

If we could measure this last, we could easily discover a cost so high that the cost of collecting funds through the United States income tax statutes has been and is still greater than the whole amount realized on it. Unbeknown to the government, the foundation may be here laid for ultimate internal strife.

The implications of Adam Smith's fourth maxim are nothing compared with those of Number 2. It reads as follows:

The tax which each individual is bound to pay ought to be certain and not arbitrary. The time of payment, the manner of payment, the quantity to be paid, ought to be clear and plain to the contributor, and to every other person. Where it is otherwise, every person subject to the tax is put more or less in the power of the taxgatherer, who can either aggravate the tax upon any obnoxious contributor, or extort, by the terror of such aggravation some present perquisite to himself. The uncertainty of taxation encourages the insolence and favors the corruption of an order of men who are naturaly unpopular, even where they are neither insolent nor corrupt. The certainty of what each individual ought to pay is, in taxation, a matter of so great importance, that a very considerable degree of inequality, it appears, I believe, from the experience of all nations, is not near so great an evil as a very small degree of uncertainty.

According to the manner of enforcing the income tax laws of the United States it does not appear that anyone can know finally and certainly whether or not he has ever discharged his income tax obligation. The unwieldiness of the thing and limitations growing out of funds provided for the administration of the law—impressive as these amounts are—have made it impracticable for the tax-gatherers to cover the ground and examine critically a very large percentage of the reports. An interesting aspect of these potentially unpaid accounts is the possibility of their being resurrected. The law provides:

1. If the amount excluded from gross income is less than 25% of such income it is not collectable if three years have passed since the tax was due. (Sec. 275)
2. If more than 25% was excluded from gross income the tax may be assessed anytime within five years. (Sec. 275)
3. If no return was filed or if fraud is involved court proceedings may be started at any time. (Sec. 276)

The date used to calculate the period of time elapsed is March 15 of the year following the receipt of the income.

Most of us find it hard enough to get the money to pay our current bills. It is certainly not too much to expect of an enlightened government to provide its citizens with a discharge from tax obligations after one has made the payment in the amount and according to the form which is to the best of his knowledge in conformity with the law. Neither the contributor nor "any other person" can be sure of the amount nor the time of payment of his United States income tax.

The great difficulty here referred to accounts for the introduction of college courses related to accounting problems of the income tax law. What more need be said in condemnation of the arbitrariness of a law than that it presumes that anyone should be able to pass an advanced college course in order to know how to find out what he owes? And even then there are some questions that no one knows the answer to—not even the highest men in the organization.

In addition to the criticisms against the background of Adam Smith's canons of taxation are several other significant facts. They are:

1. Even that which looks like revenue from the tax is extremely undependable. It varies directly with the phases of the business cycle.

| | |
|---|---|
| In 1930 it was: | |
| Corporate | $1,242,595,783 |
| Individual | 1,090,372,611 |
| Total | $2,332,968,394 |
| In 1934 it was: | |
| Corporate | $ 321,453,193 |
| Individual | 354,985,194 |
| Total | $ 676,438,387 |
| In 1936 it was: | |
| Corporate | $ 674,416,000 |
| Individual | 738,522,000 |
| Total | $1,412,938,000 |
| In 1938 it was: | |
| Corporate | $1,286,312,000 |
| Individual | 1,299,932,000 |
| Total | $2,586,244,000 |
| In 1941 it was: | |
| Corporate | $1,417,655,000 |
| Individual | 1,851,988,000 |
| Total | $3,269,643,000 |

In other words, the money taken in a year of depression is only about one fourth of the amount taken during the so-called period of "prosperity." Any source of revenue that varies between such wide points has little to commend it at all and certainly not as the main source of funds for governmental purposes.

2. The income tax is an instrumentality of political persecution. Probably the less said about the subject of the employment of the income tax as an agency of political persecution the better. The fact that it can be employed as an agency of political persecution grows out of the impracticability of anyone's making out an income tax statement which does not contain within itself the possibility of being shown fraudulent. The hair-splitting distinctions that have to be made in order to keep the amount to be paid down low enough not to be disastrous account for the fact of possibility of proof of fraud in almost anyone's statement. Hence all that is really required for political persecution is a close scrutiny of almost any influential man's income tax statement. It is of course a credit to persons in high places that the instrumentality has not been made more use of. But, after all, persons who live in glass houses seldom throw stones.
3. Income as an economic concept is an illusive one. That accounts for the hair-splitting distinctions which appear in income tax statements.

For the last century and a half, economists have been attempting to formulate a clear definition and description of the term "income." It began with the physiocratic concept of the *net product* and it has not ended yet. It is in fact much easier to show what income is not than what it is. One thing that it clearly is not is the composite of private incomes. The mere statement of this fact is almost enough to prove the truthfulness of it. There are too many instances when private incomes overlap and are tied in with the same economic values. Then, too, to gain anything like an accurate knowledge of the nature of social income, complexities associated with distinctions between corporeal, incorporeal, and intangible properties have to be examined. Matters such as this are beyond the scope of this paper.

Very little trouble would be experienced in convincing many of the so-called income tax payers that the tax is not an income tax. It is to them a debt-creating tax. On this ground as well as on several others, the United States income tax statutes could conceivably by an impartial court be declared unconstitutional.

## War Comes to Mexico

JOSEPH SIDNEY WERLIN, Associate Professor of Sociology, University of Houston, Houston.

The old Biblical phrase: "The Spirit is Willing but the Flesh is Weak," aptly characterizes Mexico's war efforts to date. The contrast between strength of spirit and weakness in the military arms for achieving the war ends is noticeable wherever ones goes in the Republic. In Zacatecas, in central Mexico, as in all the other leading cities, one sees the placard posted conspicuously in restaurants and hotels: "The workers of this establishment will not serve subjects of Germany, Italy and Japan." But on the outside, drilling in the plazas and streets, one observes workers marching with imitation wooden rifles—remarkably life-like to be sure, complete with bayonet, made by the inmates of the State Prison of Zacatecas—but imitations, just the same.

And so it is everywhere throughout Mexico. Parades fiercely patriotic in character, with soldiers, workers, professionals, farmers, military cadets, *charros,* public school students, women, and children, marching with resolute step and serious mien; drilling in the parks and fields by civilians during after-work hours; resolutions and manifestos from governors, legislatures, business firms, social and political organizations proclaiming loyalty to government and nation; patriotic rallies and mass oaths of allegiance to the flag; banners and posters aflame with nationalistic and military ardor—no, there can be no question about Mexico taking the war seriously or her willingness to join battle with the common enemy, yet there can also be no question that Poverty, which has so long dogged her footsteps, and the traditionally weak military structure, are hampering her every effort to get ready to play a real part in the common struggle against the Axis.

But, it must be repeated, whatever may be the material shortcomings of Mexico in waging war—and they are legion—morally she is ready to take the plunge, so that in the end Mexico may well consider the unity which the war is creating among the people as an achievement easily worth the heavy sacrifices that she will be called upon to make. For it is a fact that the Mexican nation has not known such identity of sentiment, such cooperativeness, such self-denial, such awakened pride of race and nation, as now prevails.

Nor is the war sentiment merely one of passive acquiescence to the orders and behests of the government; everywhere it is manifesting itself as strong and positive. Why? Because virtually every social stratum has a grievance against the Axis or else senses danger to itself: to its economic or class interests, to its political or religious faith, to its ideals or its pride o'worth. Labor has joined hands with capital, socialists with capitalists, Catholics with non-believers, *hacendados* with *peones,* upper class with proletariat—all are casting aside their long-standing differences and co-operating under the banner of *"Patria, Libertad, Democracia y Honor."*

"It can be asserted that now there is no Mexican worthy of such name who discusses the war as an academic problem, before which it is permitted to propose just any solution: the only admissible one is the triumph of the international group in which Mexico figures; and, consequently, there is only one attitude to adopt: that of contribution to the victory by every method and with the unlimited cooperation of every inhabitant." (1) So the editor of *El Universal,* the leading newspaper of Mexico, summed up tersely the situation in the issue of August 12, 1942.

The racial and national self-esteem of all social categories in Mexico has been greatly outraged by the behavior of the "modern pirates" under Hitler. There was not only burning indignation against the wanton sinking of the oil tankers, "Potrero del Llano" and "Faja del Oro," as well as the barges, "Tuxpan," "Las Choapas," and "Oaxaca," but operating just as effectively in bringing Mexico into the war was the mixture of resentment and wounded pride at the failure of the Hitler government even to acknowledge receipt of the complaint, let alone give some excuse for the acts of inhumanity. That fact, as much as anything, awakened thinking Mexicans to their lowly position in the world and to the contempt which the Germans had for them because of their national weakness. It made them see, as through a blinding flash of Revelation, how necessary it was for them to arm themselves, to unite and get strong materially and morally, if the name "Mexican" was to command any respect among the nations. As President Camacho phrased it in his Report to the Mexican Congress on September 1:

"Mexico, traditionally pacifist, should pride itself in having always respected its agreements and in not having ever waged a war of aggression; but it should also gladly boast, as a hall-mark of legitimate glory, of the fact that during all its independent life it has shown a scrupulous zeal in defense of its sovereignty, without ever tolerating that its dignity and its honor should be violated, however powerful the State attempting it." (2)

The racial insults of the Nazis likewise played a part in fraying the cable of good relations between the two countries. The educated Mexicans found themselves becoming more and more sensitive to the sneers and jibes of the "Nordics": to the thinly-veiled allusions to the "inferiority" of Latins and, particularly, race-mixtures like the Mexicans, coupled with the arrogant preening of the Nazis about their own "creativeness," "mastery," "superiority," and other self-deceptions of the present-day rulers of Germany. Vicente Lombardo Toledano, the Mexican labor leader, voiced the resentment of all cultured Mexicans when, on August 27, from the stage of the Palace of Fine Arts in Mexico City, in a speech condemning anti-semitism and the terrible mistreatment of the European Jews at the hands of the Nazis, he said:

"For Hitler and his accomplices we are an impure race. Perhaps for that very reason we understand the Jews in so exact a manner. There are no bad Jews merely from the fact of their being Jews, as there are no bad Germans for being Germans, nor Yankees nor Mexicans whose goodness or badness may be determined by race." (3)

An interesting as well as valuable contribution to national solidarity is emanating from the Mexican church hierarchy. Long estranged from the political leadership of the nation, the ecclesiastics have by word and deed encouraged their flocks to rally behind the war banner. The greater benevolence of the Camacho regime toward the Mexican Church, together with the menace to Catholic faith and position inherent in Naziism, are important factors in this changed relationship of Church and State in Mexico. We can glean this from a statement of Archbishop Luis M. Martinez, head of the Mexican hierarchy, made in Mexico City, September 27. Acknowledging the existence of various "difficulties" between the two Powers that still had to be eliminated, he went on to say: "So far as the present situation of the Church is concerned, the Avila Camacho regime has greatly bettered its standing, because the President, with his sincerity and serenity, has kept his promise of fair government for all." Then calling attention to the support being rendered the Government by the Catholic Action Society, through military drill by the male members and courses in nursing by the women members, he voiced disapproval of Naziism in the following words: "Our attitude toward the Nazis is that expressed by the Holy Father who has condemned with exalted energy the doctrinal errors of Naziism." (4)

Even the women of Mexico, long kept in the background of public affairs, are showing unusual zeal in helping to ward off the common danger. Sensing keenly the peril to "feminism" from a Hitlerian triumph, the organized, progressive women of Mexico have formed the Feminine Civilian Defense Service and are engaging in a varied series of activities designed to harness the moral and physical support of the female half of the population to the chariot of war.

What, however, is most impressive about Mexico's war effort to date is the outstanding part being taken by the unionized workers. The sign in the restaurants about not serving subjects of the Axis, alluded to above, is revealing on more than one count: not only that Mexico is really angry, but that the organized proletariat is in the front-ranks of the war supporters, for this sign emanates from the "Union of Hotel, Cantina and Restaurant Workers."

Everywhere one goes, proof of workers' support for the war is easily evident. In most of the towns they have been the first to volunteer and actually to engage in military drill. To this very moment, when the war spirit is only just beginning to take on flesh and blood, one is apt as yet to see only humble, blue-shirted men drawn from the lowest strata of the population marching and wheeling in columned ranks in the public places.

Equally impressive are their demonstrations of solidarity with the Camacho government in its war policy, as shown by the numerous proclamations of fealty and patriotism of the trade unions. Here is one example taken at random: the newspaper-advertised statement of the Union of Sanitary and Transport Workers of the Federal District: "In each member of the Union exists a soldier of the country, lover of democracy and liberty who, as yesterday and today, will back up tomorrow the patriotic decision of the President of the Republic." (5)

The explanation for all this lies in the commanding role that the trade unions have played in making and perpetuating the "Revolution of 1910"—the "to the people" movement initiated three decades ago by President Madero and carried on, despite setbacks and profound national disturbances, to this very day. Under the banner of the Revolution, trade unionism has flourished in Mexico for the first time and real benefits have come to the workers. Hence the unions have made themselves the jealous guardians of the Sacred Ark of the Revolution and look suspiciously at every development or trend that might endanger the gains of the Revolution. And that is why, also, they have been foremost in decrying Fascism and in pushing their country into opposition to all that the Mussolini-spawned movement has been trying to do ever since it began cutting a swath for itself in the world's meadow.

The workers are largely responsible for Mexico's consistently pro-liberal and pro-democratic policy in international affairs ever since 1930. They, more than all other groups, bitterly castigated Italy for her invasion of Ethiopia; who condemned the Franco Revolt in Spain and gave asylum to the loyalist refugees; who raised their voices against the brutality and predatoriness of the Hitler regime; who have favored Pan-Americanism, Good-Neighborliness, moral repudiation of the Axis, and all the other achievements of Continental Solidarity of recent years.

*Military Actualities.* But, however willing the spirit and determined the resolve to take a worthy place by the side of the other United Nations in the struggle against the common foe, stern realities intrude themselves and no amount of wishful thinking can dispel them.

The truth of the matter is that Mexico still lacks everything for waging modern war. It is not only without heavy military equipment like cannon, airplanes and tanks; it lacks the very landing fields for the airplanes, the very arsenals for the tanks and cannon. It not only lacks the officers and men, either in active service or in trained reserve; it lacks the very cantonments and schools for their training and maintenance. It is poorly supplied with coastal fortifications, anti-aircraft guns and searchlights. It has no navy or shore-patrol craft worth mentioning. It is without an adequate and rapid system of interior communications. Other than a few main highways connecting certain key cities, it is woefully deficient in arteries of automobile travel. This is especially true, both in the case of railway and rubber-wheeled traffic, in east-west directions, an inadequacy especially serious just now when the danger points are the coastal regions, while the centers of resources are inland.

The railways have been noticeably defective for ordinary peace-time haulage, let alone the stepped-up volume of war traffic. This is true, whether one considers rolling stock, or road beds, or weight of rails, or depots. Julian Montanez, the state railway construction head, already a year ago, declared: "We have rails in use more than 60 years . . . We are 40 years behind the time in technique," while on December 1, 1941, General Enrique Estrada, the new Administrator of the National Railways of Mexico, stated: "Ten years ago 1000 locomotives were at the disposal of the National

Railways to cope with half of our present traffic. Today we have no more than 650."

To cap it all, Mexico is entirely without the necessary cash resources, and hence must depend on the United States, not only for the military goods themselves, but for the very money with which to pay for them.

Nevertheless, despite these tremendous handicaps, Mexico has made a brave beginning, and the future may well reveal that she not only made herself strong in warding off the blows of the enemy but actually made positive contributions to the joint task of winning the war. Certainly, there can be no quarrel with the comprehensiveness of the war program projected and already under way for building up military strength and meeting the foe adequately.

Mexico has decreed universal military service for all male citizens 18 to 45, and while conscription has yet to take place—actual induction of 18 year olds, the first class to be called up, does not begin until January, 1942—limited-scale enrollment of educated youth into army- and aviation-officer training schools has already started. For this purpose a number of military academies is functioning in various parts of the country, and others have been authorized; also, a number of officers has been sent abroad, mainly to the United States, as observers and military attaches, and to "specialized institutions" for rounding out their military effectiveness.

The lack of training centers, officers and equipment acts as a brake on military conscription, but the government has resorted to the next best thing: physical and military training of civilians during non-working hours under the direction of army officers. The program is just getting under way, having started only September 7, but promises to make rapid headway. It is believed that no less than 200,000 men between the ages 18 and 45 will be receiving training shortly. Just now it is voluntary, but a compulsory system is anticipated for all those adjudged capable of bearing arms. Estimates vary as to the ultimate success of the program, but one learns from various sources that the country will be able to count on a militarized and equipped force of 500,000 within a "brief time."

The government is appreciative of the importance of aviation and, according to President Camacho, this phase of the program is developing satisfactorily. A few months ago, the Mexican air force could show less than 100 planes, all old-style observation or training models. Now it possesses a number of naval-type observation planes, with bombers and other aviation equipment due shortly from the United States. New servicing and assembly shops for military airplanes are being built at various points, and only a few weeks ago, on August 19, there was celebrated the occasion of the assembling of the first training planes, the *Ares,* by Mexican aviation workers. The parts and materials were American, but the putting together was done wholly by Mexican mechanics at the Balbuena Airfield, near Mexico City.

This reliance on the United States for military equipment extends to all branches of the service, for while various manufacturing plants are being converted to military purposes, it is clear from the Report of September 1 of the President that Mexico is depending heavily on our country for all basic items. This could be seen in the impressive military parade of September 16 in Mexico City where 40,000 soldiers participated, driving jeeps, scout cars, 1½-ton trucks, 77- and 105-millimeter guns, anti-tank batteries and planes, all of latest American design.

In his Report, the President made frank acknowledgment of the scarcity of ships and other naval deficiencies, but pointed out certain developments to indicate that progress was being made in this sphere also. These included: the building of ships—all of small tonnage but useful for Mexican coastal navigation—in the shipyards of the Gulf of Mexico and the Pacific; the dredging of harbors, navigation canals and river mouths and the clearing away of sand-bars and other impediments to shipping; the repairing of breakwaters and the building of wharves; the initiation of construction of a drydock on the Gulf and of a shipyard on the Pacific.

Highway and railroad building and improvement is moving ahead. During the past fiscal year 75 million pesos were expended on some 3,764 kilometers of roads under construction, while 1,888,000 pesos have been set aside for new bridges. Large sums are likewise projected for new trackage, tunnels, and railway stations. Contracts with American firms have been signed for the acquisition of 33 locomotives, 2000 freight cars, 270 gondolas, 200 tank-cars, and 20 express-postal cars. Of these, already 1000 freight cars have been received during the past 12 months. Success, however, for the entire program hinges upon the obtaining of loans, and for this purpose negotiations are under way with the United States to obtain the necessary funds for rolling stock, rails, shop machinery and equipment-repairing tools.

Civilian Defense is viewed as an integral part of the war effort, and for that reason far-reaching plans are being considered for utilizing civilian help. In addition to blackout rehearsals and blood banks, which have already been undertaken by various cities, the government is relying heavily on civilian organizations to carry on the services of "orientation and propaganda," "direction and control of economic activities," "vigilance and investigations," and "Smoothing the cooperation between the military and civil authorities."

*Economic Repercussions.* However removed as yet the Mexican people are from a war atmosphere—and in general the war is still barely perceived in the country, if one has in mind uniformed men in public places, airplanes flying overhead, troop trains pulling in and out of stations, and all the other signs and portents of a military "visitation"—the war is being rapidly brought home to the masses through price fluctuations, commodity scarcities, employment uncertainties, business nervousness and other indicia of war-time economy.

Generally speaking, business conditions, while uneven as between sections of the country, are definitely not bad. The high prices for strategic minerals, metals and fibers, in the purchase of which the United States figures so prominently, are accelerating production and turnover, so that even a place like Zacatecas, moribund since the closing-down or reduction in activity of so many of its silver mines following the expropriation decrees of the Cardenas regime, is experiencing a quickening of her economic life.

The favorable outlook is causing the opening of new mines and the investment of considerable capital for this purpose, most of which is done under the auspices of the Commission for Mining Development, a governmental agency. Sixteen-cent cotton, with correspondingly high prices for cotton seed and wheat, is putting money into the pockets of the citizens of the entire Torreon "Laguna" as well as other cotton-grain areas.

Various new industries and plants are springing up, the outcome both of the military needs of the government and the difficulties of importing needed consumer goods. The removal of competition from outside foreign firms has given native enterprise a golden opportunity, and while the lack of capital and experience acts as a deterrent, here and there it is being "grasped by the forelock." This can be seen in the recent establishment of the largest steel mill in Mexico, the Altos Hornos, at Monclova, Coahuila, funds for which were largely furnished, to the extent of 6 million dollars, by a loan from the United States Export-Import Bank. In addition, the government granted concessions in the past year to 129 other new enterprises, including 12 processing food, 28 producing metal articles, and 35 manufacturing chemical products, all told representing an investment of 3 million dollars and giving employment to 4,197 workers.

But there is another side to the ledger which is disturbing government and people profoundly. Mexico is worried, no less than the United States, about run-away prices, and while the government is resorting to various artifices to hold them down—regulation and threats of still further drastic measures, appeals to patriotism, threats of public exposure, etc.—it has been unable to stop the upward trend. This is especially noticeable in medicines and various food staples, more specifically meat. In part, the inflationary trend is due to "legitimate" reasons: higher import prices, increased transportation rates, and defective distribution, particularly by the overburdened railways, which has resulted in tremendous spoilage, and consequent higher prices of staples such as wheat, corn, potatoes, onions, beans and tomatoes. But in part it is attributed to canny middlemen who, sensing an opportunity of profit for themselves, are driving up the prices through speculation and "withholding" activities.

The government has acted vigorously in the case of two important commodities, meat and medicines, setting up price commissions and establishing a schedule of maximum prices for all classes and grades of meat, and for a list of the most commonly-used drugs, oils and vaccines, such as quinine, aspirin, castor-oil and typhoid serum, but time alone will tell whether or not the tide of inflation can be stemmed.

Considerable worry also exists about the fate of the "little man," owing to the scarcity of materials and consumers' goods heretofore imported. Those in large manufacturing, able to convert their plants to war-time needs and benefitting from priorities, are considered in a promising position, but the small manufacturer, wholesaler, merchant and middle-man generally is being threatened.

Hotel, restaurant and "curio" people whose business had heavily depended upon tourist trade are, in particular, badly hurt. This is explainable by the large falling-off of American travel, the chief source of a growingly lucrative income for Mexico, owing to the war. It is necessary now to get a travel permit to leave the United States from the local draft board, and few boards will issue one to individuals in 1-A classification or even 3-A, if without children. A spirited campaign has set in to induce Mexicans to "learn their country." Editorial writers are urging the reduction of hotel rates to meet Mexican, not American, pocket-books. San Luis Potosi has chosen this year to inaugurate its first national fair. All this is helping, but nevertheless it cannot make up for the leveling-down of the golden flood pouring from across the northern border.

*Close Relations With the United States.* One monumental fact stands out as a peak above all others in the present war crisis of Mexico: the intimacy of the relations with the United States. Mexico has made her decision to go to war with the Axis; she has crossed the Rubicon; she knows that there is now no turning back and that now, more than ever, her destiny is linked with the success of the Allied cause, which, to Mexico as to the world as a whole, means the success of the United States. She understands full well what a ghastly fate awaits her if the Axis wins. She also realizes how pathetically weak she is if dependent upon herself alone; that the planes, tanks, guns, ships, even the very uniforms for equipping her mass army, must come from the United States. These fundamental reasons, together with the chain of circumstances drawing the two countries together ever since the first day of Roosevelt-Hull, make her anxious to work in every possible way with the United States.

The report of President Camacho to the Mexican Congress on September 1 is one long citation of political, financial, military, commercial and ideological interchanges and acts of growing friendship. The military, industrial and commercial sections are replete with instances of the vital part that the United States is playing in the war economy of Mexico, specific allusion to which has already been made in foregoing paragraphs of this article. In the sphere of political relations, the President mentioned the satisfactory handling of the claims growing out of the oil and land expropriations and high-lighted the details of the agreements. In the domain of finances, he referred to the "three agreements": the one stabilizing the exchange value of the peso, the one involving the purchase of a maximum of 6 million ounces of Mexican silver monthly, and the third relating to the extension of a 30 million dollar credit by the Export-Import Bank for development of highways and roads. In the field of commercial relations, he dwelt on the arrangements to assist Mexican production and business through loans, purchase of strategic materials and granting of export priorities on necessities, and he also referred to the favorable conditions set up for using Mexican labor in the United States.

The minutiae of the Report are thus a verification of the words he himself used to describe the intimate character of the relations between the two countries: "I am pleased to emphasize that the confidence, cordiality and mutual respect which serve as a basis for these relations have not only remained sound, but that they have come to strengthen themselves still more by being crystallized in a series of agreements which have, in a just and equitable form, put an end to diverse questions which for some years now were waiting solution between Mexico and the neighbor republic of the North." (7)

The closeness and cordiality of the friendship can also be seen in the way news about the United States is featured in the newspapers. Every important American development, not only of a military but of an economic and social character which is linked in some way to the war, is given generous space in the Mexican papers and is commented upon sympathetically in editorials and leading articles. As a result, Mexicans of every degree reveal an astonishing amount of information about what we are doing, and there is almost as much satisfaction among them about a particular American military or industrial triumph as among us.

While Mexico still has her cynics and people with a "show me" attitude, there can be no mistaking the confidence that exists in the sincerity of the Roosevelt-Hull friendship for Mexico as well as for Latin America as a whole. There are also some who express concern about the mounting, overwhelming influence of the "Gringo" in Mexican life, who see Mexico tied to the chariot of the American "Colossus" more securely than ever as a result of the war, and who deplore this as a setback to Mexican nationalism, self-determination and "Hispanism"—men, for example, of the Jose Vasconcelos school—but on the whole these voices are few and noiseless. The mass of intelligent Mexicans is unwilling to trade theoretical dangers of the future for dread realities of the moment—and this means that they are willing to accept the leadership of the United States and trust in the sincerity of her promises, and to give open and warm endorsement to the policy of active collaboration of the Camacho government with the American government of Roosevelt and Hull.

Secretary of State Ezequiel Padilla undoubtedly spoke for the entire nation when in Washington, on April 6, 1942, before the Administrative Council of the Pan-American Union, he uttered the following words:

> "I can confirm, with profound satisfaction, the declaration of the illustrious Secretary of State, Sumner Welles, that on no occasion of history have the relations of Mexico and the United States been more cordial. During my visit in this country I have had eloquent and unforgettable proofs, which at times have stirred my emotions to overflowing, of this new era, which commences and which I am sure will last, of our firm and honorable friendship." (8)

*Ultimate War Aims of Mexico.* What does Mexico expect to get from the war? To put her aims on a strictly egotistic or material plane would be to do her a profound injustice, for Mexicans are an idealistic people, of warm and generous emotions. They want respect for their rights; they want no one trampling on them; they want security; but they want something more besides. They look forward to a world in which justice, humanitarianism, brotherliness and equality will hold sway. They want these things for themselves, but they also want them for all mankind.

"The peace we seek will not succeed in maintaining itself without a general modification of the methods of labor, without a humanization of the systems of commerce, and without an effective recognition of the rights of each nation, not only that its sovereignty be respected, but that its legitimate interests be taken into account within a program—first, continental, and afterwards, universal—which dislodges every suspicion of imperialism and which gives to all countries equal possibilities of access to primary materials as well as to the indispensable elements for that rational mechanization which contemporary industry requires." (9)

So spoke Avila Camacho on September 1, yet not for himself alone but for his people.

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## Psychological Problems in Winning the Peace

O. A. ULLRICH, Dean, Southwestern University, Georgetown.

Both peace and war result from states of mind. The activities of the masses in peace and in war are overt mass behavior patterns activated by emotional tensions, the one being mutually beneficient, the other mutually destructive. To understand either, and to secure the one and avoid the other, one must understand their nature and their antecedents.

Because life is dynamic rather than static, changes in social structures are inevitable. Since life continuously renews itself and in its young burgeons onward, it creates for itself new forms. In so doing, it encounters the more or less rigid social forms set by past generations. In this respect, each new generation may be compared to the chick breaking the shell which confines and restrains it. The more unyielding the old social forms, the greater is the tension developed until one or the other yields. Within a given country, the tensions come in blocks; labor against capital, agriculture against manufacturing. In a democratic society, the tensions are released before an eruptive stage is reached by provisions for effecting changes in an orderly manner. In monarchial and dictatorial forms, the necessary changes are usually blocked until the time for orderly reforms has passed. The result is a revolution followed by the establishment of a new order.

On the international stage, similar tensions develop between states, nations, or empires, except that racial tensions may appear to complicate the problems. Thus far, no adequate provisions have been made and accepted for effecting the release of international tensions by orderly processes. Allowing for a few exceptions, the favored method of settling international differences has been a resort to war. A dispassionate analysis of the causes and consequences of wars reveals the fact that wars do not release the emotional tensions of the masses. While a war may release the tensions in the victor nations, it intensifies all the more the emotional strains in the vanquished. To be sure, treaties are signed, commonly misnamed treaties of peace, but a document signed by the vanquished is in fact a truce marking the cessation of armed hostilities and does not necessarily mean the advent of peace and good will toward the victor. Peace will not be forced, and love cannot be winged into the hearts of men on the backs of bullets. The struggle between the nations will be shifted from the battle field to the fields of economics, politics, and ideology. Bitter hatred rankles in the hearts of the defeated peoples; and the harsher the terms imposed, short of extermination, the greater the intensity of hatred and desire for revenge, making inevitable another war.

The history of the human race since the First World War gives ample evidence in support of the statement that international tensions were not removed at Versailles but that, on the contrary, they were intensified. It is not an overstatement to say that the Allies won the war at Campiegne and lost the peace at Versailles. The interim between Versailles and Munich was hardly a truce, if the invasion of China and Ethiopia and the war in Spain are taken into consideration. After the signing of the Versailles treaty, Lloyd George is reported to have made the significant statement that in that treaty the seeds of the next world war had been sown. Over-looking or ignoring the rising economic, political, and ideological tensions during and since the signing of the treaty, many have expressed the view that the terms of the treaty were too mild. Some propose that the treaty after this war shall be so severe that Germany shall never again be able to threaten the peace. The lesson taught us by the history of wars and their consequences should make us skeptical of the efficacy of such proposals. Unless the good will of the Germans and Japanese toward us is developed and won, or unless the proposal has in view the extermination of both peoples, World War III may be postponed but not avoided. If the destruction of these peoples were undertaken, the moral depression of our people would be so deep that we could hardly remain a Christian nation. It would be tragic indeed if we should win the war and in so doing lose our souls. Moreover, it would be an irony of fate if we should win the war and again lose the peace so that our children would have to fight an even more devastating war.

A few leaders in this country, endowed with keen minds, trained in the historical perspective, and gifted with psychological insight are fully aware of the problems involved in winning the peace and have made valuable suggestions in that direction. Among these are Albert W. Palmer, E. Stanley Jones, Louis Adamic, and Wendell Willkie. The late Woodrow Wilson, of course, gave us a formula which we promptly rejected, but which we shall in some form have to reconsider. He was too far ahead of his time. The Churchill-Rooseveltian Atlantic Charter announces four freedoms to be guaranteed to all people everywhere. Unfortunately, this Charter, according to Churchill, excludes India, Hong Kong, and other imperial possessions from its benefits. Moreover, it lacks a specific plan for getting and holding the four freedoms. Louis Adamic, Albert W. Palmer, and Wendell Willkie are more specific in their proposals.

Adamic, in his "Two Way Passage," advocates the sending of an American Reconstruction Mission on the heels of the American Expeditionary Force for the purpose of (1) rebuilding the devastated areas and (2) teaching the Europeans the American, that is, the democratic way of life. For this mission, he would send Americans of Polish extraction to Poland, Americans of German extraction to Germany, Americans of Czech extraction to Czechoslovakia, etc. It is his view that Americans of foreign extraction, not too distantly removed, will be able to prove to the nationalities of Europe that a United Nations of Europe, comparable to the United States of America, is not only desirable but possible and practicable. A similar plan, he thinks, would work in the case of Japan.

Albert W. Palmer proposes a Congressional Commission charged with the function of drafting a peace plan and inviting both friends and foes to discuss the plans. These plans are to be advertised all over Europe by radio and by leaflets dropped from planes and perhaps by underground organizations. He is interested in winning victory for humanity. Willkie, since his trip to the Orient, is convinced that imperialism, including English imperialism, must end. Other peace proposals, too numerous to survey here, have been offered. All of them state in fairly precise terms what we want and what we are determined to secure if possible, but few have done more than mention incidentally the factors which must be taken into account if enduring peace is to be possible.

As was indicated at the beginning of this paper, my thesis is that where there is life there are tensions. These tensions must be released from time to time. In the individual, organic tensions arise, known as hunger, sex desire, desire for security and for prestige. When these are gratified or released in the proper manner, well-being and good will result. When the individual is frustrated in the expression of these, the emotions of fear, anger, and hate or a combination of these three arise. When considerable numbers of individuals are similarly aroused, a social block, crowd, or even mob is formed. Sooner or later one of the frustrated individuals gifted with the ability of leadership steps forward, or is thrust forward, and becomes the mouthpiece of the group and the contest begins.

We may ask ourselves, then, what are the factors that make for tensions between nations? No attempt is made here to enumerate and to discuss all of them. Only four of the obvious factors can be discussed in the time allotted to this paper. These are hunger, prestige, race, and ideology. Let us consider these in the order named.

It has been emphasized by others that the food problem seems to be one of the, if not the basic, problems leading to international friction. Some areas of the globe are overstocked with humans. The land on which certain teeming populations reside simply does not feed the inhabitants by the processes of agriculture now known. Examples of such peoples are the British, the Dutch, the Belgians, the Germans, and the Japanese. They are like a thousand sheep trying to survive in a pasture which will support only five hundred or eight hundred. The only solutions are (1) reduction in number by birth control, (2) removal to other pastures, unoccupied or partially occupied, (3) the hauling in of feed from other sources, (4) slaughter of the excess number, (5) starvation. If the globe is fenced off in national pastures, and if the immigration fences are high and firm, it requires little imagination to foretell what will likely happen. Excess populations which find themselves blocked from immigration will seek to break the barriers. The tension points on our globe are the over-stocked areas. Whether we like it or not, we must look at the matter realistically. Australia, which is about the size of the United States, with a population of that of Texas, namely 6,000,000, will continue to be a temptation to Japan and perhaps to China. Portions of South America, particularly Argentina, will be a temptation to European nations. The van Zeeland Economic Commission, organized after World War I had, in my judgment, in outline at least, the solution to this aspect of our problem. You will recognize in this the old problem of the "Have" and the "Have Not" nations. Until a more equitable distribution of the natural resources of the earth is effected, wars will continue to plague the human race. It is a truism to say that people must eat to live. If an attempt is made to block people off from their source of food supply, fear is generated. Fear, in turn, generates anger in the strong and hatred in the weak. These emotions become intensified until an eruption takes place. It is not within my province here to give a formula for the proper solution of the problem. We must refer this matter to the economists, or the geo-politicians.

The second cause of war is the factor of prestige. After a man has satisfied his biological needs, he craves "his place in the sun." He desires the esteem of his fellows. Our history books and even our literature are full of statements about backward people. We of the Occident, for example, have regarded the yellow races, in fact all colored races, as inferior. Hitler and his mouthpiece, Goebbels, have preached this doctrine as persistently as can be done. We now seem to have good grounds to revise our opinion and to change our attitude.

This matter connects with the third cause of wars between peoples; and that is race prejudice. E. Stanley Jones, Edgar Snow, Willkie, and many others have warned us that unless we revise our attitude toward colored peoples, especially the yellow race, we shall experience a rude awakening about 1970, if not before. In 1920, Frederick Starr, at the University of Chicago, made the significant statement that the final global war will take place between the Orient and the Occident, with the advantage on the side of the Orient. His thesis was that the Orient, including China, Japan, India, Malaya, Indo-China, contains one-half the population of the globe. By the time these peoples become thoroughly conscious of their powers and become mechanized, the Europeans will have bled themselves white through international wars, and it will be an easy matter for the Oriental people to push over the weakened Westerners. It is fortunate that China is our ally in this War. If we could equip China adequately now, she could and would show Japan her place in the sun. Eventually, China will dominate the Orient. Of that there seems little doubt.

The last factor we shall have time to discuss is that of ideology. In our thinking, indeed in our education, we have taken a limited point of view with respect to the world. And yet, the Americas are now only an island. Not only have we limited our view geographically but even more so psychologically. We have assumed that the Orientals with their philosophies of life, not to speak of their religions, have been all wrong and that we have the only right views. We have made them feel our contempt for their ways. Because of my training, I cannot help but feel that our way is better than theirs and that our religion is the right one. On the other hand, I must not allow myself the privilege of trying to force them to my way. I might as well tell a farmer bluntly that his way of plowing is all wrong and that I have come to show him how to do the job as it ought to be done. If we wish to win the Orientals to our ways, we must love them into it. We must demonstrate to them that our Golden Rule is merely the positive side of their Confucian rule, "Do not do unto others as you would not that they do unto you."

The suggestions made in this paper are neither new nor original. In fact, Woodrow Wilson announced these principles and Roosevelt and Willkie have echoed them. The Atlantic Charter re-affirmed them, except for India, Malaya, and a few other countries under the British domination. In my humble judgment, before lasting peace can come to this troubled world, an international economic mission must adjust the economic inequalities existing between nations and thereby release the economic tensions arising from population pressure. Second, the allied nations must, after this war, make it possible for all nations to maintain their self-respect. Third, we must learn to hold the colored races in much higher regard than we have in the past. And finally, we must learn to respect the personalities of other peoples who hold views different from our own, and try to demonstrate a better way of life. An arrangement for exchange of college students and professors would be a practical step in this direction. In the meantime, we should widen our horizons by teaching global geography and global history. Our students must become "air-conditioned," for the airplane is destined to make neighbors of us all.

Finally, permit me to sound a note of warning. In our struggle to win the war, we must not allow ourselves to lose our democratic way of life and to adopt a dictatorship. That danger is more real than some think.

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**Other papers listed on the programs of meetings**

Some Characteristics of the Schools of the Republic of Texas. T. H. Etheridge, Sam Houston State Teachers College, Huntsville.

2. The Use of Science in Elementary Education. S. E. Smith, Sam Houston State Teachers College, Huntsville.

3. Hitler's Blueprint for World War II. Louis Kestenberg, University of Houston, Houston.

4. The Growth of Cultural Interchange With Latin America. James Manfredini, University of Houston, Houston.

5. Food in Wartime. Fred H. Arnold, Agricultural and Mechanical College of Texas, College Station.

6. Spanish in the Public Schools of Texas in Relation to Natural Bilingualism. Gladys Henry Baird, Sam Houston State Teachers College, Huntsville.

7. Some Post War Aspects of the Federal Debt. George C. Hester, Southwestern University, Georgetown.

8. Social Studies in the New World Tomorrow. W. W. Freeman, East Texas State Teachers College, Commerce.

9. Trends in Mexican Education. Spencer Stoker, Texas State College for Women, Denton.

10. The Psychology of Panic and Panic Prevention. W. A. Varvel, Agricultural and Mechanical College of Texas, College Station.

11. A Rank Order Method Applied to the Selection of War Slogans. Catherine Gulos, Baylor University, Waco.

## SECTION IV: GEOLOGICAL SCIENCES

DR. L. W. BLAU, Chairman.
Dr. F. B. Plummer was elected chairman for 1943.

### ABSTRACTS

**Rivers of the Edwards Limestone**—J. G. BURR, State Game, Fish and Oyster Commission, Austin. The entire natural flow of the Frio River plunges into the Balcones fault zone a few miles north of Uvalde, while the Nueces loses a little more than half its ordinary flow, according to reports of the U. S. Geological Survey and the State Board of Water Engineers.

Comparing the annual flows over long periods, the Nueces carries 38% more water than the Frio before they reach the fault line areas, thus affording the Nueces a greater means of leaping over the earth cracks or to wallow through the beds of gravel.

Water lost in the fault zone is believed to enter the artesian reservoir. That of the Frio does not appear again, and any springs below the fault are said to come from the Carrizo sand. That the Nueces loses more than one half its ordinary flow before reaching the Uvalde gaging station is indicated by tests made by the U. S. Geological Survey. Beyond that station, the river alternately appears and disappears in the gravel or fissures of the limestone, "as far as 25 miles south of Uvalde where the gravel is without question the medium of storage and release."

Quoting the report, "The combined losses in the Edwards limestone in the various streams from the Medina to the Frio and Nueces rivers may average as much as 150,000 acre feet annually, most of which enters the artesian reservoir."

Impounded water in the Nueces near Crystal City supplies water for the great winter garden of that area. Below the Bermuda dam and through Dimmit County, some 45 miles, the river goes dry in the summer. Other dams near Cotulla provide irrigation and stock water. Eastward, there is no flow in dry weather until the Frio and Atascosa combine with the Nueces at Three Rivers, giving the town its name.

The Nueces empties into Nueces Bay near Corpus Christi. The annual average run-off over a 23-year period is 1542 acre feet.

**Interval Maps of Cretaceous Sediments of the United States**—HAZEL A. PETERSON, Tulsa, Oklahoma. Although oil companies have been using thickness interval maps for several years, very few maps of this type have been published. The maps described and interpreted in this paper are a series which show the extent of Cretaceous seas in the United States and the position of highlands and embayments. The series includes maps of the Laramie, Montana, Colorado, Dakota, Washita, Fredericksburg, and Trinity groups, and Upper and Lower Cretaceous, Neocomian being included on the latter map.

Base maps used are those of the United States with counties defined on them. The contour interval for Upper and Lower Cretaceous maps is 500 feet, except for 2000 foot contours used in the Pacific Coast area. The interval for all other maps is 250 feet.

Various geologic publications have provided the statistical information, except for certain figures obtained from unpublished sources.

In interpreting these maps, it would appear that pre-Trinity, or Neocomian, seas were smaller than in epochs which followed. Along the California-Oregon coast, a long, narrow trough sank rapidly and received an almost unbroken series of sediments.

The sea apparently moved south from Canada for the first time in the Trinity epoch, and shallow waters spread around the Black Hills into eastern Wyoming and Montana. In the western Gulf Coast area, seas from southwestern Arkansas and southern Oklahoma swept over the Sabine Uplift and across Texas into the deep trough in southwestern New Mexico.

Fredericksburg seas retreated and lands were elevated. Shallow seas spread over the west side of the Sabine Uplift and swung southeast. Seas in the West were shallow also, as shown by thin beds.

The advancing waters of Washita time did not reach Trinity boundaries. The East Texas Basin was for the first time almost wholly in Texas. Lands were high east of the Sabine Uplift. Judging from outcrops found, the seas did not cross the Llano uplift and extend into North-Central Texas as in previous epochs, but swung south of the uplift into West Texas and New Mexico. The Cordilleran seas advanced into southern Kansas.

Dakota lands were uplifted in the Gulf Coast area. The Sabine Uplift was probably elevated noticeably at this time, thus forcing seas to the west. The East Texas Basin was long and narrow, extending into southwestern Arkansas. Deposits in West Texas must have been very thin, and seas shallow. Cordilleran seas, however, although likewise shallow, were long and wide in extent. They spread into New Mexico and northeastern Arizona, and may have connected with Gulf Coast seas through a narrow channel in northern Mexico and southern New Mexico. On the Atlantic Coast, advancing seas swept over an irregular surface in northern New Jersey and over Lower Cretaceous beds to the south. The southern Atlantic Coast was relatively high.

Colorado seas were wider everywhere except on the northern Atlantic Coast. Shallow Gulf Coast seas went over the Llano Uplift into southern Oklahoma, and over the Sabine Uplift into Louisiana and beyond. The north-south-trending Mississippi Embayment first became apparent in the central states. From this long, narrow trough, seas spread toward the southern Atlantic Coast and joined retreating waters. Cordilleran and Mid-Continent seas had perhaps their greatest expanse, but were probably shallower than seas following. Basins and troughs were subsiding rapidly, and waters connected with the Rio Grande Embayment in Texas.

Montana seas were the last of the great Cretaceous submergence, since later Laramie waters were retreating. Deeper seas spread from Long Island southward along the Atlantic Coast and joined Gulf Coast and Mississippi Embayment waters. The Embayment axis had shifted slightly to the west, and waters extended west of the River for the first time. The East Texas Basin reached its maximum depth, apparently, but seas still remained south of the Llano area. Cordilleran basins were deeper, and seas were very extensive, although probably distinct from Gulf Coast waters.

Laramie waters were retreating. Swampy, continental beds are typical of the Cordilleran area. Lands were uplifted and subject to erosion in the East Coast, Gulf Coast, and Mississippi Embayment areas.

In summarizing Lower Cretaceous depositional conditions, the California-Oregon trough is the most unusual feature. The trough was very narrow and subjected to extremely rapid, but constant, subsidence.

The Cordilleran-Mid-Continent seas were shallow and restricted, compared to those later. Basins were relatively few. Lower Cretaceous beds appear to be absent throughout much of Colorado, New Mexico, Utah, and states south of North Dakota, unless some of the so-called Dakota beds are Lower Cretaceous in age. This area may be similar to northwestern Texas, where sediments were deposited on an irregular surface and later destroyed by erosion. The northern seas may have joined southern seas at times, but ordinarily the Panhandle area of Texas remained high, it appears. Any connection existing had shifted westward by Upper Cretaceous time.

Gulf Coast seas spread farther northwest in Texas in the Lower Cretaceous than later. Remnants are found in West Texas oil fields and in Stonewall County. The Rio Grande Embayment appears to have ranged across Southwest Texas and Mexico and possibly joined Cordilleran seas in New Mexico. The East Texas Basin and Sabine Uplift are prominent features of this time. The uplift appears to have consisted of two parts, running north and south. A sharp change in thickness in the Caddo Lake district suggests a narrow channel between the two high areas. The northern high became increasingly important with later epochs.

The Mississippi Embayment does not appear evident on the Lower Cretaceous maps, but was probably present in southern Mississippi. The East Coast, however, was receiving thin deposits at this time. Seas stretched along the coast from New Jersey to Georgia, left northeastern Florida barren, and twisted eastward again to cover southern Florida.

In Upper Cretaceous time, the California trough was still important, but had been partially uplifted and shifted. Cordilleran and Mid-Continent seas were deep and extensive. The East Texas Basin, to the south, tended to be longer and deeper than in the Lower Cretaceous. The Sabine Uplift either shifted eastward later on or sank so that basin seas could spread east more readily.

Upper Cretaceous seas covered Florida completely. To the north, waters overlapped Lower Cretaceous beds and covered most of the coast to Long Island. This area was elevated, however, in Laramie times.

Later deposits of the Cenozoic have failed to cover uppermost Cretaceous beds, even at time of deposition. The Cretaceous period marked, apparently, the last of the great sea invasions in the United States.

In conclusion, maps of the type described are of great help in interpreting conditions of structure and deposition. It is believed that if similar maps were made for other periods, a better understanding of generally existing conditions would result.

**Remarks on a Giant Sloth Found Near Humble, Texas**—KEITH M. HUSSEY, University of Houston, Houston, Texas. What may eventually prove to be the most complete specimen of *Megatherium* ever found in this country was discovered by Sam Kay, of Humble, Texas, in September, 1941. While fishing in Cypress Creek near Humble, he noted some large bones protruding from the bank of the stream about 15 feet below the surrounding surface level. He carried the news to town and several persons visited the scene, among them one Ira Hosea, who attempted excavation but, on noting the size and number of the bones, he sent word to the writer at the University of Houston. With the aid of his students the writer undertook the task of recovering the bones.

A study of the teeth, skull and foot bones of the specimen served to identify it as Megatherium sp., the largest of the giant ground sloths which ranged this country as recently at 500,000 years ago. M. sp., was of elephantine proportions, attaining a height of eighteen feet and a breadth of six to eight feet through the pelvic region. A cursory survey of the literature indicates that this may be the most complete specimen found to date. The pelvic girdle seems to be the only important bone missing. The discovery location marks an extension of the range for this genus of sloth. The bones are in a comparatively good state of preservation, and the writer hopes that a reconstruction of the skeleton will be possible at some future date.

**The Probable Earthquake Origin of Caddo Lake**—J. G. BURR, Game, Fish and Oyster Commission, Austin. Evidences of the earthquake origin of Caddo Lake are found in the Indian artifacts picked up from the lake bottom now covered by ten feet of water, a mile from the shore; in the submerged trees and stumps of great size which apparently grew before the inundation; and in the sunken lake bottom which in general is five to 30 feet lower than at the lake ends at Jefferson and the government dam near Mooringsport. The slant of the lake surface is approximately .8 of a foot per mile. The lake is 32 miles long and has an average width of three miles and an area of 70,000 acres, the largest natural fresh water lake in the south.

Caddo Indian tradition says that an earthquake formed the lake and destroyed an Indian village. The New Madrid earthquake of 1811-12 is believed to have produced Caddo Lake at the time when the earth sank and formed a number of lakes in the Mississippi Valley, notably Reelfoot Lake.

(The full text of this paper was published with illustrations in The Shreveport Times, Shreveport, Louisiana, March 7, 1943.)

**Chlorides of Rivers Originating in the Permian**—J. G. BURR, Game, Fish and Oyster Commission, Austin. Unfit for drinking and sometimes producing nausea, the water of the upper reaches of the Red River and the Brazos is highly impregnated with chlorides and sulphates. This discovery was first made by Capt. R. B. Marcy and his party while exploring the upper reaches of the Red River in 1850. (Marcy's survey was authorized by Jefferson Davis, then Secretary of War, and published in 1853.) But when the expedition, traveling along the Red River, had reached to within a few miles of what is now the city of Canyon, the water was found to be sweet and wholesome.

Captain Marcy mentioned only the head waters but gave no location. Such a spring occurs just west of Canyon in the Palo Duro Creek. But midway in the Palo Duro Canyon to the east, good water was doubtless found, as now determined by a government test, where the chloride is 124 parts per million.

Geologists explain that the salt streams of the west originate in or flow through soil outcrops of the Permian Basin which was once a salt sea. Salt deposits, dissolved by underground water, reach the surface, producing salt springs in the main forks of the Red River and the Clear and Salt Forks of the Brazos. The saltiest of Texas streams is the Pecos which runs through Permian soils in New Mexico and through Texas as far as Crockett County. So much of the stream passes through the Permian that extremes of salt result when not relieved by the all too scant rainfall of the Pecos region.

There is just one remedy for excess salt and that remedy is dilution. Great dams have been erected in the Colorado, the Brazos and the Pecos Rivers, the main purposes being hydro-electric power and flood control. Further benefits are the creation of superb fisheries and the dilution of the salt content to a point compatible with domestic and agricultural uses.

Also, the Red River is to be changed, let us hope, from the brine that nauseated Captain Marcy, into a vast reservoir of good water by the Denison dam that is now under construction. (April 1942).

Although the salinity is high in some of the western tributaries, the volume of water normally discharged is not great, and the salts are reduced both by freshets and by their flow through non-Permian soils. Finally, with the impounding of the water, immense dilution takes place. Here are dilution figures for the Brazos and the Pecos:

The Brazos, before entering Possum Kingdom, on February 12, 1942, had chlorides 1775 parts per million; at the lake outlet, 823 p.p.m.; at Waco the Brazos had 330 p.p.m. The Pecos River just above Red Bluff Lake on March 24 had chlorides 2165 p.p.m.; at the lower end, 710 p.p.m. The Pecos and the Clear and Salt Fork of the Brazos all have more than 2,000 parts per million of chlorides. The statute which fixes the maximum toleration at 2,000 parts per million of total salts was designed for central and eastern Texas where no excess is ever found unless induced by oil field brine. West Texas rivers, excepting the Conchos and Devils River, have a combined average salinity of 1988 parts per million. Central Texas' average is 380 p.p.m. and the East Texas streams, when unpolluted, 143 p.p.m.

Possum Kingdom Dam has transformed the Brazos from a dirty red to a clear and beautiful stream suitable for game fish for a long way down. Most notable of all, the Pecos dam has made irrigation possible in that arid region.

## Peat—A New Natural Resource of Texas—Its Development and Uses

F. B. PLUMMER, University of Texas, Austin.

*Importance of Peat Deposits in Texas*—Peat moss, because of its humus content, its water absorbing qualities, cleanliness, lightness and acidity, has been used extensively in Texas by florists, gardeners, and horticulturists to condition alkaline soils, to lighten and enrich heavy clay loams, to propagate seedlings, and for packing material for preservation of roots during transportation, sales displays, and flower shows. During 1939, 78,611 tons of peat were imported into the United States from North Europe to meet this demand. In 1940, owing to the war, importations from Europe were entirely cut off and a supply had to be sought in this country. New peat bogs were located, tested, and opened up in western Canada, Washington, Michigan, Wisconsin, Minnesota, Maine, and other northern states. Due to higher labor charges in America and high rail transportation costs, prices for the material in southwestern United States became exhorbitant, and in 1942, with the entry of the United States into the war, transportation from the northern states has nearly ceased. Therefore, the opening up of a supply of this valuable material in Texas became imperative. It was generally considered that, since peat normally forms in glaciated areas where undrained marshes and stagnant lakes replete with vegetation persist for long periods of time, the unglaciated, hot, and more or less dry Southwest was unfavorable territory for peat and that none would be discovered in Texas. However, as soon as the demand arose, search began and early in 1940 Mr. J. J. Joiner and Mr. Sanguinot discovered peat bogs in the valley of Yegua Creek between Lexington and Giddings in Lee County. At about this same time, Mr. B. P. Atkinson of Austin became interested and during 1940 explored peat possibilities throughout East Texas and found half a dozen prospective bogs. In 1941 members of the Bureau of Economic Geology investigated Mr. Atkinson's prospects, determined that they were genuine deposits of peat and located several other bogs in Gonzales, Polk, and San Jacinto counties. In 1941 and 1942, Mr. Atkinson acquired the bog in Lee County opened up by Mr. Joiner and also started development of a bog in Milam County 4 miles east of Rockdale. These two bogs are now supplying peat to the Dallas, Houston, and Austin markets.

*Description of Peat*—Peat is a brown or black spongy, fibrous, lignite-like mass composed largely of plant detritus and produced from mosses, sedges, and other water plants in poorly drained marshes and bogs. It consists generally of a tangle of more or less disintegrated moss, ferns, rootlets, leaves, sedges, algae, grasses, and partially decayed wood all pressed together to form a soft, spongy layer underneath the moss, fern, and sedge covering of a marsh. Peat bogs can be distinguished by the fact that when one steps on the bog vegetation, it gives way under the weight of the feet and then springs back when the foot is lifted. The phenomenon is referred to by New Englanders as "quaking," and peat bogs are called quaking bogs. In Canada, the natives call these swamps "muskeg," the Indian term for quaking. If a pole is thrust into the muskeg, it penetrates surprisingly easily, in many cases the whole length of a long rod. It is as if one were standing on water instead of semi-solid looking ground. If a sample is removed from beneath the feet, the material looks like a tangle of rootlets, vines, plant stems, and moss quite fresh looking, but colored brown or black. If cut with a knife, the fresh looking plant stems and woody fibers are found to have no hard substance, but to cut like soft cheese or butter.

*Origin of Peat*—The formation of peat is brought about by conditions which favor abundant growth of marsh plants, particularly mosses, abundant and continuous supply of shallow water which will promote growth, preserve the woody substance from destructive decay, favor the life of bacteria which destroy the hard parts and much of the cellulose, and leave and concentrate the lignin. An analysis of peat deposits shows how these changes take place as follows:

| | % Total C | % Cellulose Content | % Protein, lignin, etc. | % Humus | Depth below surface |
|---|---|---|---|---|---|
| Sphagnum moss...... | 49.57 | 54.72 | 23.7 | 1.0 | 0″ |
| Young sphagnum peat | 54.21 | 14.98 | 54.6 | 45.9 | 12″ |
| Sphagnum peat....... | 56.0 | 11.37 | 56.0 | 68.2 | 24″ |
| Old sphagnum peat... | 58.57 | 8.50 | 66.6 | 88.3 | 48″ |

Thus, as time goes on in a peat bog, cellulose decreases and the protein, lignin, and humus increase. Conditions are necessary, therefore, which permit the marsh to persist for a long time and which preclude the deposition of much silt, sand, or calcareous ooze which will contaminate the plant detritus. In the north, where the country has been covered with glacial ice, peat accumulates in undrained depressions left by the ice sheet below the normal ground water table so that they are continually filled with water. In the south, marshes occur in most cases where there are large continuously flowing springs or strong water seepages and where the water accumulates due to partially choking a valley by sand or stream alluvium during a formerly extremely high flood or torrential rain.

*Geology of Texas Peat Bogs*—All of the Texas bogs that have been reported to us are located in sandy areas, in most cases along the outcrop of the Queen City, Sparta, or Carrizo sands. Most of them lie in low areas along old stream valleys clogged with sand and alluvium where there are poorly drained spots. Most are near a valley side or along a fault escarpment where water seepages and springs occur. None has been found in the dry regions of North and West Texas, although very large springs occur there and undrained depressions in limestone sinks are common. The bogs near Giddings are on the Queen City sand formation along the valley flat developed by Yegua Creek Large springs continually saturate the sand, and water accumulates in the low spots along the side of a broad valley which is flat at points above the normal flood level. Each bog covers an area of about 10 acres and the marsh is 10 to 20 feet deep. A cross section of the peat as exposed by excavation shows about 12 inches of brown young peat containing many rootlets, leaves and dead vegetation, then two feet of black spongy peat, next a layer 6 to 8 inches thick of brown spongy peat, then 6 feet or more of black silty, very soft colloidal peat containing one or more layers of brown peat.

The bogs in Gonzales County are in the upper Carrizo sand. One large bog is located in Palmetto park near Ottine in the valley flat of San Marcos River. A prominent bluff which may be seen near the entrance of the park exposes a thick section of Carrizo sand capped by a ferruginous sandstone belonging to the Reklaw formation. Seeps and springs occur along the foot of the bluff 45 to 50 feet above the level of the San Marcos River and furnish a permanent water supply which impregnates the soil along the side of the high river terrace and promotes an abundant growth of marsh plants. The peat deposits lie partly upon the back margin of the terrace, below the present surface, and partly upon the foot of the slope of the bluff where the permanent springs are located. The peat deposits have been occasionally flooded by extremely high floods of the river, and a section through the peat shows a few thin lentils of silt and sand furnishing a clearly written record of recent events in the history of the river. The following analyses show the percentage of organic matter, ash, moisture, and acidity of the Gonzales bogs:

| Bog | Layer below surface | Moisture % | Ash % | Color of Ash | pH |
|---|---|---|---|---|---|
| Soetse | Upper | 20 | 12.2 | White | 3.9 to 4.5 |
| " | Middle | 23.2 | 12.7 | White | 4.1 to 4.4 |
| " | Lower | 28 | 19.4 | White | 3.8 to 4.1 |
| Berger | Upper | 23.8 | 9.7 | Gray | 6.3 |
| " | Middle | 28.6 | 15.9 | Gray | 6.3 |

*Methods of Harvesting Peat*—Peat is removed from bogs by hand labor. Water in the bogs is drained by cross ditches, trees and brush are removed and all roots pulled. Then the upper brown leafy portion is raked off and the rich brown peat below exposed for cutting. The layers of peat are next cut into rectangular briquets with a special cutting tool resembling a rectangular tin box with a sharp outward edge or blade fastened to the handle like that of a spade. The tool is thrust into the peat and a rectangular block about 4 x 8 x 12 inches is cut off from the side of the trench. The blocks or cakes of peat are then dried, ground and bagged or baled for market. Drying is accomplished by spreading the blocks of peat on woven wire screens tacked to frames and raised about 2 feet above the ground to form a convenient platform. During wet seasons, the frames are placed under cover but left exposed to open air and as much breeze as possible. After all the excess water has dried out, a process which requires 4 to 8 days depending upon the humidity, the frames containing the cakes are slid along on the supports to a shredder, resembling a machine for chipping ice; the cakes are shredded and all hard lumps removed. The peat in most cases is marketed in 25 and 54 pound sacks resembling cement bags.

*Properties of the Commercial Product*—The Texas product varies considerably from bog to bog and also at different depths and localities in the bogs. Some is brown, clean, fibrous and equal in quality and composition to any foreign peat. Other samples contain much silt, sand, foreign material; still others are black, sooty, highly colloidal and disagreeable to handle. Some samples are high in sulphur and highly acid, a condition known as "sour" by operators and likely to be detrimental to plants. It follows, therefore, that all peat deposits should be sampled, tested chemically, graded, blended if necessary, and the production carefully controlled to insure a good product, and also to prepare various grades for different uses. For example, upper young sphagnum moss in our northern bogs is light in weight, low in acidity, low in humus, low in water, and is best used for packing and shipping rooted plants, bulbs, etc. Older peat is richer in humus and lignin, lower in cellulose and higher in acidity. Its best use may be for propagating acid-loving plants, such as azaleas, hydrangeas, and rhododendrons, in soils otherwise too alkaline. Blacker, older, less acid peats may serve best in gardens where neutral soils and high humus content are desired. This summer, at the Bureau of Economic Geology, a half load of natural peat was mixed with ordinary, rather poor alkaline Austin soil for a bed of Hibiscus. No additional fertilizer was used. The result was an excellent bed of blooms which persisted all summer and required very little watering. Peat soils absorb and hold water remarkably well. A bed of water iris blossomed luxuriantly, spread widely, and grew remarkably well during the first year in a bed of Texas peat placed in a water pool.

*Conclusion:* In closing, it should be emphasized that peat is not a fertilizer. It is low in nitrates, phosphates, potash. Wherever soil needs these important fertilizers, they should be added along with the peat. Peat furnishes soil with organic matter, porosity, moisture, insulation against rapid heat and humidity changes for delicate roots, and promotes bacterial action which increases available plant food. Dr. Dachnowski-Stokes of the U. S. Department of Agriculture states, "By far the most valuable constituent of a soil is organic matter. The destruction and loss of soil organic matter by tilling, leaching, etc., is taking place much more rapidly than it was accumulated. A deficiency in soil humus, already deplorable in long-established farming regions, cannot continue without imperiling the most vital resources of the Nation." The use of peat as a source of organic matter is one way to help conserve the nation's soils. It is especially adapted for impoverished nurseries, parks, and gardens.

# Certain Recent Geological and Biological Changes in South Texas, with Consideration of Probable Causes

W. ARMSTRONG PRICE, Consulting Geologist, Corpus Christi, and GORDON GUNTER, Texas Game, Fish and Oyster Commission, Rockport.[1]

## INTRODUCTION

The writers, separately engaged in field work in the coastal region of Texas in geology and biology, have observed evidences of rapid recent changes in the biota of the coastal prairies. Association through programs of The Texas Academy of Science[2] led to pooling of information and contemplation of causes of the changes. The senior author has sought evidence of concomitant and possibly related geological changes in the same region and has found some evidence that such changes have been in progress. The information on late geological and biological changes in South Texas is collated and presented here with speculations on basic causes for the diverse phenomena.

## GEOLOGICAL OBSERVATIONS

The Texas Coast contains many segmented bays and tidal estuaries. Its rivers are in general not navigable today. During historic and pre-historic times in the Recent geological period there has been a notable amount of silting of rivers and inner segments of bays. Outer bay segments have remained strikingly static with regard to silting, except that where ship channels have been dug silting has taken place widely over the bays as well as adjacent to the courses of the channels.

The last great expansion of ice sheets over the continents occurred toward the close of Pleistocene time and caused a notable fall of sea level, resulting in entrenchment of rivers and the cutting of gorges in the soft valley-fill material and other soft coastal sediments inside the present coast lines, as well as on the now submerged parts of the continental shelves. These gorges seem to have reached a depth of at least 240 feet near the present coastlines. The Recent period began with the rise of the sea accompanying the melting and retreat of the ice sheets. This rise of sea level

[1]The senior author is responsible for the geological portion of this paper, while the remarks on biological changes are the result of collaborative effort. The responsibility for the discussion of animals belongs to the junior author.

[2]The senior author read a paper entitled "Climatic changes versus overgrazing in South Texas" at the meeting of the South Texas Branch, Texas Academy of Science, May 10, 1942. The abstract will probably be published by the Academy. The conclusions followed Kirk Bryan's conception of late slight, climatic change as the most probable explanation of the vegetational changes here discussed. Bryan set forth this idea in "Pre-Columbian agriculture of the Southwest, as conditioned by periods of alluviation," Annals, Assoc. Amer. Geographers, 1941, vol. 31, 219-42. The basic data of Bryan's article, or some of them, have lately been brought into serious question by work done in the same areas by C. W. Thornthwaite and associates and reported in the paper entitled: "Climatic and accellerated erosion in the arid and semi-arid Southwest, with special reference to the Polacca Wash drainage basin, Arizona," Tech. Bull. 808, U. S. Dept. Agri., 1942, by C. W. Thornthwaite, C. F. Stewart Sharpe and Earl F. Dosch.

Since the scene of these studies is remote from the Texas coast, the writers of the present article omit consideration of Bryan's postulated epicycle of aridity of climate beginning about 1880.

caused progressive silting of the entrenched valleys and resulted in filling of gorges, and the formation of flood plains terminating at the heads of the now embayed mouths of rivers emptying into the Atlantic and Gulf of Mexico. A few of the rivers emptying into the Gulf have developed deltas, the flood plains having advanced to the coast, filling the temporary embayed estuaries.

Few studies have been made to determine how much of the late silting of tidal bodies of water and coastal rivers occurred after the white man arrived in North America. It has not been determined, for example, whether the late silting of the inner segments of present bays is a normal extension of flood plains or has been caused in significant part by accelleration of erosion since settlement of the country. It seems to be established by many studies, however, that man's occupancy of territory suitable for grazing and farming has often led to depletion of vegetational cover of the land and locally resulted in gullying, loss of soil water and lowering of the water table. Such accelerated erosion has occurred to some extent in Texas and must have caused accelerated alluviation of coastal bodies of water.

In South Texas, some of the earliest depletion of the vegetational cover of which the writers have learned began during serious droughts occurring in the decades 1880 to 1890 and 1895 to 1905. Some of this depletion has recently been repaired since the unprecedented rainy seasons of 1941-42.

The following observations of silting since the arrival of the white man in Texas are not based upon exhaustive studies of the scattered historical data available. They are offered here to indicate that there is a problem which geologists may attack and which seems to be related to the problem of late biological changes in the same region.

*Former (Restricted) Navigability of Some Texas Rivers*

At least three rivers of Texas were navigated in colonial times, which, according to report, have not since been navigable. At least, they are no longer navigated. San Felipe de Austin, early administrative center of the Austin Colony, is located on the south bank of Brazos River in Austin County, some 50 miles west of Houston. There was a dock or docks, and some sorts of boats, including a gunboat, used the dock. There was a certain amount of navigation of the river, perhaps never without difficulty, from its mouth to San Felipe during the colonial period, 1820 to 1840. According to local report, there would have been little chance of navigating the river to that point in 1928, when the writer visited San Felipe.

In 1925, large lakes in the flood plain of Colorado River in Matagorda County fed a gravity irrigation system having its intake a few miles above Bay City, 20 miles from the Gulf. Subsequently, an abandoned, heavily silted river channel was cleared below and the lakes drained. The reestablishment of a narrow channel along the course of the choked river bed led to the widening of the channel by erosion of considerable alluvium during the next flood and the formation of a small delta in Matagorda Bay. The material eroded, which had filled the former channel, was one of the locally celebrated "rafts" of the Gulf Coast. It was stated by a local surveyor and other reliable residents that the main "raft" had begun to form about the time of the Civil War and that it had choked the river to

Bay City in the period 1865-1925; also that the river had formerly been navigable to Wharton, 20 miles farther up stream. It was to restore the former navigability of this river and prevent flooding of bordering lands during periods of high water that the channel was opened to the bay, chiefly by dynamiting the "raft." Aerial surveys were made by the War Department to assist in the work of opening this river to navigation. The surveys showed the extensive choking of the stream bed in several former positions. The "raft" consisted of silt held by water-logged timber. It is said to have started with a jam of floating wood caused by a chain stretched across the river in the effort to salvage timber.

Between 1846 and 1865, or at least during the time of the Mexican and Civil wars, steamboats were active on the lower Rio Grande from Brownsville, Texas, to the opposite town of Matamoras, Mexico, and thence to the Gulf, 20 miles away. Captains Richard King and Mifflin Kenedy, later be-

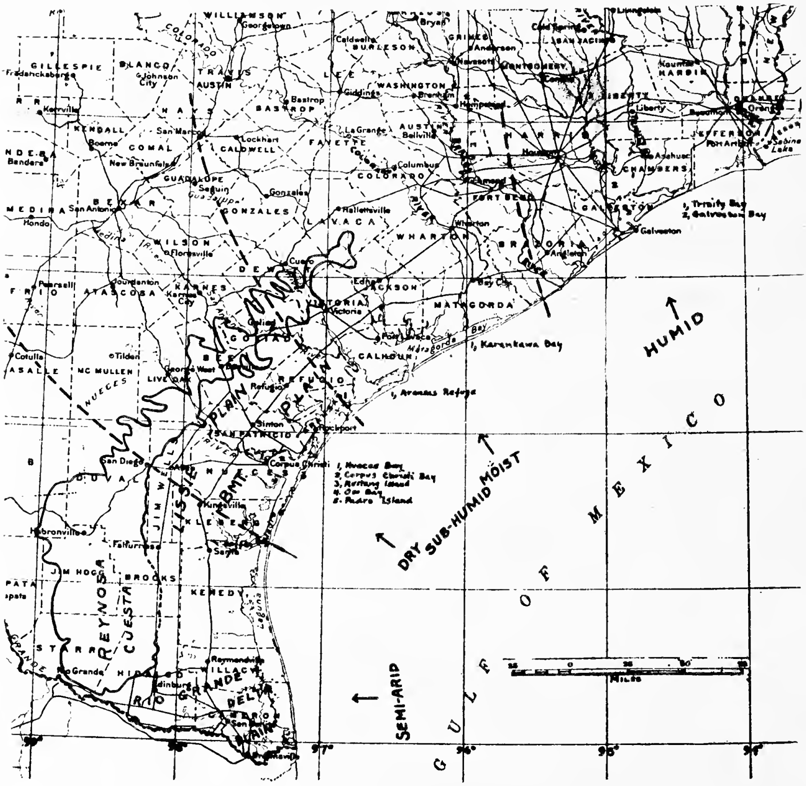


FIGURE 1

Climatic zones of South Texas, after Thornthwaite. Major physiographic divisions of the smoother coastal plains (coastal dispositional planes) are shown. Boundary between Beaumont (Bmt.) and Lissie plains is irregular and is not shown.

coming cattle barons of South Texas, conducted the steamboat operations. According to Bartlett (1856), in 1846 the river could not be ascended, but he said it could be made navigable to Laredo for boats of four feet draught. The river is open today and it cannot be said that boats of some sort could not still navigate it. That river navigation for anything but rowboats has not been regularly carried on there since 1865 may be due to economic as well as physical factors, but the presumption is strong that silting had a prominent part in the change of conditions.[2a]

*Silting of Bays and Estuaries*

Coast charts show that Trinity Bay, the northeastern arm of Galveston Bay, is silting up due to the underwater extension of deltaic sediments of Trinity River. (Figure 1.) This seems to have begun when the river flood plain advanced to the head of the Trinity Bay segment, after filling a more interior segment of the drowned valley. Since 1880, this delta has advanced the length of the bay. The first grazing and cultivation (cotton) up-stream occurred in 1820-40.

The Nueces River is slowly filling Nueces Bay while the outer segment, Corpus Christi Bay, seems to have remained static until ship channels were dredged across it in the past two decades. The recorded silting of this bay (comparison of 1880 and 1937 coast charts) grades from 4 feet near the

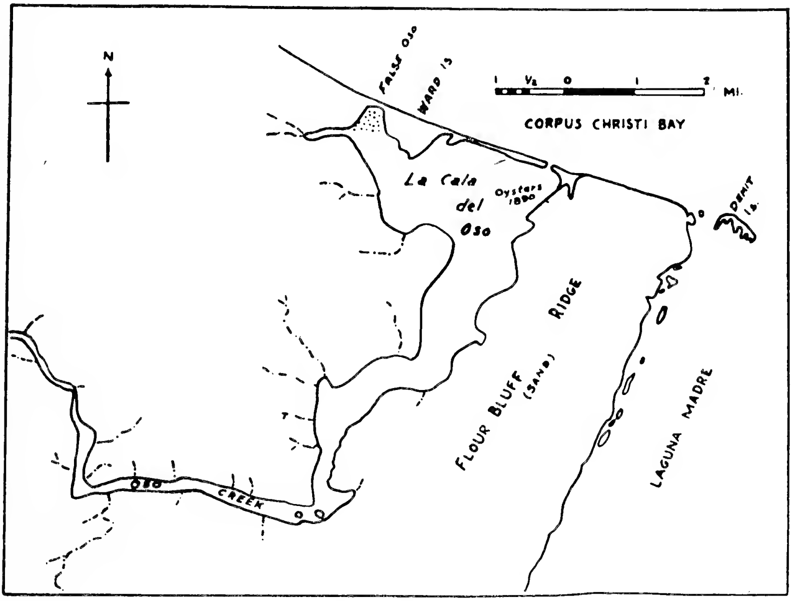


FIGURE 2

Oso Creek and its tidal bay (la Cala del Oso), south shore of Corpus Christi Bay, Nueces County, Texas.

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[2a] Reid's Tramp (See Footnote 12a) says that in 1855 a small steamer was accustomed to make occasional trips up the lower Guadalupe River from Victoria to Hines Bay without obstacle.

ship channel to less than 1 foot at the south shore. Proof that some of this silting antedated the channel is not in hand.

Oso Bay is the expanded coastal part of the tidewater portion of Oso Creek (Figure 2), a tributary of Corpus Christi Bay. The creek rises in swales on the prairie, the headwater drainage area lying 15 to 20 miles west of Corpus Christi. The prairie in the elbow of the creek south and southeast of Corpus Christi is the site of one of the earliest cattle ranches of Nueces County, the Villarreal ranch, granted by the Mexican state of Tamaulipas in 1831. On a portion of this ranch, acquired in 1840 by H. L. Kinney, the original settlement of Corpus Christi was made.

As early as 1889, the prairie in the elbow of Oso Creek was thickly covered with thorny brush. Robert Poenish, farmer, now owning extensive holdings there, states that he so found it when he settled there that year. Only a few farmers had made clearings in the area at the time of this settlement, and they had cleared and owned only a few small tracts, usually of 40 to 80 acres in size. Previously the land had been used for ranching, presumably with no more than a few small garden tracts planted. Clearing of the brush over a large part of the elbow of Oso Creek and the adjacent prairie south, southeast and southwest of Corpus Christi was begun in 1899 and by 1902 most of the land was under cultivation. This clearing was part of a campaign to raise winter vegetables for shipment by rail, according to the statement of C. E. Coleman, a leading vegetable buyer and shipper of this region and originator of the movement. About 1910-15, during the boyhood of Congressman Richard M. Kleberg, the route from Kingsville to Corpus Christi which lay west of the elbow area is said by him to have been open prairie. It has since grown up in brush.

The writer has attempted to ascertain to what extent silting in the Oso estuary followed grazing and cultivation in the Oso Creek area. Clay dunes (Price 1933, Fig. 8)) line the western shore of this small bay. They have been formed by silt blown from mud flats exposed immediately offshore to the east. These dunes must be several centuries old as they contain flint points apparently older than those last used by the coastal Indians, the Karankawas, with other Indian midden materials in a sandy layer which runs through some of the dunes at their mid-height, or about six feet above the original land surface. However, water several feet deep was found at the south shore of Ward Island in the mouth of Oso Bay in the decade 1870-80 when "Red" John Dunn, ranger and well-known resident of Corpus Christi (now deceased), worked there at a "hide and tallow factory." This "factory" had a dock on the south shore of the island to which boats "of fair size" came and departed loaded. He stated to the senior author, about 1933, that shallowing of the bay at the site of this dock occurred "a long time ago." During the last decade rowboats are said to have been unable to approach the site of the dock.

Mr. Robert Poenish states that he fished oysters in the northeastern part of Oso Bay between 1890 and 1900. By 1929, when the senior author first saw this bay, it was quite shallow and Mr. Poenish states that it has been "many years" since there were oysters in it. Much of the east side of the bay has been filled artificially in the last two years.

Mr. Poenish states that in 1890 to 1900 there were boards in the so-called "False Oso," then silted up, remaining from "mud-shell" operations. Such operations are normally carried on by dredging and it was his belief that the "False Oso" probably carried water at the time of this operation. However, it is possible that someone attempted to secure shell here otherwise than from boats, or that it was attempted during times of high wind-tides when water enters the channel. The "False Oso" is a broad, silted and abandoned channel between Ward Island and the mainland.

From the foregoing it appears that Oso Bay had partly silted up before the white man came and that some water deep enough for oysters and boats remained 40 years after the first settlement by Spanish-Americans, and twenty years later when the first farmers came; also that appreciable silting occurred after the farmers cleared and drained their lands.

From these data alone it is not possible to determine satisfactorily the full history of the later silting. From other information it is known that the coastal prairies of the Corpus Christi area on blackland soil, such as covers the Oso elbow, were typically treeless and brushless when first seen by the white men. The brush of the elbow area possibly came in after the initial grazing by domestic herds of the Villarreal and Kinney ranches. If the "mud-shell" story is correctly interpreted, the silting which had been going on before grazing also continued during grazing. After the brush was cleared and farming commenced, additional silting occurred. Finally, the bay has been much shallowed and narrowed by artificial filling within the past two years. The presence of the oysters in 1890 suggests that silting had been slow at least until late years and that acceleration of silting came only with the advent of the clearing made by the farmers. Drainage ditches dug along the roads during the farming period certainly accelerated erosion and silting.

*Drying Up of Perennial Streams; Eastern Reynosa Cuesta, South Texas*

Observations of a resident surveyor and civil engineer of the Corpus Christi hinterland, a man[3] locally well known for accuracy, show that small streams of the eastern flank of the Reynosa cuesta (Figure 1) or "plateau" (Price 1933a), which came under his observation about 1870, have since dried up and have for several decades been only intermittent in flow. Specific ground-water studies of these streams have not been made. The drying up of the streams so long ago can not be ascribed to discharge of ground waters from bored wells, as it was the drought of 1896 to 1903 which brought the first boring of water wells in this region. Edward L. Caldwell[4] of Corpus Christi, whose firm has for many years furnished well materials throughout this region, states that the first sales of pipe to line (case) bored wells were made about 1895. The area was settled by Spanish-Americans prior to 1836, and probably as early as 1820. Ranching and subsistence farming were carried on by these early settlers. Their wells were hand dug, mostly at ponds or along water courses.

[3]C. F. H. von Blucher, County Surveyor of Nueces County for many decades; recently deceased. Oral statements to his son, Conrad M. Blucher, present county surveyor, and to W. Armstrong Price.

[4]Oral statement to Price.

## GEOLOGICAL AND BIOLOGICAL OBSERVATIONS

### *Filling of Laguna Madre by Sediments and Thinning of Vegetation On Padre Island*

Laguna Madre, the section of the coastal lagoon between Corpus Christi Bay and the Rio Grande, now has only small areas of open water in comparison to its great size (4 to 10 by 125 miles), as shown by aeronautical charts of the U. S. Coast and Geodetic Survey. Marine navigation charts of the survey, however, show open water once to have been rather general over the lagoon. The basic work on marine charts was done in 1881, with minor revisions in 1909 covering only the navigable waterway along the mainland. The aerial maps were made in the decade 1930-40. Widespread filling of the lagoon has taken place. A map published by the Texas Game, Fish and Oyster Commission (1929-30 yearbook, p. 56) shows a great encroachment of low sand foreland from Padre Island, the offshore bar separating the lagoon from the Gulf. The encroachment is in the open water of the lagoon just north of the mouth of Baffin Bay (Figure 1). The compiler of the yearbook, J. G. Burr, predicted that Baffin Bay would in a matter of years be cut off from the upper Laguna by further encroachment of the foreland. Twenty miles below the mouth of Baffin Bay, the Laguna is completely divided today and Padre Island is connected with the mainland except at the highest tides, when water a few inches deep connects the upper and lower Laguna. This change has taken place since the mapping of 1881.

An item related to the late sanding-up of large parts of the lagoon is the thinning of vegetation on Padre Island. In a statement to the senior author a retired foreman of the Laureles Headquarters of the King Ranch, confirmed by John Kenedy of the Kenedy Ranch, said that Mifflin Kenedy, founder of the ranch, found Padre Island when first seen by him, "as green as a garden." Pat Dunn, former owner and ranchman of Padre Island, recently deceased, said that this verdure disappeared sometime after 1870, along with the numerous cotton-tail rabbits and spotted skunks which formerly inhabited it. Today, jack-rabbits and coyotes are the conspicuous large mammals of the island. Green meadows are scattered over the inner parts of the island, but up to 1941 large parts were bare sand, and in general it had the appearance of a desert. The "suddenness" of the disappearance of the skunks and rabbits, as reported by Dunn, may have been only the layman's somewhat sudden realization of the effects of a more gradual change, or their departure may have been hastened by the effects of a severe drought. That the vegetative denudation was not quite so sudden is indicated by the fact that men living today, whose age is about fifty years, can remember when Padre Island was "green." The same change took place on Mustang Island, just to the north. Bailey (1905) states shin-oaks up to eight feet tall extended along the bay shore of the upper end of Padre Island for seven miles. Wild celery abounded in the lagoon. A few willows, buttonbush and huisache grew on the north end and center of the island, while salt grass and waxy and creeping plants grew on the south part.

Today all the woody vegetation has disappeared[5], the wild celery has gone from the lagoon and the southern portion of the island is almost bare of grass. The great reduction in the vegetative cover of the sand has permitted hurricane tides and winds, and normal winds, more readily to carry sand from the beach and dunes across the island into the lagoon. Thus depletion of vegetative cover "after 1870" promoted filling of the lagoon.

Mr. Burton Dunn of Corpus Christi, son of Pat Dunn, reports that sheep were grazed on the island at an early date, but only for a few years because of the depredations of coyotes. Also, the sand began to "blow" following the grazing of sheep and an ensuing series of dry years prevented restoration of the range. Whether there had been a noticeable reduction of the vegetative cover before the sheep were run, seems not to be clear from the available record. In the present ranching, Mr. Dunn reports that only 800 calves a year are branded on the north 25 to 30 miles of the island, whereas, in the 1880's, the number for the same area was 1,600. There has been no decrease in the size of this part of the island since that time. On the south 50 miles of the island no cattle now range. Mr. Burton Dunn reports there has been "no grass" there since it was severely denuded by high water of the 1933 hurricane. The northern part of the island was also flooded, but less eroded and, according to Mr. Dunn, this area has more grass now than at any time in the past forty years. There has been very heavy rainfall in this region during the past two years, (Gunter, 1941).

An event in this filling of the Laguna Madre was described to the senior author by one of the owners of the King Ranch. In the strong hurricane of 1919, Gulf waters poured over Padre Island and its dune wall as a hurricane "tide." Cattle, driven into the lagoon before the offshore wind, were later overwhelmed by quicksand following the entry of the Gulf waters. After the storm, three thousand pairs of horns were counted sticking up out of the sand of the lagoon bottom. The assumption is that this quicksand was largely composed of sand newly entering the lagoon from the Gulf, the beach and higher parts of the island with the hurricane tide. Much of the general filling of the lagoon has probably been by wind-blown dune and beach sand from Padre Island, which has been carried into the Laguna at an increased rate by the prevailing southwest winds, since the onset of denudation of the vegetation of Padre Island. Some sand may have been blown in from the land by hurricanes, for the prairie is deeply sand covered south of Baffin Bay for a distance of fifty miles.[6] During hurricanes the transportation of dune and beach sand by wind is greatly increased up to the time when all is soaked by rain and flood waters. Airplane photographs of the island show its western side to be composed of great overflow fans of sand washed by flood waters from the Gulf pouring through high-level gaps in the line of sand dunes which faces the Gulf of Mexico. If the vegetative cover had remained intact these movements of sand would have been considerably reduced.

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[5]Photographs "from Padre Island, locality unknown," show that some brush plants were killed by moving dunes. A reliable report received as this goes to press is that a pond on Padre had oak brush a few years ago and may still have it.

[6]However, no dunes formed by north winds or other offshore winds occur in the region.

In recent years the Game, Fish and Oyster Commission has been much concerned about the oversalting of Laguna Madre, which kills large numbers of fish, and has cut one pass through Padre Island to the Gulf (completed in April, 1941) in hopes of alleviating this condition. The pass filled, and recutting was completed in November, 1942. Burr, in the paper cited above, the junior author and others, have collected samples of lagoon waters in this region which, in some cases, were three times as salty as sea water. The data are mostly unpublished. It is assumed that, since the filling of the Laguna, the water on shallow flats becomes warmer and the rate of evaporation has increased. Young men who sailed the Laguna fifteen years ago say much of the old open water is gone. It would follow that the development of oversaline conditions occurring aperiodically every ten years or so, in dry years, has been more frequent since the turn of the century, but on that there is no information due to lack of records in former years. If the denuded state of the southern half of Padre Island continues, and if the northern part is again denuded, filling of the Laguna will continue and there is nothing that man can do to minimize or alleviate the development of oversaline conditions.

The filling of Laguna Madre is not an isolated phenomenon. There are no specific data at hand to establish the rate of filling over a century, but there seems to have been an acceleration since 1880. It is certain that a critical stage of shallowing has been reached since 1880, when the survey for the hydrographic charts was made.

Other factors than sand transportation have been slowly active to a minor extent in the filling of Laguna Madre. The accumulation of the bodies of marine grasses and algae, gypsum deposition (Baker 1929), and the calcareous shells of worms and other organisms have played their part. Shallowing of the lagoon and the occurrence of droughts would cause an increase in gypsum precipitation. The precipitated salts would be renewed by inflowing tides. It is a common phenomenon for dredges to find large bodies of crystalline and alabaster gypsum in the coastal bays.

It is concluded that the disappearance of much of the native vegetation of Padre and Mustang Island—noticeable some years after 1870—accelerated the rate of filling of the Laguna Madre by sediments and that the incidence of droughts combined with the activities of grazing animals was responsible for the creation of desertic conditions between 1880 and 1941.

## BIOLOGICAL OBSERVATIONS

### *Century-old Trees Killed by Drought*

C. F. H. von Blucher, surveyor, formerly cited, stated to J. P. McAuliffe, Weather Bureau observer at Corpus Christi, that he saw numerous oak trees that were killed by drought in the early 1880's. Some of these he estimated to have been as much as 100 years old. Local Weather Bureau data begin with 1886 and show the next severe drought to have been in 1896-1903. Launce Knight of Corpus Christi states that thousands of dead mesquite trees were scattered through the brush of Dimmit, La Salle, Maverick, Webb and Zapata (counties bordering the Rio Grande in the semi-arid zone), during his boyhood (1903-1912) and were said to have been killed by a drought occurring "not long before," the date of which he did not know. The occurrence of such a great stand of dead trees was, however, then considered a unique phenomenon by mature men of that time and place. It is noteworthy that by no means all the mesquites were killed. These observations suggest that no such severe drought had previously occurred during at least the latter part of the preceding century in the region where the trees were killed. Dobie (1929, p. 202) said that the terrible droughts of the previous fifty years killed many live oaks on the South Texas plains but no chaparral[7] thickets. Knight confirms the latter observation. If the trees killed were badly diseased or otherwise enfeebled, these observations do not indicate it, as the number of trees killed was too great.

*Northward Spread of Mesquite*

The memory of the progressive spread of the mesquite and other elements of the spiny brush or chaparral of South Texas is strong among the older people of the coastal country (Barton 1924, *p. 721*). Many statements made to the writers between 1925 and the present also evidence it. These statements were made by ranchmen, lawyers, surveyors, bankers and merchants from Victoria to Corpus Christi. Soldiers returning from World War I were in some cases astonished to find prairies grown up in brush. Mesquite and other brush has long been present in the border counties and some adjacent districts of the state and the region was known as the "brush country" (Dobie 1929). The coastal prairies north of Nueces River, however, were conspicuously treeless, brushless and covered with high grass, when first seen by Anglo-Americans, and so continued until about 1870 to 1880. Since that time mesquite has covered large areas of the coastal region[8] northward and eastward to the Colorado River. Dobie (1929, p. 203) remarks that the brush is "stabbing a great range to death." Lehmann (1941) lists the encroachment of mesquite and other kinds of brush onto open prairie land as an extremely important factor in reducing the range of Attwater's prairie chicken in Refugio and other counties to the south and west: "Within the memory of living men, extensive prairies have been transformed into brush jungles." He further says that hundreds of thousands of acres of what was once tall-grass prairie are now brush land. He lists lowering of the water table[9] as one cause of brush encroachment. The northeastern boundary of mesquite today is approximately the mid-

[7]The word **chaparral** has been in current use in Texas for a century or more. Although now popularly used for any kind of thorny brush, the Texas-Mexican has always had a more precise botanical usage for it (Dobie 1929, p. 202). The term is properly employed for a plant assemblage in which **Acacia amentacea**, the "chaparro prieto," or black chaparral, is an important member (Clover 1937). The same term has long been used by Pacific Coast botanists for oak-brush and other brush assemblages.

[8]The data collected by the writers refer chiefly to the history of the mesquite on the coastal Beaumont deltaic plain and the adjoining Lissie plain (Barton 1930 a, b; Price 1933b, p. 115). These have been characteristically treeless north of Nueces River except for sandier parts of the Lissie (Figure 1).

[9]The text does not indicate that Lehmann had made specific local applications of this factor, but only that he reported it as a possible cause. There is no information in hand for this region to connect brush encroachment with water table lowering except adjacent to stream valleys. The broad interstream areas may not have suffered important water table change during the period of mesquite encroachment.

line of the wet half of Thornthwaite's (1931, 1941) sub-humid zone (Figure 1). The Colorado River is the approximate boundary of typical mesquite in the coastal prairie section. The most eastward stand of mesquite known to the writers is at the San Bernard River, east line of Wharton County, where the mesquite meets palmetto.[10] The brush is, of course, cleared from large areas for farming, but soon grows again in abandoned fields.

Two things have happened with respect to the spread of brush, especially mesquite. It has advanced several miles eastward and has grown up thicker in areas formerly occupied. Bailey (1905) gave a map showing the territory of Texas where mesquite grew. The eastward border roughly followed the 98th meridian south to Travis County from where it then ran southeastward to Calhoun County and the Lavaca River. Today the area of typical mesquite growth extends as far east as the Colorado River in Matagorda County and stragglers extend beyond. Thus the mesquite has traversed some 50 miles in less than 50 years.

On December 27, 1851, John Russell Bartlett and his party of the Mexican Boundary Commission left Ringgold Barracks for Corpus Christi. He stated (Bartlett, 1856) that dense chaparral covered a belt of 5 to 6 miles wide there along the Rio Grande. Havard (1886) said at Rio Grande City (Ringgold) the belt of dense woody vegetation was 30 miles or more wide.[11]

On p. 529 (1856), Bartlett states, "The land near Corpus Christi is very fertile. Groups and belts of timber are found near the coast; but after leaving this, a vast undulating prairie extends from the Nueces to within three or four miles of the Rio Grande. This plain is covered with richest grass, and abounds in mustangs, deer, antelope and large herds of beef cattle."

Havard (1886) said that the area included between the coast and the Rio Grande was sandy, dry, riverless and mostly covered with fair grass. Zones of chaparral and small timber traversed it in several directions but he said it was "entitled to consideration under the heading of prairie——." He further said that "from Laredo approaching Corpus Christi" the chaparral becomes thicker. Around San Diego[12] the vegetation was dense.

Havard specifically described the vegetational characteristics on the route from Laredo to Corpus Christi. Although the routes traveled were not the same, a reading of Bartlett's and Havard's accounts leaves the impression that the brush was growing thicker in the interval, some 30 years, between them. Whether or not this is correct, it is true that this process has gone on in parts of that area in later years, as is evidenced by statements such as that of Congressman Richard M. Kleberg, cited above. It has also gone on north of the Nueces River as shown by many statements to

[10]Mesquite on the abandoned delta plain, palmetto below on modern flood plain.

[11]The flood plain is 5 to 6 miles wide here, trending eastward. Brush would grow most heavily along the terrace scarps which are four in number, two on each side of the river. The 30 mile belt might have been parallel with the river or might have referred to the north-south belt of the Reynosa cuesta or "plateau" with its sand and its shallow-lying and outcropping caliche, typically brushy today. Bartlett might not have mentioned this belt.

[12]Reynosa cuesta.

the authors made by residents of areas as widely scattered as San Patricio, DeWitt and Calhoun counties, as well as areas lying in between. These are much too numerous to cite in detail.

The rate of "march" of the mesquite and other brush northward and eastward is not definitely known. Mesquite appeared thick in Calhoun County[12a] areas 25 years ago. Since then it has traversed about 50 miles eastward. Between 1870-80 and 1943 the area of heavy brush growth has spread at least from Kleberg County to Matagorda County, a distance of 175-200 miles, although large parts of the country are still open prairie.

The huisache is a thorny brush of the Southwest. In the typical mesquite country, it grows in low, moist places. As the mesquite vanishes eastward through increasingly humid land the huisache climbs up on the prairie and largely takes its place. It reached the Louisiana line many years ago (Bailey, 1905). Apparently, it may be looked upon as an advance agent of the chaparral.

The change from grassland prairie to woody vegetation has gone on in areas of the State other than the coast, as is evidenced by the following statement taken from Goodrum (1942, p. 5) :

"In early years following the arrival of white men in the Edwards Plateau, the region was essentially a prairie area with tall grasses covering the hills and with timber restricted to the margins of waterways. According to early accounts, prairie game such as antelope, buffalo, and prairie chickens were plentiful while deer and turkey were few. The game was promptly exploited and cattle raising became the chief industry. In subsequent decades, however, land use practices of the settlers caused the grassland to decrease in extent until the region came to be principally woodland."

*Northward and Eastward Spread of Animals from the Southwest*

No detailed ecological study of the South Texas brushlands has ever been made. However, the fauna of the brush country is quite different from that of the coastal prairie upon which it is encroaching, and it may be conceded as a fact that some vertebrates and a large number of invertebrates are spreading northward and eastward with the brush.

Locality records for many animals are fragmentary and the importance of records is highlighted by their absence. There is some information concerning the spread of certain vertebrates northward and eastward from the Southwest.

Bailey (1905) stated that armadillos were common in southern Texas from the lower Rio Grande to Matagorda Bay and to the mouth of the Pecos and Llano. He said they had been taken in Burnet County and at Austin and Elgin and reported from Inez, Elgin, Seguin, Columbus, Navasota and as far east as Antioch on Nevil's Prairie. He said they were generally believed to be extending their range eastward and northward, but whether this was a real extension of the range, or an increase in numbers

[12a]John C. Reid, in "Reid's Tramp," (pub. 1858, see "Frontier Times," Bandera, Texas, May, June, 1943, Vol. 20, Nos. 8, 9, pp. 137-145; 167-175) states that brush (chaparral) grew (on the sand ridge) at Powder Horn (3 mi. w. of Port O'Connor) on Matagorda Bay in 1855 but grass and no mesquite inland (across the coastal prairie) until Goliad was reached (on Reynosa cuesta).

throughout an established range, was not entirely settled. He said as a rule they did not extend east of the semi-arid or mesquite country. Bailey gave the general distribution, which evidently did not include stragglers, as shown by the above locality records, as running from Stephens County diagonally through Williamson, Travis, and Victoria Counties, to Jackson County on Matagorda Bay.

About 1910 when Dr. J. T. Patterson was carrying on his classical studies on the embryology of the nine-banded armadillo, *Dasypus novemcinctus texanus* (Bailey), the animals were not numerous in central Texas. Later they became very common and were generally recognized to be spreading rapidly across the state. About 1925, the late Prof. George Williamson, of the Louisiana State Normal College, became interested in recurrent reports of armadillos in western Louisiana. He at first thought that the animals were brought in by increasing automobile tourists following the First World War, but later decided that they were moving in without assistance. In 1926 John K. Strecker published records of the armadillo in northwestern Louisiana. Two years later he published records (Strecker, 1928) from northeastern Louisiana. Twelve years ago, William J. Tucker of the Texas Game, Fish and Oyster Commission predicted that the armadillo would soon reach the Mississippi River. Lowery (1936) has discussed the movement of the Texas armadillo into Louisiana and gives records of animals taken east of the Mississippi River in December, 1935. He stated that, since the Colorado, Brazos, Trinity, Neches, Sabine, Red, Ouachita and Atchafalaya rivers have proven not to be geographical barriers to the northward spread of the animal from the "land of cacti and horned toads," it could be expected to cross the Mississippi River and extend eastward. In a letter to the junior author dated May 2, 1942, he says that a number of animals have been killed east of the Mississippi and that, since the armadillo likes pine woods, the Southern pine belt will be a perfect avenue for its spread to the Atantic Ocean. Seton made the same observation some years ago.

While the spread of the armadillo is not limited by the spread of South Texas brush, yet it is a synchronous phenomenon. The Louisiana swamps and forests are as humid as they were thirty years ago and the present environment of the animal there is quite different from that of central Texas of thirty years back. While the armadillo prefers dry pine woods in Louisiana, as stated by Lowery, it at least crosses swampy regions. The junior author saw one in the lowlands of Avoyelles Parish[13] in August, 1940. The spread of animals in the space of a few years from a region with one type of climate to a region with a different climate and very different environment raises many questions.

According to H. P. Attwater (Bailey, 1905) the first armadillo seen in Calhoun County, Texas, was observed in 1886 and in June, 1904, they were very common. H. C. Oberholser stated that as late as 1900 they were uncommon around Port Lavaca (Bailey, 1905). According to Phil Goodrum, of the Texas Game, Fish and Oyster Commission, the first armadillos seen east of the Trinity River were noted in 1902. From this information and

[13]Crossed by the Red River and Mississippi River flood plains.

that cited from Louisiana, we can infer that the animal extended its range roughly 400 miles in 54 years. In 16 years it extended its range, so far as the evidence shows, 150 miles to east of the Trinity River.

According to Taber (1940), a definite northern invasion by the coati mundi, *Nasua narica,* is taking place in the southern parts of New Mexico and Arizona. During the past two decades the coati mundi has risen from the ranks of a rare animal to that of a common part of the native fauna of that region. Three records, two of which are recent, given by Taber from the Rio Grande region of Texas, and a record from California (Hall 1940), are not free from the suspicion that the animals escaped from captivity. Another unpublished record of the animal from the Aransas Refuge (Figure 1), Aransas County, Texas, by Ernest G. Marsh, Jr., is in the same category. Time will tell the story of the spread, if spread it be, of the coati mundi into South Texas.

H. C. Blanchard, former warden for the National Audubon Society, has given information on the roadrunner or paisano, which is considered to be an arid-land bird. In 1887 there were no paisanos along the Texas Coast, but they approached to within fifty or a hundred miles of it in the south and west. Today they are present along the coast, and within the last three years Blanchard has seen them between Houston and Beaumont. They have also been seen lately by other observers as far east as Tyler, Crockett and Sherman, Texas. J. Frank Dobie, who has observed the paisano for many years as layman, wrote the junior author that he had no specific information but was under the impression that the bird has extended its range eastward, but not to anything like the extent of the armadillo. During June, 1939, Marshall V. Clark and a crew with the Civil Aeronautics Authority saw two paisanos at Vinton, in southwestern Louisiana. George H. Lowery, Jr., of the Louisiana State University, Museum of Zoology, previously cited, has several paisano records and one specimen from near Shreveport in northwestern Louisiana, all taken in recent years. This species is not listed from Louisiana in the recent publication by Oberholser (1938). The bird is definitely spreading eastward.

Recently (1941), Texas Game, Fish and Oyster Commission biologists have found that the chachalaca, a gallinaceous game bird of Mexico and the Rio Grande Valley, has extended its range northward to northern Willacy County and along the river through Zapata County. The whitewing dove is still concentrated in the Rio Grande Valley and was formerly found in numbers only as far north as Duval County, Texas. They have recently been reported in numbers as far north as Bandera County. This may be to some extent a reoccupation of former range. The Inca dove of the Southwest was seen in Louisiana for the first time seven years ago (Daigre, 1936). These isolated facts are without significance unless coupled with future data, but it is felt that such observations should be summarized now to stimulate further investigation of the suggested spread.

It is well known that the coyote is spreading eastward and northward and is now established in some places east of the Mississippi River. The jackrabbit is spreading eastward, and there are some indications that the prairie dog is doing the same thing. The relationship, if any, of the eastward movement of these animals to that of Southwest Texas animals is unknown. A contrary migration of plant or animal species in the region, if it has occurred, has not been encountered.

## DISCUSSION

There are, so far as we can ascertain, only two logical explanations of the changes described here. One is overgrazing, which would bring about thinning of cover, increased evaporation, increased rate of run-off and resultant general lowering of the water table. The second is an epicyclic or progressive change in climate tending to more arid conditions, the effect of which may or may not have been increased by overgrazing. It is difficult to demonstrate clearly that one or the other of these two factors was dominant in producing the changes or was alone operative.

The biological data asembled make it evident that some of the larger animals of the Southwest, as well as leading elements of the South Texas brush land fauna, are spreading eastward and northward from the Texas-Mexican border region. No movement in the reverse direction has been observed in the same region. The armadillo has covered about 400 miles in 50 years. Some animal species of the region now in the doubtful class may prove later to be spreading in these directions, as is suggested by meager data.

The movement of the animals has been coincident with the spread of thorny brush or chaparral. The brush has advanced northward and northeastward from the Mexican Border region. Some of the animals have run ahead of the brush which seems to have stopped its movement in a fundamental climatic transitional zone, the sub-humid zone (Thornthwaite 1931; 1941). This zone is halved by the line along which precipitation and evaporation are believed to be balanced. This thorny brush, in which mesquite is prominent, is a characteristic of the dry zones and nowhere in Texas has invaded the humid zone as it is currently mapped.[14]

It seems that, prior to the coming of the white settlers, the thorny brush was excluded from the fertile coastal prairies, being present only here and there in small areas of special soil and edaphic conditions. These coastal prairies had a covering of grassy vegetation—a vegetational climax, or stabilized growth. Beginning at different times in different places, but generally occurring in the coast prairies coincidentally with the coming of the Anglo-American rancher and farmer, the thorny brush spread into the area of depleted grass and occupied it, *but only to the outer boundary of the dry climatic zones, to which it seems to be restricted.* Here it has halted for two decades of the senior author's observation and for a much longer period from the accounts of others. Similar grazing, or over-grazing as is generally charged, occurred across this line along the northeastward extension of the same geologic and geomorphologic formations and units; namely, the coast prairies and the outcrop of the Beaumont formation with its blackland soils. It is to be particularly noted that the thorny brush[15] did not replace the depleted virgin prairie growth in the humid zones. Other vegetation, not the chaparral brush, followed the original grasses there.

[14]Not including huisache which extends to the Louisiana line.
[15]Excepting the huisache.

The climatic map, Figure 1, shows that, *within the limits of the coast prairies,* the animals and plants here noted moved from more arid to less arid country, but the most conspicuous plant association, the spiny chaparral brush, did not cross a fundamental climatic line. Therefore, it is possible that the initial movement was merely one within a climatic zone, the brush replacing the grass vegetation as the latter was depleted by grazing animals. Before it can be established that the movement of the brush has a climatic significance through having had an impetus in a climatic change, the subject would have to be studied over the entire state.

If it should be shown that the brush frontier everywhere in Texas moved from more arid to less arid country, it would still have to be shown that the replaced vegetation had not established itself in marginal more moist parts of the arid zones at some previous time during a fluctuation of climate and was not a temporary hold-over.

The spread of the animals with that of the brush may be an example of an upset biological adjustment resulting in a dispersion of diverse forms. Once dispersed, the barriers which would hold one form might not—and seemingly did not—hold other forms. Hence, the outrunning of the brush by the armadillo.

The geological evidence of recently accelerated silting and erosion now in hand is incomplete. However, taken with the biological and human changes in the coastal region, a historic picture begins to emerge. The history of changes brought about by man on the North American continent goes back to the earliest days of settlement along the Atlantic coast. First came the slaughter of inconceivable numbers of wildfowl, then of larger game animals, buffalo, antelope and others. Concomitantly there was the introduction of domestic animals. The grazing animals introduced had different habits from the wild species displaced. Man restricted their movements and controlled, to some extent, their food. Cutting and burning of forests, fencing and draining of lands, pollution of streams, the clearing of protecting brush from streams, occupation of springs, close settlement of large areas and all the multitudinous operations of an expanding civilization produced tremendous changes in the native fauna and flora.

The coast of Texas was late in being settled. The light and slow occupation by the Spanish-Americans began in 1749 on the Rio Grande, spreading slowly northeastward to the Nueces, with outpost communities to the northeast. The Anglo-Americans began to come in from the east and north about 1825-28 and rapidly increased. However, heavy settlement of some parts, such as the Rio Grande delta, came much later. It was heavily settled chiefly after 1916.

With this background of extensive changes, the migrations of plants and animals here discussed may seem minor elements of a complex and incompletely known whole. However, the following suggestions are advanced as a working hypothesis to explain the observed changes.

It is suggested that the mesquite and other brush had, during the period of aboriginal occupation, become stabilized on lands which these plants had seized at some prior time and were excluded from other lands on which prairie grasses had become well established. These plant assemblages, so far as the coast prairies of South Texas are concerned, remained stabilized until the time of the introduction of large herds of grazing animals by the Spanish-Americans.

Even this invasion did not seriously affect the prairie vegetation, at least not over the land north and east of the areas of their heaviest occupation, that is, not north of Kleberg County or east of Duval County. With the coming of herds of grazing animals to the blackland prairies of the coast and the great expansion of the cattle business in 1870 to 1880, the prairies began to be overgrazed and the mesquite to invade them. At the same time there occurred several severe droughts. The incidence of the droughts increased the damage done to the grass by cattle and allowed the soil to begin to blow under the action of the exceptionally steady and strong hot-weather winds of this region. The damaged soil, under continued grazing, did not allow the grasses to reestablish themselves after the droughts, and the brush encroached still further. While the grass was depleted and before the establishment of the following brush, soil erosion occurred, only the flatness of the prairies preventing it from being widespread and severe. The drought upset the balance of nature then existing and many species began to migrate. The movement observed in Texas is northeastward and eastward.

As farmers began to displace ranchers over large areas, their operations further depleted and displaced the grass, but they also cleared out the brush, planting crops. As farming increased, the need for drainage was felt and extensive drainage-ditch systems were constructed. These were largely left unprotected by sodding or other lining, resulting in much additional erosion of the prairies. Earth from the spoil banks was washed into the ditches by rain and some of the loose material was gradually transported by storm run-off to streams and estuaries.

The occupation of the Texas Coast by man seems to have caused a certain amount of acceleration of the normal rate of silting. This silting is noticeable, even without records and quantitative observations, but the flatness of the prairies and the small amount of total topographic relief has prevented it from being large, or its increase rapid. Without full records it is difficult to determine the time, or times, of the amounts of definite acceleration of erosion and silting.

Taylor (1934) has called to attention the significant fact that one extreme year or time of climatic or other environmental stress may initiate more changes in the animal and plant life of an area than a hundred or more normal years. The droughts in Texas of the 1880's, early 1900's, 1917 and early 1930's must have had great influence in bringing about the changes noted in these pages. Whether they alone could have produced all these changes in the same environment in the absence of the white settlers and their introduced stock, it is impossible to say. However, it is evident that variations of the weather, particularly the local incidence of severe droughts, were important in the history here outlined.

## SUMMARY

1. Some perennial streams of the eastern Reynosa cuesta, South Texas, dried up about 1870 and since have been only intermittent in flow.

2. Silting of an isolated estuary was first noted between 1870 and 1890, prior to cultivation but not prior to grazing in the region. There is some evidence that inner segments of coastal bays also seem to have been silting more rapidly in recent years.

3. Padre Island, the southernmost barrier island of the Texas Coast, was green until shortly after 1870 when it became greatly denuded of vegetation and the fauna changed. Extremely rapid filling of the lagoon, Laguna Madre, has taken place since the first maps were made in 1881, chiefly by sand from Padre Island carried into the Laguna by hurricanes and the southeast winds and presumably at an increased rate since denudation of the island. The record rains of 1941 and the heavy precipitation of 1942[16] have restored much of the green cover of the northern half of the island—that least disturbed by the numerous hurricane tides of the past decade.

4. Century-old live oak trees and many mesquites were killed in South Texas in the early 1880's.

5. Since 1870 mesquite, chaparral and other thorny brush from the Southwest has covered the coastal prairie northward and eastward from the Nueces River to Karankawa Bay—and also areas eastward to the San Bernard River—and within the memory of living men, hundreds of thousands of acres of tall grass prairie have been transformed into brush jungles.

6. The coati mundi has in recent years become established in southern New Mexico and Arizona and there are indications that it may be invading Texas. The roadrunner has spread eastward in recent years to East Texas and has recently been seen in Louisiana. The armadillo has spread from the "land of cacti and horned toads" to points east of the Mississippi River, covering a distance of 400 miles or more, in fifty years. There are indications that other elements of the biota are spreading northward and eastward. Contrary migrations in the region have not been observed or reported.

7. It is concluded that these changes were brought about by farming, draining, grazing and other influences of the white settlers, coupled with a series of hard droughts in South Texas beginning in the 1880's.

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[16]Average yearly rainfall at the Corpus Christi Weather Station is 27 inches. In 1941 the excess was 15.13 and in 1942 it was 6.67 inches.

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# A Preliminary Report on the Miocene Vertebrate Faunas of Southeast Texas*

CURTIS J. HESSE, Curator at the Museum of the Agricultural and Mechanical College of Texas, College Station.

Early in 1938 the writer was brought to Texas A. & M. with the intention of preparing a report upon the collection of vertebrate fossils that had been secured by the late Dr. Mark Francis. The collection contained both Miocene and Pleistocene material, mostly from the Gulf Coast and to a large extent from the eastern half of the State. It had been acquired over a period of thirty years and represented dozens of localities as well as hundreds of donors.

Dr. Mark Francis deserves special mention here, since to him we are indebted for no small part of the information set forth in the following pages. Dr. Francis was a veterinarian, for many years dean of the veterinary school, but from the turn of the century on, the collection of fossil vertebrates was his avocation. Unlike most amateurs, he wanted his collection

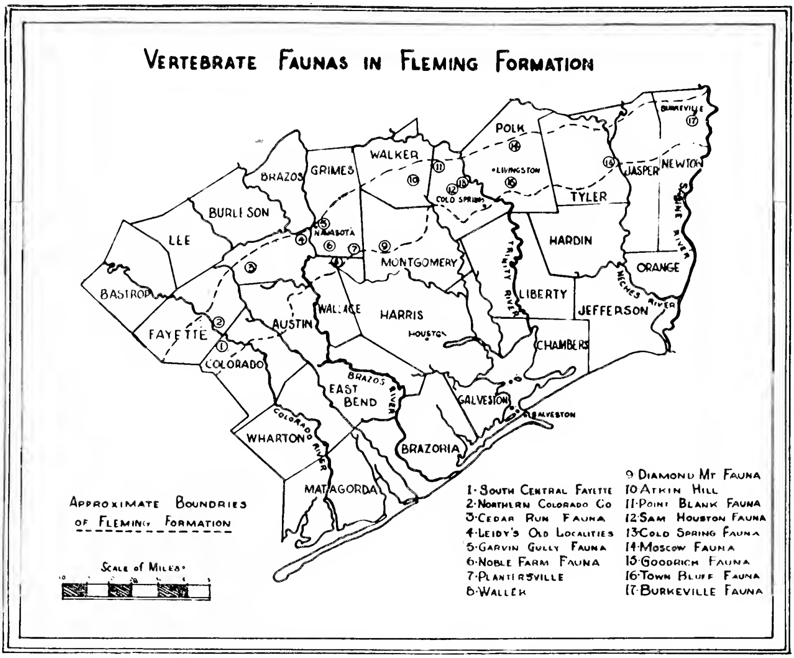


Fig. 1. Approximate Boundaries of Fleming Formation.

*Assistance on this project was received from the Geological Society of America by a grant from the Penrose Fund.

available to those interested, and was very cooperative with anyone who wished to study his material. It is to be regretted that he died before the recent wide-spread activity in paleontology began in our State. Throughout many years he worked at his hobby quite alone, and, no doubt, often discouraged. We now begin to see some of the results of his patient efforts.

The task of cataloging, checking, and preparing this collection was an extensive one. Particularly difficult was the establishment of many of the older localities, and revisiting them to determine their stratigraphic position. It has not always been possible to do this since additional vertebrates were not found upon visiting some of these older localities. Nevertheless, it is fairly certain that all of the localities recorded in the following pages are correct.

It now seems unlikely that an extended report upon the collection would be published at this time. The following brief report deals with the Miocene faunas of the Gulf Coast of Texas, east of the Colorado River. There are no new forms described in the text, although several are indicated in the various faunal lists. These were not described since no figures of specimens were to be published, nor are the many other valuable specimens described in detail as they should be. This summary is intended to aid those interested in the geology of this region. With the coming of a less troubled time a larger, more complete discussion of the faunas must be published. The writer hopes that it will be his good fortune to complete this interesting task; meanwhile the following pages may show something of the extent and age of the vertebrates of this part of the State.

*Geographic position of localities.*

The Miocene localities in East Texas are within 100 to 125 miles of the Gulf. (See Figure 1.) They lie in a belt of sediments which extends from near the Mexican border to the Sabine at the inner edge of the flat coastal plain. Within this belt of sediments vertebrate faunas of different ages are now known to occur. The older series of these faunas is described in this report; in the southwestern part of the Gulf Coast, younger faunas of Pliocene age are found. This Pliocene material is in the collection of the Bureau of Economic Geology, at Austin, Texas. East of the Colorado River, the Miocene sediments form a band from 10 to 15 miles wide. In the western counties these beds are sandy, while toward the Louisiana border calcareous clays make up most of the outcrops. The general elevation is from 300 to 400 feet above sea level, and the area of the outcrops is not of a high relief. Except in the most westerly parts, the country is heavily wooded, and where logging operations have been carried out in the past it is now densely wooded. Good exposures are few and are confined to the vicinity of streams and eroded fields. The entire section cannot be seen at any one point, and most of the major contacts are obscured.

*Stratigraphy.* Since outcrops are few and lateral gradations great, the stratigraphy of the Miocene area east of the Brazos is not well worked out. Originally these beds were all referred to the Fleming formation of Kennedy, a usage that will be followed in this paper. Along the Brazos itself and in adjacent areas of the west, other formations have been described. None of these subdivisions has been extended east of the Brazos for any great distance. That they do extend into this area has been established, but for the purpose of this report it seems best to discuss the entire section as Fleming.

This formation was described by Kennedy from what would now be considered a type locality. He states (1892, p. 62), "These deposits are best seen in the neighborhood of Fleming, where, a little west of the station, the Trinity and Sabine Railway line passes over a high hill made up entirely of these deposits." Shortly after Kennedy wrote the above, the saw mill at Fleming sawed out and moved. The remaining settlement was then known as Hampton. About 1900, the Trinity and Sabine Railway became the Missouri Pacific, and some twenty-five years ago it was abandoned and torn up. Nothing remains of the settlement of Hampton, but locally the site is known as "Old Hampton." It is now on Highway 287 between Corrigan and Woodville. The remains of Fleming's old mill pond and the abandoned railroad grade are less than 300 feet north of the highway, .5 mile east of the present county line markers of Polk and Tyler County. To the west of the former station the old cut is heavily over-grown and little may be seen of the section there.

The most evident material exposed in the cut today is a gray, unconsolidated sand. Much of this appears to have slumped into the cut in the intervening years, obscuring exposures which vegetation has not covered. These sands are evidently the bed 20 feet thick, which in Kennedy's time capped the section here (op. cit., p. 63). On through (west) the cut, across a fill and to the left of the former right-of-way, gray clays are exposed in a gully. These are evidently the clays described by Kennedy as dark blue, pale blue, brown, red, yellow and pale green in color. This color range is not evident in the present exposure, as, exposed, the clays are a dull gray-brown, but fresh samples are gray blue. In all their observable characters, they resemble the Fleming clays as exposed in that vicinity and elsewhere on the Gulf Coast. This is in accord with the observations of authors, subsequent to Kennedy, who saw the locality in the intervening years.

Following the grade through to Old Barnum, one mile north of the present Barnum Postoffice, one finds the Fleming clays exposed in and about the old town. To the north of the old town, across a narrow stream valley, green tuffaceous clays, believed to be Catahoula, are exposed. The stream evidently flows along the contact of the two formations at this locality. Unless the above observations be in error, the original type locality of the Fleming is in the lower part of the complete section of that formation. Although an examination of this area, particularly of the type locality, is not as satisfactory as one could wish for, enough may be seen there and at near-by exposures to prove that past interpretations are correct. Unfortunately, no vertebrate fossils could be found there.

The Fleming formation as it is understood today shows considerable lateral and local variation. It is composed predominantly of clays, green, gray, and brown. Here and there cross-bedded sands appear and calcareous nodules, both large and small, are not uncommon. The section is possibly more sandy toward the base through East Texas and is certainly more so in the western part of the area. In the vicinity of the Brazos at least two of the described subdivisions may be readily recognized.

These have recently been discussed by Renick (1936, p. 75) who describes a prominent cuesta-forming sandstone in this area as the Moulton sandstone. Beneath this sandstone, and above the Catahoula, are some 50 to 75 feet of clays and sands which are regarded as lower Oakville, and the heavy sandstone as Middle Oakville. These subdivisions are thought to be the probable correlatives of the lower part of the Fleming formation east of the Brazos. Two of the faunas described in this report occur beneath the Moulton sandstone in the lower Oakville. These faunas have no counterparts in East Texas thus far, nor have either of the subdivisions been traced east of the Brazos for more than a few miles. This suggests the possibility that these older beds may wedge out, and the entire section in the eastern part of the area may be made up of the top-most member of the section west of the Brazos. What these Upper clays and sands may properly be called in East Texas is possibly open to question. It seems most expedient to call them Fleming for the purpose of this report.

In May 1942, Mr. R. N. Welch published a paper on the geology of Vernon Parish in Louisiana. This Parish is just across the line and contains the eastward extension of the Fleming surface outcrop of the area discussed in this report. Mr. Welch also retains the name Fleming for the formation, but he describes six subdivisions of this formation in his area. None of these is extended into Texas and it remains to be seen if this is possible. He does not mention any heavy sandstone such as the Moulton sandstone of Renick, nor is the section divided into lower, middle and upper parts as it has been west of the Brazos. In the Castor Creek member Mr. Welch obtained a small invertebrate fauna which has some forms in common with that found near Burkeville, Texas. The Louisiana fossils seem to be much higher in the section than are those in Texas. No vertebrates are mentioned by him; their absence is difficult to explain.

*Occurrence of the Faunas.* No general type of deposit seems to contain the vertebrates in this area. In one case they were found in a definite channel deposit, in another in a fine, sandy clay similar to some of the high plains quarries. Most of the Fleming exposures are barren and not even fragments may be found. None of the localities contains an abundance of material; collecting, compared with the high plains area, would certainly be considered poor. When vertebrates do occur, they seem to be confined to certain ill-defined zones or areas within an exposure, although their scarcity makes this less obvious in many exposures. There are few evidences of associated material; two skulls and lower jaws have been found, and one complete *Merychippus* skeleton was collected a number of years ago. In the main the localities contain indeterminate fragments and splinters, some showing abrasions from transportation and others appear to be but recently broken. Some rounding of these fragments has occurred from exposure at their present sites. By and large the fauna impresses one as having been transported from a near-by locality and here and there deposited in its present location.

*Faunas of the Fleming Group.* The following localities and faunal lists have been compiled from the literature and from collections. Most of the material has been re-examined where it was possible to do so. Other collections have been redetermined on the basis of evidence of closely associated faunas and from a re-study of the figures given by the original authors. These are listed under the name in use today, followed by the name used by the original author and a citation to his work.

The present location of the collections is indicated where it is known; any other information believed to be of value is added. Unfortunately, some of the older localities cannot be accurately placed in the section; hence, their position is assigned more or less arbitrarily.

In redetermining the older specimens and in placing some of the localities in their stratigraphic position, personal opinion has played an important part. That some of these may be in error goes without saying. Nevertheless, it seems best to dispose of them in the most logical manner rather than carry them on in literature in their questionable state. Such, for example, is the status of *Aphelops meridianus* of Leidy. It is based upon an inadequate type and is probably an indeterminate species, yet it is widely discussed in the literature and its final status can be decided only by a thorough revision of the entire genus.

Fayette County:

There are no complete faunas from this county, but the following specimens have been collected:

*Aphelops meridianus,* right maxillary, $P^3$ to $M^3$. Figured and discussed by Matthew (1932, p. 420, Fig. 2). University of California Museum of Paleontology Number 31042, re-examined by author.

*Locality;* James Fiestam farm, Armandville, southern Fayette County. This area is mapped as Lagarto but is here considered as Fleming. Collected by Lee Hager, 1903.

*Aphelops* cf. *meridianus,* fragment of a left maxillary, $P^3$ to $P^4$. This specimen has not been noted in the literature before. U. C. Mus. Pal. No. 31042, re-examined by author.

*Locality;* August Sherris pasture near Beigle. Beigle does not appear on any of the recent maps of this county; it was a small community 8 miles east of La Grange, between Cedar and Baylor creeks, on the Fayetteville road. This area is mapped as Oakville but is here considered as Fleming. Collected by Lee Hager, 1903.

*Merychippus* sp., fragment of a right lower jaw, $P_3$ to $P_4$. This is not one of the smaller species but is not well enough preserved to identify. U. C. Mus. Pal. No. 31044, re-examined by author.

*Locality;* Ernest Kurgeis land, 8 miles north of Schulenburg. From an area mapped as Lagarto but here considered as Fleming. No collector or date.

Colorado County:

There are no complete faunas from this county, but the following specimens have been collected:

*Merychippus* (P.) *perditus (Protohippus perditus),* right lower $M_3$, also a worn upper molar and a fragment. Figured and described by Bailey (1923, p. 81, Fig. 6), determined by E. H. Sellards. These specimens are in the Bureau of Economic Geology collections, No. 880-1 (on specimens 1-088).

*Locality;* Bureau of Economic Geology Locality Number 880. Dripping Springs, 1.5 miles east northeast of the town of Bordon. This locality is discussed as Lagarto by Bailey and is at the top of the exposed section in this area. It is here considered as Fleming.

*Merychippus* sp? *(Protohippus* sp?) recorded by Plummer (1932, p. 748) on the basis of material obtained by Bailey (1923, p. 81). This material could not be found for re-study.

*Locality;* .2 mile west of Bordon, in the "cross-bedded Lagarto sandstone."

Both of these localities are at the top of the exposed Fleming (Lagarto) section, in the northern part of this county.

Bastrop County:

The following record is here given for completeness; it is regarded as questionable.

*Merychippus* sp. *(Protohippus* (?) s. *Merychippus?)* was recorded by Leidy (1873, p. 249, Pl. XXIII, Fig. 18), from a specimen sent to him by S. B. Buckley (p. 247). Leidy speaks of "a few (teeth) in the contiguous county of Bastrop," as if there were several in his possession. However, in his discussion, only one tooth is alluded to. This specimen is probably in the collections of the Philadelphia Academy of Sciences; it has not been re-studied.

*Locality;* "from 'Little's Well,' 30 feet in depth from the surface in Bastrop County, Texas." The present limits of Bastrop County lie some 10 miles or more north of the surface outcrop of the rocks from which one would expect this specimen. At an earlier date, all this area was included in Washington County, but by Buckley's time the present boundaries were in existence. Since other material has not subsequently been found in this county it seems best to regard the locality as questionable.

Austin County:

Although the Miocene beds outcrop throughout the northern third of this county, there are no records of fossil vertebrates from here.

Washington County:

From Washington County eastward, records of fossil vertebrates are more common. Here the first fauna is encountered, and here also the first vertebrates from the Miocene of Texas were discovered.

The Cedar Run Fauna.

*Locality;* this small fauna was discovered and described by the Wood brothers in 1937. It was collected in a typical channel deposit some 6 feet thick lying directly upon the irregular erosion surface of the Catahoula. It lies at the very base of the formation under discussion here and is stratigraphically speaking the oldest fauna collected from these beds. The collecting area is an exposure some 150 feet long, on the west bank of a small stream named Cedar Run by the Wood brothers. It is the eastern of two small branches which are the headwaters of Cedar Creek in western Washington County. This small stream is 4.5 miles west of the town of Burton, and it is on the J. P. Derrick 17-acre tract in the west central part of the O. Hudson Survey. The collection made here is in the American Museum of Natural History, New York City; it was not re-studied since it was so recently described.

Faunal List:

| | |
|---|---|
| *Lamna* cf. *cuspidata* | *Palaeocastor* cf. *simplicidens* |
| *Galeocerdo* cf. *aduncus* | *Palaeolagus* sp? |
| *Heptranchias primegenius?* | *Tephrocyon?* |
| *Rhinoptera* cf. *dubia* | *Archaeohippus blackbergi* |
| Crocodilian | Peccary (new form?) |
| *Lepisosteus* sp. | *Blastomeryx texanus.* |

In the above list the sharks may be derived from the older Eocene rocks although they are not eroded according to the finders. The alligator and gar-pike are fresh water forms still fairly common in this area today. One of the two *Paleocastors* tentatively identified by the Woods is present at Garvin Gully in the next county east. *Archaeohippus blackbergi* is present in both faunas, and the fragment of a larger horse tooth figured by them possibly represents *Anchitherium australis,* another Garvin Gully form. The molar of a Carnivora may be a cynodesmid, but the peccary from Cedar Run has no counterpart in the other fauna. *Blastomeryx texanus* is now believed to be referable to *Syndoceras* on the basis of material collected at Garvin Gully.

Eastern Washington County, Leidy's Old Localities:

The material listed below was described by Joseph Leidy over a period of some 20 years. The records were obtained from the literature as indicated, with the original determinations. The probable stratigraphic position and the present reference of each form are the opinions of the writer.

*Parahippus texanus (Anchippus texanus),* an incomplete $M^1$ or $M^2$, described by Leidy in 1868 (p. 231), but no figure was published until 1869 (Pl. XXI, Fig. 13). The specimen is probably in the collections of the Philadelphia Academy of Science; it was not available for re-examination.

*Locality;* "submitted to my examination by B. F. Shumard. It was obtained from 'Hutchen's Well'; from a yellow sandstone, supposed to be of Miocene age at a depth of 50 feet below the surface, in Washington County, Texas."

In the intervening years all trace of "Hutchen's Well" has been lost. The yellow sandstone might come from any part of Washington County, although such sandstones are more common in the northern half of that area. A check of early records, headrights, grants and interviews with old residents has failed to disclose a Hutchen in this area. The specimen is now considered as *Parahippus texanus* and is most closely related to species in Garvin Gully and in Florida. It is, however, larger than any specimens from these other faunas.

*Merychippus* sp? *(Hipparion speciosum),* the outer half of an upper tooth, figured and described by Leidy (1869, p. 283, Pl. XXII, Fig. 17). The specimen is probably in the collections of the Philadelphia Academy of Science; it was not available for re-examination.

*Locality;* "It was submitted to my examination by Dr. B. F. Shumard, of St. Louis, Missouri, who informed me that it was obtained, in digging a well, from a white calcareous sandstone of medial tertiary age, at a depth of forty feet below the surface."

" . . . discovered in Washington County, Texas."

From the figure, no character can be seen that separates this specimen from *Merychippus.* It does not appear to be one of the primitive species and is probably similar to the species of this genus found at other localities in this area.

*Parahippus leonensis* and *Merychippus francisi (Merychippus insignis),* three upper teeth, figured and described by Leidy (1869, p. 298, Pl. XVII, Figs. 51-53). These teeth are probably in the collection of the Philadelphia Academy of Science; they were not re-examined.

*Locality;* "The late Dr. Samuel Moore submitted to my inspection three specimens of isolated upper molar teeth from Washington County, Texas. The specimens were picked up from the surface of the ground, and have no adherent matrix."

The three teeth do not all seem to represent the same form. Figures 52 and 53 resemble in all details the teeth from Garvin Gully referred to *Parahippus leonensis.* The third, which Leidy suggested was probably *Protohippus* (p. 299), strongly suggests the form *Merychippus francisi.* There is nothing to indicate that all were collected together, but it is stated "two appear somewhat smoothly water-worn at the root; the other has minute lichens attached."

*Merychippus* sp. *(Hipparion),* "a small collection of fossils," described by Leidy (1873, p. 247, Pl. XVIII, Figs. 14-15). The collection is probably in the Philadelphia Academy; it was not re-examined.

*Locality;* "submitted to my examination by S. B. Buckley . . . most of them were obtained in Washington County, Texas . . . They were usually found in digging wells, at a depth of from 25 to 30 feet, imbedded in rocky stratum."

Supposed by Leidy to resemble *Hipparion speciosum* in the above list, and referred to that form by him, it is apparently the large species of *Merychippus* which has subsequently been collected in this area. As to crown height Leidy gives no measurements but states "the crown is quite short, and exhibits a considerable degree of curvature." A third specimen, which was not figured, has a crown height of 10 lines (22 mm.) and a breadth of 9 lines (19 mm.), so it could not be considered a high crowned form.

*Merychippus* sp. *(Protohippus?* or *Merychippus),* two upper teeth, figured and described by Leidy (1873, p. 248, Pl. XX, Figs. 16-17). These are probably in the collection of the Philadelphia Academy of Science; they were not available for re-examination.

*Locality;* the two teeth are recorded as follows: "Fig. 16, Pl. XX, represents a specimen obtained from a well at a depth of 32 feet at Independence, Washington County, Texas." . . . Fig. 17, represents a specimen found in association with those of Figs. 14-15 *(Hipparion-Merychippus)* at a depth of 24 feet, in Washington County, Texas."

The two teeth under discussion here by Leidy were not considered by him as typical of either of the above genera as he understood them. His Figure 16 resembled *Merychippus* in its proportions, but in the crown pattern it was similar to *Protohippus perditus.* Figure 17 was found in association with Figures 14 and 15 of the same plate; these were regarded as *Hipparion* by Leidy. Since the third tooth did not have an isolated protocone, he was inclined to regard it as *Protohippus.* Time has changed our conception of generic lines; isolation and connection of the protocone varies with wear and the position of the tooth; in light of modern evidence both the above teeth may be referred to *Merychippus.*

*Anchitherium australe (Anchitherium* (?) *australe),* a right $P^2$, described and figured by Leidy (1873, p. 250, Pl. XX, Fig. 19). This tooth is in the collection of the Philadelphia Academy of Science; it was not re-examined.

*Locality;* "It was found in association with that of Fig. 16 etc." Obtained from a well at a depth of 32 feet, at Independence, Washington County, Texas.

This is one of the few fragmentary records described by Leidy that has remained unchanged by time. Later finds have substantiated this form, although the species is still known from fragmentary material. It was found in association with another tooth now regarded as *Merychippus.*

*Aphelops meridianus (Rhinoceros meridianus),* a fragment of $M^1$, described by Leidy (1865, p. 176) and figured (1869, Pl. XXXIII, Fig. 10) by him at a later date. The specimen is probably in the Philadelphia Academy Collections; it was not re-examined.

*Locality;* "from the tertiary deposits of Washington County, Texas." It was sent to Leidy by B. F. Shumard.

The above list is all of the material that Leidy described from Washington County. So far as can be determined, no other writers have recorded additional material at a later date.

In summary of the above list the following points are emphasized, after consideration of these records. The localities given by Leidy are, in most instances, unknown today. Those that can be accurately placed are low in the Fleming section, while the other specimens all suggest a higher position.

The following are probably from the same fauna as that at Cedar Run and Garvin Gully:

Leidy's Figure 16 of the above list, regarded as a large *Parahippus leonensis* or perhaps the rare *P. texanus.* Neither the description nor the figure is sufficient to decide this point.

Leidy's Figure 19 of the above list, regarded as he originally described it, *Anchitherium australis.*

Both these specimens were associated in a 32-foot well at Independence, Texas. This would place them below the base of the Moulton sandstone in that area. Both forms also occur in the two faunas mentioned above which are also below this sandstone.

The remaining horse material described by Leidy is considered in this paper as representing the genus *Merychippus,* and as coming, probably, from above the Moulton sandstone. At least two species of this genus occur in this stratigraphic position and have subsequently been collected in this area. Just which teeth represent which species is difficult to determine from the figures; the smaller form, *M. francisi*, has not been definitely recognized.

To the above list we may now add the following records from the files of the Bureau of Economic Geology, Austin, Texas.

*Locality;* Bur. Econ. Geol. loc. No. 31085; on right-of-way of Southern Pacific Railroad, .5 mile east of depot at Brenham. In Oakville sandstone. Also Bur. Econ. Geol. loc No. 31086, near culvert 25F, east of Brenham. These two localities are the same, and the material is in the collection of the Bureau at Austin. It was re-studied by the writer and the following identifications made.

*Merychippus perditus,* No. 31086-1, Right molar, also Nos. 31085-3, 31085-4, which have isolated protocones.

*Merychippus francisi,* No. 31085-5.

Rhinoceros indet.

Antilocaprid; this appears to be a fragment of the base of one of the temporal horns of *Prosynthetoceras.*

Alligator.

Turtle.

*Locality;* Bur. Econ. Geol. loc No. 31162; a road metal pit south of State Highway 90, 15.5 miles northeast of Brenham on the Brenham-Navasota road, Oakville formation. This is 2 miles southwest of Washington, in the northeastern part of the county. The locality is, according to this report, at the top of the Moulton sandstone of Renick. The material is in the collection of the Bureau at Austin and the following determinations were made.

*Merychippus perditus,* Nos. 31162-1, 31162-2, 31162-3, 31162-4, fragments of teeth all large.

Alligator.

*Locality;* Bur. Econ. Geol. loc. No. 31158, halfway between mile-posts 128 and 129 on the Gulf Colorado and Santa Fe Railroad north of Brenham; Oakville formation. Collector, Baker. This collection could not be located at the Bureau; it was listed as "Bone fragments, none of which are identifiable." It may have been destroyed.

In our own collection here at The Museum of the Agricultural and Mechanical College of Texas, the following Washington County locality is recorded.

*Locality;* Hidalgo Bluff, A. & M. Mus. loc. No. 47, 5.5 miles northwest of Washington, on the south side of the Brazos River. The bluff faces north and is capped by the Moulton sandstone, underlain by the usual clays. At the base of the bluff, the Catahoula is exposed. This is the lower Oakville of Renick; the fauna is fragmentary.

Alligator
Artiodactyla
Rhinoceros?

This completes the list of vertebrate fossil localities from Washington County.

Grimes County:

Garvin Gully fauna.

*Locality;* A. & M. Mus. loc. No. 20. One of the few Gulf Coast faunas that is fairly well known. The fauna was collected in a cross bedded channel of fine sand, above the Catahoula-Fleming contact and below the Moulton sandstone. It is in the lower Oakville of Renick. The locality is 1.5 miles north, slightly east, of the Navasota city limits on the "old River road." The exposures in Garvin's pasture are between (north of) this road and the International and Great Northern railroad tracks (Madisonville branch). The best exposures are on the Daniel Arnold survey and are about 50 feet above the base of the Fleming formation. That these exposures were fossiliferous was discovered by C. L. Baker, and one area here was sufficiently rich to be quarried by Dr. Francis and his associates. Over a period of years a large fragmentary collection was built up. The main collection is in the Museum of the Agricultural and Mechanical College of Texas, and a small collection in the Museum of Paleontology of the University of California at Berkeley. Part of the A. & M. Collection was described by the late O. P. Hay (1924) but was to some extent overlooked by subsequent authors until recent years.

Faunal List:

*Lepidosteus*
*Ameiurus? decorus*
Alligatoridae
*Paleocastor*
*Cynodesmus scitulus*
*Amphicyon* sp.
Rhinocerotidae
*Archaeohippus blackbergi*
*Parahippus leonensis*
*Anchitherium australis*
Tayassuidae (small)
*?Paratylopus* cf. *wortmani*
*Oxydactylus brachyodontus*
*?Syndeoceras texanus* (Hay)
*?Longirostromeryx vigoratus* (Hay)

The above is the most extensive list of the older Fleming fauna that has yet been obtained. The area would not be considered productive in the ordinary sense of the word, but repeated visits over a period of years by Dr. Francis resulted in a large fragmentary collection.

Noble Farm Fauna:

*Locality;* A. & M. Mus. loc. No. 19 is about 5 miles southeast of the town of Navasota on the Gulf Colorado and Santa Fe railroad. It is .5 mile west of Wood Station and tank, some 300 yards south of the tracks, in the southeast quarter of the Tandy Walker survey, and was referred to by Hay (1924) as on the Noble farm. The locality lies near the middle of the Fleming section, some 7 miles air line southeast of Garvin Gully.

The area is drained by Walker Creek, referred to in early reports as "Grassy Creek." At one time the exposures here were much better, but with improved pasture management grass has covered most of them. The collection from here is not large but contains good rhinoceros material and several dozen horse teeth.

Faunal List:

Alligatoridae
*Aelurodon francisi* (Hay)
*Aphelops meridianus*
*Aphelops* n. sp. (Small form)
*Merychippus francisi*
*Merychippus perditus*
Artiodactyla (Cervid and Antilocaprid)
Camelid
*Trilophodon* sp?

The Noble farm fauna (also referred to as Barry farm) is younger, of course, than Garvin Gully. It is the fauna typical of the Fleming formation east of the Brazos. This locality lies above the Moulton sandstone, in the part of the section called Lagarto by some authors. Locally the Fleming section is very sandy here, with many well cemented thin beds of sand and less clay than is ordinarily present.

Niscavit farm.

*Locality;* This specimen was described by Hay from the collection sent to him by Francis. It was collected while digging a well on the J. Niscavit farm 3 miles north of Stoneham in southeastern Grimes County. The well was 22 feet deep, and the matrix adhering to the specimen is a well cemented sandstone. This is in the upper one third of the Fleming section; the specimen is in the A. & M. Museum.

*Aelurodon francisi.*

Red Hill:

*Locality;* A. & M. Mus. loc. No. 48 is also spoken of locally as Pleasant Hill. It lies near a small settlement called Retreat which does not appear on any map. The locality may be reached by turning off the Houston Highway 8 miles south of Navasota and following the county road 4 miles east and 1 mile south. Here the road climbs out of the valley formed by the headwaters of Beason Creek, and on the west side of the road is a good exposure of the Fleming clays some 100 feet thick. Near the top of the hill is the Fleming-Willis contact; some 25 feet of the latter caps the hill, giving it the name Red Hill. The hill and road lie near the center of the Dudley White Survey, 1 mile north of the southern boundary of the county. Horse teeth are the most common determinable fossils found here.

*Merychippus perditus*
Carnivora
Artiodactyla (Camelid and antilocaprid)
Alligatoridae

Other exposures in this vicinity have been searched without yielding a fragment. This locality is of interest since the fossils are found so near the upper contact of the Fleming.

Plantersville:

*Locality;* A. & M. Mus. loc. No. 45 is very small and has produced but three specimens. The exposure is only a few feet square directly in the bed of Hurricane Creek, 1 mile southwest of the town of Plantersville. The exposure is about 100 feet north of the point at which the road crosses this creek and may at times be completely obscured by mud and water.

*Merychippus francisi* *Merychippus* sp?

The *M. francisi* is based upon a heavily worn tooth, but two fragments suggest a larger form, possibly *M. perditus* which is represented at other localities near by.

Waller County:

*Locality;* A. & M. Mus. loc. No. 44 is in the northwestern part of Waller County, south of Grimes County. It is a small exposure on Cedar Creek east of the Houston Highway (State Highway 6), on the Obediah Pitts Survey.

*Merychippus* sp?

There are but few fragments from this locality and none that is specifically determinable. In size they approximate the larger Merychippine form from other Gulf Coast localities.

Montgomery County:

Diamond Mountain Fauna.

*Locality;* this small fauna, A. & M. Mus. loc. No. 40, was collected 3 miles south of the town of Montgomery, on the Magnolia road. The locality is on the R. R. McPherson land and is in Landrum Creek, a small branch which flows westward into Lake Creek. This small creek is north of a prominent hill called Diamond Mountain or Iron Mound. The fossil-bearing exposure is in the bed of Landrum Creek, about 200 yards upstream from the bridge across the highway. Here two layers of well cemented conglomerates break the stream bed into a series of riffles. In this conglomerate are fragments of bone and here and there is a good specimen. The entire collection is in the A. & M. Museum.

Faunal List:

| | |
|---|---|
| Alligatoridae | Rhinocerotidae (large) |
| Turtle | Camelid (medium size) |
| Carnivora (size of a small canid) | Camelid (large *Megatylopus*-like) |
| *Merychippus francisi* (scarce) | *?Prosynthetoceras* sp? |
| *Merychippus perditus* (common form) | Artiodactylid indet. |

The material in the above list is largely fragmentary. However, there is a sufficient number of *Merychippus* teeth for accurate identification, and the *?Prosynthetoceras* is represented by a right lower jaw.

Walker County:

*Locality;* Akin Hill, a landmark for which this locality is named (A. & M. Mus. loc. No. 46), lies about 7 miles northeast of Huntsville in Walker County. The best exposures lie between the main peaks of the hill, on the southwestern side. At present the nearest approach by car is from a county road a mile to the east; from this, a road through the fields and woods leads to the base of the hill. This is an unusual locality in that no fossil horse teeth have as yet been found here, although other forms are represented by good material. This exposure is very low in the Fleming section, and most of the exposures in this vicinity are Catahoula. The entire collection is in the A. & M. Museum except for the specimen noted below which is in the Bureau of Economic Geology at Austin.

| | |
|---|---|
| Alligatoridae | *Prosynthetoceras* n. sp. |
| *Blastomeryx* sp. | Artiodactyla |
| Camelid (medium size) | Rhinoceros indet. |

To this list we must add as questionable *?Titanothere?* Bur. Econ. Geol. loc. No. 31387-1 to 31387-6. This small lot of material appears to represent one individual. Its collector, Mr. Claude Riley, obtained it in 1935 supposedly at the above locality, but both the identification and the collecting sites are being subjected to further consideration. The above locality deserves special comment because of the associated material of *Prosynthetoceras* n. sp. which has been collected there. This specimen has for the first time a lower jaw in association with the skull, and parts of the skeleton. The rest of the collection is the usual fragmentary material, unusual only in that it is made up of artiodactyla exclusively.

Navarro County:

*Locality;* Leidy (1873, p. 247) contains several statements regarding fossil horse teeth from Navarro County. He states that Buckley sent him material from Washington County and "several others in Navarro County." He speaks of the middle portion of an upper molar as *Hipparion* but does not figure the specimen. On page 249 is the following paragraph:

"A third specimen, accompanied by a label in the handwriting of Dr. Shumard, is marked (Eocene, . . . ) Trinity River, Navarro County Texas. It is a lower molar, represented in Fig. 20, Plate XX, and may perhaps belong to the same species as the preceding."

The tooth figured is called *Protohippus,* and appears to be similar to those referred to *Merychippus* in this report. As to the locality, no other information can be given. Navarro County is some 75 miles north of the Miocene exposures; within its borders the Cretaceous and Eocene rocks are extensively developed.

It seems best to regard this record as questionable, possibly due to confusion of locality names.

San Jacinto County:

Cold Spring fauna.

*Locality;* Mr. C. L. Baker was the first to discover the fossil vertebrates at this and the following localities in 1912. His small collection was sent to W. D. Matthew and a report upon it published by E. T. Dumble (1918, p. 225). The fossil-bearing exposures are 1.3 miles north of the Court House in the town of Cold Spring. An old sand road leads north out of this town past one cemetery and ends at another small private cemetery. From the northeast corner of the latter, the exposures are easily visible. The Bur. Econ. Geol. loc. No. 31219, site 3, is 2000 ft. N., 20E. of the N.E. corner of this cemetery. Here, in a small quarry, 240 specimens were obtained. The collection at the A. & M. Mus. loc. No. 38, was made over the entire exposure. The area is on the southwestern half of the James Rankin Survey.

Faunal List:

| | |
|---|---|
| Alligatoridae | *Prosynthetoceras francisi* (type skull) |
| *Batrachasauroides dissimulans* | *Prosynthetoceras* sp? |
| Rodent (Lepus?) | *Palaeomerycid* |
| *Tomarctus* sp. | *Blastomeryx* |
| *Aphelops* (probably *A. meridianus)* | Camelid (Medium size) |
| *Aphelops* n. sp. (small form) | *Trilophodon* sp. (fair skull in A. & M. Museum) |
| *Merychippus francisi* | |
| *Merychippus perditus* | |

This is one of the oldest and most productive of the Gulf Coast localities. The collection obtained here is, however, very fragmentary, teeth, toe-bones, and a few jaws and maxillaries. In this area, Mr. Claude Riley obtained a complete skeleton of *Merychippus francisi* a few years ago. This specimen, along with some other material, is in the Frick Collections of the American Museum of Natural History, New York City. The *Prosynthetoceras* material may possibly represent more than one form; great variation in the characteristics of the horns is indicated by this collection.

Sam Houston fauna.

*Locality;* this area lies just inside the boundary line of Sam Houston National Forest. This locality, A. & M. Mus. loc. No. 38; Bur. Econ. Geol. loc. No. 31191, is stratigraphically the same as the Cold Spring fauna and is separated from it by about .5 mile. The area is 1.4 miles northwest of the Court House in Cold Spring, to the east of the Cold Spring-Point Blank Highway. A county road turns to the left (northeast) after entering the Sam Houston Forest, and along this road is an extensive area of exposures. Another road turning off of the above county lane gives access to the more remote parts of the area. Fossils occur toward the top of the exposed section. This area lies at the western end of the James Rankin Survey. The collection from here contains 16 specimens at the Bur. Econ. Geol. in Austin, but the A. & M. Museum material was not separated from the Cold Spring fauna in its original collections.

Faunal List:

| | |
|---|---|
| Alligatoridae | *Alticamelus* sp. |
| *Tomarctus* sp. | Camelid (small) |
| Amphicyonine | *Blastomeryx* sp? |
| Carnivare indet. | *Prosynthetoceras* sp. |
| *Prosthennops* sp. | Palaeomerycid |
| *Aphelops* sp. (large) | Cervid |
| *Merychippus francisi* | *Trilophodon* sp. |
| *Merychippus perditus* | |

This list is based, in the main part, upon the material secured by a mobile unit of the W.P.A. project sponsored by the Bur. Econ. Geol. at

Austin. Although the list is long, it is based upon a small collection and in most cases cannot be specifically identified.

In the northwestern part of San Jacinto County is another series of localities, from 12 to 13 miles from the above. These are in the basal part of the Fleming formation, while those above are at the top of the section exposed at the surface. Thus, in San Jacinto County, we again have an accurate check on the age of the surface outcrop.

One of the localities listed below is represented in the A. & M. Museum collections, and the rest are in the Bur. Econ. Geol. at Austin. Since the collections are small, and not from a large area, they are listed under one name. Time may show that this must be subdivided.

Point Blank fauna.

*Locality;* Bur. Econ. Geol. loc. No. 31190. From town of Point Blank take country road northwest at edge of village. Keep to main traveled part. At 2 miles turn left between rail fences; at 3.4 miles just beyond washed out culvert turn again left (south) for 1.4 miles into open field. The best exposures are at the south end of this field on the C. E. Abby Survey A-65. Fossils are not abundant here but a few wash out from time to time. The collection from here contains about 29 specimens. This locality is about 200 feet above the base of the Fleming group in East Texas and is about the same horizon as the Moscow fauna described in the following pages.

Faunal List:

*Ameriurus* sp.
*Lepisosteus* sp.
Alligatoridae
Carnivore
Rhinoceratid indet.
*Merychippus* sp.
*Equid* indet.
*Prosynthetoceras* sp. (incomplete skull)
Palaeomerycid
Camelid indet.

Point Blank fauna.

*Locality;* on a road leading west from Point Blank, 3.5 miles out is a pump station of the American Liberty Pipe Line Company. Here a lane turns south for 2 miles to the farm operated at present by Mrs. Lilla Bennett. The fossiliferous beds lie some 300 feet northeast of the Bennett farm house in a gully between the Bennett and Nelson farms. Fossils are found throughout the exposure but are very fragmentary and few are determinable. This is Bur. Econ. Geol. loc. No. 31242 and is about the same horizon as No. 31190. None of the material collected here was catalogued in the Bureau's collection.

Rhinoceratid
Equid

Point Blank fauna.

*Locality;* to the right (west) of the Snow Hill road, 2.3 miles south of Point Blank, a trail turns through the fields to an exposure of the Fleming 2.8 miles from the town. This locality is on the Morris Survey; at present the farm is operated by Bob Wanza. The road borders the bad land area which slopes to the west. Bur. Econ. Geol. loc. No. 31243; none of the material collected here is catalogued in the Bureau.

Rhinoceratid
*Merychippus* sp?
Point Blank Fauna.

*Locality;* continuing on the field road described above for 1.4 miles, past house of present farm operator, to winding part of road, which soon passes into an open area with an extensive bad land exposure. This is Bur. Econ. Geol. loc. No. 31244; the exposure is not a productive one, and the Bureau has no catalogued material from here. The land is part of the D. Foster estate.

Rhinoceratid
Equid
*Amblycastor* sp.
Point Blank Fauna.

*Locality;* a small exposure north of the main highway about 3 miles west of Point Blank on the Oakhurst road. This exposure is not large and is not productive; it is of note since it has produced a somewhat rare form. A. & M. Mus. loc. No. 71, material collected by Claude Riley, 1935.
*Amblycastor* n. sp.

Red Bluff:

*Locality;* in Dumble (1918, p. 229) under the heading Trinity River Section is the following, "At Red Bluff on the Trinity River on the James Rankin Survey, Fleming greenish-gray clay with calcareous nodules and cross-bedded sands contains a few bone fragments." On page 233 quoting Matthew is the following, "352. Red Bluff, Trinity River. *Protohippine* horse, lower tooth. Indicated age Middle Miocene to Pliocene: nothing more definite." In keeping with the interpretation expressed elsewhere in this report, the above tooth is regarded as:
*Merychippus* sp.

Polk County:
Moscow fauna.

*Locality;* Bur. Econ. Geol. loc. No. 31057 lies about 4 miles east of the village of Moscow in the northern part of Polk County. From Moscow the dirt road to Camden runs east; 2 miles out of the former this road forks and to the left (toward Camden) it crosses 4 bridges over the headwaters of McManus Creek. Beyond the last bridge a dim road leads to the left (south) past a house to an open spot in the heavy pine forest. The exposures are to the right, (northeast down the slope) and are believed to be about 200 feet above the Catahoula-Fleming contact. Vertebrates are fairly common in the green and brown marls about 5 feet above the top of red variegated non-calcareous zone. The Bur. Econ. Geol. has some 85 catalogued specimens from here representing the following forms:

| | |
|---|---|
| *Lepisosteus* sp. | Rhinoceratid |
| Crocodilian | *Merychippus perditus* |
| *Amblycastor* sp? | *Prosthennops* sp. (small) |
| *Amphicyon* sp. | Camelid indet. |
| *Cynodesmus* sp. | Palaeomerycid (fragment of *Prosynthetoceras* horn?) |

This small fauna is of particular interest since it is so low in the section. It would seem that we could expect the older elements in Fleming faunas to show up here, but they fail to do so. In all respects this series of specimens is like those listed above and does not suggest any difference in age.

Goodrich Fauna.

*Locality;* this lies about 7 miles south of Livingston, the county seat of Polk County. On the Livingston-Goodrich road, 7 miles south of the former, the highway crosses a small creek and ascends a hill. At the top of this hill a dirt road turns to the left (east), and 1.5 miles down this road is a clearing with bad lands. This is about 2 miles east of Goodrich and is at the site of the R. Johnson Well, Bur. Econ. Geol. loc. No. **31183, near** the top of the exposed section of the Fleming. There are 99 catalogued specimens in the Bureau collections from this site.

*Alligator* sp. (good jaws)
*Tomarctus* sp.
*Aphelops* sp. (large)
*Merychippus ?francisi?*
*Merychippus* sp. (larger more advanced)
*Alticamelus* sp. (large)
Camelid indet.
*Blastomeryx* sp. (skull and jaws)
Cervid indet.
Palaeomerycid indet. *(Prosynthetoceras?)*

This locality and the one that follows are high in the Fleming section. If Pliocene material is to be found in the collections from East Texas it would be expected here. The larger species of *Merychippus* listed above is a very advanced form, the most advanced yet found in the Fleming, yet it does not suggest greater advancement than the Merychippine forms in the Barstow. This age determination rests upon a skull and several lower jaws, and not, as in most of the other faunas recorded here, on a series of individual teeth.

Goodrich Fauna.

*Locality;* .5 mile northeast of the above, another small collection was obtained. This is Bur. Econ. Geol. loc. No. 31183, and in the collection at Austin 12 specimens were catalogued from here.

*Alligator* sp.
Rodent indet.
*Tomarctus*
*Aphelops* sp. (large)
*Merychippus* sp.
Equid indet.
Camelid
Palaeomerycid
*Trilophodon* sp.

Goodrich Fauna.

*Locality;* in November 1942, the writer visited Mr. W. R. Bailey of Livingston who had a small collection of vertebrate fossils. One of these specimens was from the Fleming; it had been collected at Swartaut's Crossing on the Trinity River 4 miles west of Goodrich.

*Aphelops* n. sp. (small form)

Tyler County:

Town Bluff.

*Locality;* a section of the Fleming clay about 100 feet thick is exposed on the Neches River just above the ferry on the Woodville-Jasper road.

This bluff faces east and is on the river east of the townsite. It will soon be by-passed by a new, paved highway. This is the southernmost exposure of the Fleming on the Neches. From here Baker records (in Dumble, 1918, p. 226) : "fragmentary bones of fossil turtles and a well preserved mammal vertebrae." The report of the WPA project operated by the Bur. Econ. Geol. states: "a few bone fragments and an alligator vertebrae were cleaned etc."

Smiths Ferry:

*Locality;* (Dumble, p. 199) ; this is very near the base of the Fleming. Plummer (1932, p. 738) records a limb bone of *Procamelus?* from here. The specimen could not be found for re-examination.

Newton County:

Burkeville Fauna.

This locality is of particular interest since the vertebrates of the Fleming are here associated with a brackish water invertebrate fauna. This invertebrate fauna has been noted by Veatch (1902, p. 136), Maury (1902, p. 80), Dall (1913, p. 226), Deussen (1914, p. 72) Dumble (1918, p. 224) and Plummer (1932, p. 748). The vertebrates were first noted by Matson (in Dall, 1913, p. 227, fragments only) and later by Baker (in Dumble, 1918, p. 225). Recent collecting in the area has yielded a more complete vertebrate fauna, and new localities, but the invertebrate material is not as good as that described by Dall. Further work here and a special paper on the area are in progress.

*Locality;* much confusion has been encountered in trying to relocate the original localities near Burkeville. It seems certain that most of them have been revisited but not always recognized. A. & M. Mus. loc. No. 42 is on the south side of Little Cow Creek valley, .5 mile up stream (west) of the bridge on highway 87 over creek. This bridge is the first one south of the village of Burkeville. This is a large area of exposure extending from near the creek back (southwest) to higher ground.

| | |
|---|---|
| Alligatorid | *Aphelops* |
| Turtle | *Merychippus perditus* |
| *Amblycastor* n. sp. (skull) | |

To the east of the highway and bridge, again on the south side of the creek, is A. & M. Mus. loc. No. 43. It is between .25 and .5 mile east (downstream) from the highway at the edge of the uplands, forming the south side of Little Cow Creek valley. The exposures face north and east and are fairly extensive. In the lower part of the exposed section is a small area of beach conglomerate weathered to a brownish zone; here many fragments were found.

| | |
|---|---|
| *Plinthicus* cf. *stenodon* | *Merychippus perditus* |
| *Lipidosteus* sp. | Camelid |
| Turtle (at least two species) | *Blastomeryx?* |

Where the original invertebrate collection in this area was made has not been definitely determined. At the first of the above localities, a small amount of invertebrate material has been collected but is as yet not identified.

*Age, Distribution, and Probable Relationships of the Fleming Faunas.* It may again be emphasized that the above faunal lists are, in the main part, based upon fragmentary material. The various localities, even the best ones, could not be regarded as productive as one usually thinks of localities. Here and there a good specimen has been found, and over a period of years a fairly adequate collection of material has been amassed. New localities are likely to be found and much additional material can be collected. However, it seems unlikely that faunas of greatly different age will now be found in the Fleming formation at least in the area considered here.

East of the Colorado River enough vertebrates have now been collected to establish with reasonable certainty the age of the Fleming formation. True, in the western part of this area the localities are somewhat scattered and one wishes that more material had been found there. However, the distribution of localities from west to east across the area is fairly good, and the vertical distribution throughout the section is also good. There are no fossil vertebrates in the collections that cannot be older than Pliocene; some could be that young. None of the faunal assemblages suggests such an age, and several of them occur at or near the top of the section. For these reasons it seems safe to assume that the Pliocene surface outcrops of Southwest Texas do not extend into this area but are overlapped west of the Colorado. The supposed Pliocene age of some of the vertebrates east of the Colorado is based, in the main part, upon old records of the genus *Protohippus* from within this area. These records are based upon lower teeth and the determinations were made over 30 years ago. Since that time our concept of genera has changed as well as our ideas of their age. Lower teeth are difficult to determine and, many years ago, they were even more so, when generic lines were less clearly drawn. In light of the evidence which has accumulated in recent years, the fossil horses of the Fleming are all referred to the genus *Merychippus*. This genus is characteristic of the Miocene with only a few scattered records from the Pliocene. The species of the genus which are recorded from the counties under consideration are fairly well advanced forms comparable to those found elsewhere in the Upper Miocene faunas.

With the exception of the faunas from Cedar Run and Garvin Gully, which are clearly the oldest faunas in the series, there is little to indicate a great difference in age. It is true that there is considerable variation shown in the *Merychippus* teeth, strongly suggesting that such differences may exist, but the collections are not yet adequate for proof of this point. Indeed, these faunas are no exception in this respect, for even well-known faunas are often difficult to place in sequence and correlation charts are thus subject to minor variations.

The Cedar Run fauna described by the Wood brothers was regarded by them as having "a distinctly Lower Miocene aspect" (p. 140). In the correlation table published later (Wood, et. al., p. 17) this fauna was again recorded as late Arikareean in age. Although the original collection has not been re-studied a careful comparison with the Garvin Gully fauna leads to the conclusion that the two are of the same age (see Wood and Wood, 1937, p. 140). The larger fauna contains elements of the older Lower Miocene, as well as forms which are in advance of that age. Since the parahippine material is of such an advanced character, and since certain other elements *(Amphicyon, Archaeohippus)* are characteristic of a later time (Wood, et. al., 1941, p. 12), early Hemingfordian is suggested for this older fauna beneath the Moulton sandstone.

W. D. Matthew in a letter to Dumble (Dumble, 1918, p. 239) states "the fauna of Navasota and Cold Spring localities appears to be the same." This statement was based upon a small collection of material sent in by Baker. The "Navasota" of Matthew is the Garvin Gully of this report, and the small collection submitted to Matthew contained only one form which was of significance as to age. This specimen Matthew determined as "*Merychippus,* small species, cf. *M. severus,* but probably not identical, upper molar." He regarded this specimen as similar to the Cold Spring material, thinking possibly that it was heavily worn. Hay also (1924, p. 7) regarded the larger horses from Garvin Gully as Merychippine in their relationships. In the years since the above opinions were expressed more details of the development of the horse have been worked out, and other faunas unknown to Matthew and Hay have been described. These horses are here regarded as *Parahippus,* instead of merychippine as the above writers believed, and therefore are older than the Cold Spring and Noble farm faunas.

Dr. T. E. White has recently (1942, p. 27) published an excellent summary of the Thomas Farm fauna in Gilchrist County, Florida. This fauna is in many respects similar to that of Cedar Run and Garvin Gully. Dr. White refers to the faunas of the Lower Miocene but states that "the Equidae are all progressive and their only relations are found in the Late Middle and Upper Miocene deposits of the Plains." He further states that this deposit very probably represents the fauna of an island, and thus presents a somewhat paradoxical picture. This probably explains the peculiarities of the Florida material, but it cannot be invoked for the older Fleming faunas. The Lower Miocene elements of the latter are less distinct, and in most cases might even be Middle Miocene. The equids are distinctly Middle Miocene, and are used as the basis for assigning the age. The Texas fauna is believed to represent a Middle Miocene assemblage with "survival" forms, an idea first suggested by W. D. Matthew.

Throughout the Fleming clays of East Texas and above the Moulton sandstone in the western part of the area described in this report, a younger suite of faunas has been collected. These are best typified by that of Noble Farm, Cold Spring, and Burkeville. That all these and the allied faunas in the above lists are not of exactly the same age goes without saying. In a detailed report upon each of them these age differences may be clearly set forth, but for the present they are disregarded and the material discussed as a whole. Again it may be repeated, none of these faunas contains material of definite Pliocene age. Viewed as an assemblage they are of Upper Miocene age, with horse teeth of well advanced specialized specific characters, rather than those characters indicative of advanced age. The presence of these horses, as well as *Amblycastor, Aphelops, Prosthennops,* and *Prosynthetoceras,* seems to indicate in general the Barstovian age of this upper fauna. In the main it is not as advanced as the typical fauna of the Barstow syncline, but again certain specimens (ex. *Merychippus* skull from Livingston Fauna) are certainly comparable to some of the Barstow species.

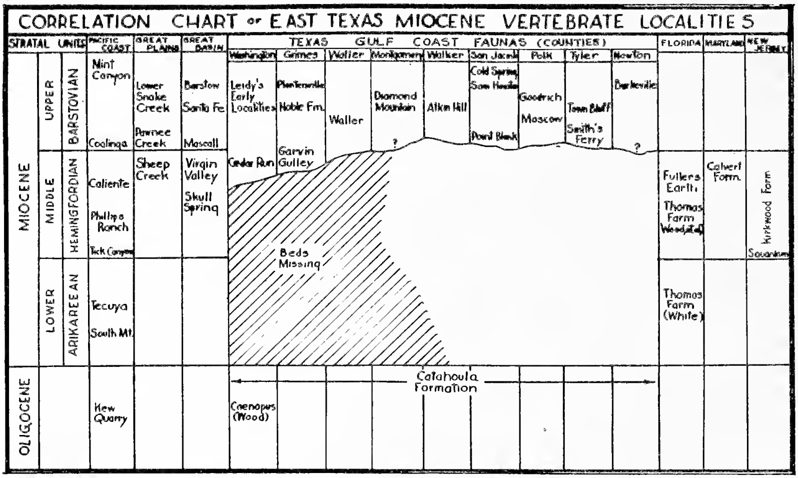


Fig. 2.—Correlation Chart

In the correlation chart (Figure 2) these faunas of southeastern Texas are placed in their approximate position relative to other well-known North American faunas. The recent correlation chart of Wood et. al. (1941, Pl. 1) has been followed as a standard in spite of certain differences with later papers (Daughtery, 1940, p. 129). Regardless of such differences of opinion, the general relationships of the faunas remain the same.

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**Other papers listed on the programs of meetings**

1. Comparative Study of Cenozoic Sediments of the Gulf of Mexico and Its Coastal Plain. Carl B. Richardson, Houston. Geological Society, Houston.

2. Relation Between the Geology and Topography of Travis County and Its Economic and Cultural Development. Hal P. Bybee, University of Texas, Austin.

3. Functions of Geological and Related Departments of an Oil Company. James D. Wheeler, University of Houston, Houston.

4. The Structure of the Santiago Mountains. G. K. Eifler, University of Texas, Austin.

5. Alpha-Count Method Applied to the Determination of the Radioactivities of Rocks. Don D. Phillips, University of Texas, Austin.

6. Mineral Investigations in Texas. E. H. Sellards and V. E. Barnes, Bureau of Economic Geology, Austin.

7. Methods of Estimating Future Oil and Gas Production. H. Vance, Agricultural and Mechanical College of Texas, College Station.

8. The Burkeville Area in Newton County, Texas. F. E. Turner and C. J. Hesse, Agricultural and Mechanical College of Texas, College Station.

## SECTION V: CONSERVATION

DR. GORDON GUNTER, Chairman, served in 1942 and was re-elected for the year 1943.

### The Place of Texas Forests in Wartime

W. E. WHITE, Director, Texas Forest Serice, A. & M. College, College Station.

The forests of Texas extend over an area of 35 million acres, an area of 10 million acres more than that of any other state. They vary considerably as to the types of timber and as to their value in yielding commercial forest products. They occur in five broad regions. From the Sabine River to the west, one belt of timber succeeds another and to many this wide variation in tree types has given rise to calling Texas "the cross roads of forest growth in America," since four of the six main timber regions of the country are found in the state. The eastern section of Texas is the site of the pine and hardwood commercial timber region and the post oak region. In central Texas are located the east and west cross timbers, cedar brakes, mesquite and live oak regions. Western Texas, in the Guadalupe and Davis mountains, is the site of the "mountain" forests, characterized by timber species found farther north in the Rockies.

As pointed out, the pine and hardwood forests in the extreme eastern part of the state form the main commercial forest region of Texas. But the other forest areas in the central part of the state, though not of the size and quality of the forests farther east, are valuable commercially in accordance with the size of the timber they support. They yield such products as fence posts, small telephone poles, fuelwood and timbers of such size as is useful in the manufacture of furniture.

In addition to their value on a commercial basis, all the forest regions of Texas are of considerable value in controlling rainfall run-off and soil erosion. Protection for game is one of the big values in all the regions. Approximately three-fourths of the tree regions have been classed as "protection" forests, although some are actually a combination of "protection" and low commercial forests. These include all the regions west of the pine and hardwood belt.

This latter region, or the "pineywoods" as they are more commonly called, covers some eleven million acres in 35 East Texas counties and forms the western extremity of the southern pine belt which occurs in eleven other states; it is the largest single forest region in the United States. In this East Texas area, the yellow pines are predominant. They are often referred to as the "hard pines," because their wood is relatively hard in comparison to the other pines in the country. Longleaf, loblolly and shortleaf pine are the three pine species. Various hardwoods occur with the pines, and in the bottomlands, fine species of oak, gum, hickory, ash, magnolia and cypress, occur.

Very little of the original or virgin timber remains in this region, but new timber crops have come in where the old ones have been harvested.

These are commonly referred to as second growth forests, although this is not an entirely correct definition since, from many areas, two and three and even four successive crops of pine have been cut.

These new timber stands or timber crops, according to Federal specialists engaged in making an inventory of the forest resources of the United States, have made a more rapid and vigorous growth than in any other southern state. This is due in a large part to the forest fire protection work and the advice rendered to timberland owners by the Texas Forest Service. The control of the fire nuisance has permitted Nature to reforest millions of acres which otherwise would now be devoid of forest growth, or, at best only supporting a partial stand.

Latest figures from the federal forest survey of the East Texas timber area show that the commercially valuable species total about 25 billion board feet in volume, based on trees 12 inches and above in diameter, 4½ feet above the ground, measured with the Scribner Decimal C rule. Including trees from nine inches and up in diameter adds another 5 billion feet to this figure. During normal years, all the timber products cut total about 2 billion board feet. Now, because the trees of our forests have been drafted for the war, and most industries are producing at capacity, the drain of timber is well over the 2 billion foot mark and will probably remain at this level for several years to come. Even so, growth for the pine belt has more than balanced drain in the past, and the reserve of timber that has been built up from this favorable condition will help to tide over the crisis.

Although actual statistics on timber production in East Texas cannot be divulged, one indication of the enormous amount of wood moving out of the pine belt for war fronts is best pictured by comparing the lumber cut alone to a picture of the 100,000 freight cars that will be required to haul it. Other products include pulpwood, poles, piling, ties, veneer, cooperage and fuelwood.

Texas ranks sixth in the Nation in lumber produced and sixth in lumber consumed. Before the war, almost 40% of the cut was exported to other states and foreign countries, but this was more than balanced by imports into the state. Slightly over 60% of the cut is used in the state now.

Naturally, the war has changed the picture now, because the Federal government is the big timber consumer, taking about 90% of all the lumber and other commercial forest products produced. It is not widely known that, during times of actual warfare, forest products furnish a larger number of essential supplies and materials than any other single crop or product.

*Forests in Connection With the War.* Lumber leads in Texas' wood cut, but other products are gaining importance as the war develops. Every week, Life Magazine is printed on high-quality, machine-coated book paper made in a $10,000,000 paper mill near Houston from East Texas pine timber. Over at Lufkin, another $8,000,000 paper mill grinds out newsprint from pine, the only mill in the world using southern pine for this product. This mill also makes shell casings and ammunition packings.

Texas fruits and vegetables in the "food for victory" program are shipped in baskets and crates made from wood in East Texas plants. Material for bomb crates is turned out by one veneer mill. Another Texas factory which manufactures 20% of the Nation's broom handles is making mop handles for the Navy.

Railroad ties cut from the deep woods are used to build new transportation lines and to keep the old ones in trim. Poles and piling, when given a preservative treatment, are used in power lines, docks and other marine buildings.

Scores of army camps are being built to house the millions of men in training—and each camp requires 60 million board feet of lumber. More wood is used in such war necessities as defense housing, shipbuilding, boxes and crates for ammunition, boats and pontoon floats, storage tanks, battery separators, dock and harbor works, truck bodies, patterns for foundry use, rifle stocks, training and fighting airplanes, excelsior for packing, wheels, hubs and spokes, barges, wood flour, airplane hangars, hospitals, factories, bridges, mine props, anti-tank barrages, air raid shelters, blackout shutters, scaffolds and concrete forms.

Wood cellulose is manufactured into paper for records, memoranda, propaganda, medical supply wrapping, and cartridge cases. Cellulose is used as a major constituent of gunpowder and other explosives, artificial leather, photographic films, shatterproof glass and in synthetic fibers such as rayon, artificial wool and cotton for clothing and parachutes.

Wood charcoal is used for gas masks and steel production. Turpentine and rosin produced from southern yellow pine are used in flame throwers, shrapnel, paints and varnishes, paper sizing, and leather dressing. Wood flour is used for dynamite, and wood plastics for telephone receivers, mouthpieces, and radio equipment.

The tanning of large quantities of leather requires tannin, which is produced from chestnut wood, chestnut oak bark, and eastern hemlock bark.

Hardwood distillation results in production of acetic acid, widely used in photography, industrial chemistry and explosives. Wood alcohol, another product, is used in paint and varnish, in aniline dye factories, as a solvent, and in the manufacture of photographic film. Acetone is important in the manufacture of smokeless powder.

Some of the new wood uses are marvels of industrial chemistry. Wood sugar is being produced by increasing numbers of European factories. Cellulose is hydrolyzed with dilute sulphuric acid to produce edible sugar. Then part of this sugar is fermented with yeast to make ethyl alcohol, or so-called "grain" alcohol.

The Texas Forest Service forest products research laboratory at Lufkin is engaged in a program of work that will be beneficial to the forests of Texas in many respects. The program follows:

1. Improvement in the present utilization of lumber and other wood products through drying studies, experiments on machining properties, determination of specific properties for specific uses and to what extent substitutions in species may be made, production of glued-up stock, and others of a similar nature.

2. Possible utilization of so-called waste, such as tops and limbs, trimmings, edgings, and sawdust.

3. Cooperation with the pulp and paper industry to assist in the production of pulp and its derived products.

4. Utilization of so-called "weed trees" or inferior species which cover an extensive area in Texas.

5. Development and expansion of minor forest products.

Experiments are being carried on with red gum veneer, impregnating and bonding it with glues, then heating and pressing it into a very strong plywood to be used in aeroplane construction in Texas if suitable. We are informed that all airplane plywood has to be shipped to Texas from other states, and the manufacturers desire a Texas product if possible in order to cut down the cost of material and transportation. Strength tests will be carried on by the Engineering Experiment Station at A. & M. College.

The work has been fitted into the war program as much as possible. We have succeeded on a small scale in making edible table sugar from pine sawdust, and alcohol that can be used in explosives and a number of other industrial products.

We have taken eleven plys of 1/16 inch red gum, glued them, and then pressed them under 1800 pounds per square inch pressure and a temperature of 315 degrees to a thickness of 5/16 inch. The resulting panel is strong and hard.

We are beginning to make plastics on a small scale from wood at Lufkin, and last week we turned out a piece of compregnated wood of very durable quality.

We are cooperating with one of the large lumber companies on a project to speed up the drying time of oak and gum lumber. Boards are first dipped in urea and then dried under controlled moisture and temperature conditions in our modern dry kiln. We hope to be able to reduce the drying time of these species which will be an important factor in getting quantities of these to the government faster.

Gum trees are being tapped for storax. This chemical has value in medicines, drugs and adhesives, and for flavoring tobacco. The original storax of commerce comes from Asia, but war has cut off that source. We do not know whether East Texans can afford to tap their gums for this product or not but are obtaining cost data from actual operation. We know that storax can be obtained from gum trees and it is there any time the government needs it.

The laboratory at Lufkin is also equipped to determine the working qualities of certain woods. Numerous small articles have already been turned out from different species of trees.

The reasons for undertaking this forest products research are numerous. Texas has 35 million acres of forests, covered with some type of tree growth. Only about a fourth of the forest area is growing commercially valuable timber. A market for the timber in the non-commercial timber regions would be a benefit to the State, the land owners and the industry. Research which finds new uses for the woods in Texas should add millions of dollars in value to these secondary regions.

The increasing possibilities for the use of cellulose and other components of wood offer a field for development through research that at the present time has only begun to be explored. Perhaps in this direction lies the answer to the question of what needs to be done with a large volume of low-quality wood to be found in Texas today. The utilization of so-called waste and low-quality materials will give sources of income in addition to those already supplied by timber of better quality.

Proper development of our forests is a constructive enterprise creating increased returns for the timberland owner and raw material for the manufacturer. State support in Forestry is returned to its citizenry many times over. In Texas today, forests constitute one of our greatest opportunities for establishment of new industrial plants and continuous maintenance and expansion of present forest industries. To realize these objectives fully we must grow timber as a crop.

## Conservation of Manpower Through Nutrition

P. B. PEARSON, College of Agriculture, Agricultural and Mechanical College of Texas, College Station.

Nutrition is an integral part of a great national effort for freedom-loving peoples over the entire globe. National defense means total defense, and as such it has two major parts; first, military preparedness and aid to our allies; second, and equally essential, is the strength and health of our civilian populations. We cannot achieve our goal of all-out defense without efficiency in our homes, efficiency in our offices, efficiency in our shipbuilding yards and other great war industries. Adequate and proper nutrition is essential to efficiency.

Great Britain has learned in a hard school of wartime experience the fundamental importance of maintaining the health and morale of its people. Now that we are at war, we should not fail to profit by lessons learned at such cost abroad. Hope for an ultimate victory depends to a considerable extent on the working efficiency of civilians. The production of food, arms, tanks and every implement of war is dependent in the final analysis on the health and morale of the people on the home front. The improved health and morale which result when inadequate diets are brought up to adequate levels may be translated into greater working efficiency, fewer absences from work, and a decrease in the number of accidents.

The need for improved nutrition is evinced in a report of the Selective Service (1). Of the first million men examined physically, approximately 380,000 were found unfit for general military service. It is estimated by General Hershey that approximately one-third of these were suffering from disabilities directly or indirectly connected with faulty nutrition. Bad teeth constituted the most important cause of rejection. In this connection, an observation made by Knudsen in Denmark is of more than passing interest. He observed that the few children in that country with perfect teeth also had perfect backs, both skeletal and muscular. It is well known that poor dentition accompanies or follows rickets. Another feature of rickets is the poor and shrunken, often pinched-up chest, and consequently, of course, a pinched-up and poorly constructed back.

I believe it is safe to say that our knowledge of nutrition gained since the last world war exceeds that gained during the two preceding centuries. In spite of this fact, the percentage of rejections in the Selective Service is as high as or higher than it was in 1917, and the causes are substantially the same. Something certainly needs to be done. Knowledge, as Sir Richard Gregory has said, is like energy. It is capable of doing work, but first it must be changed from the potential state to the kinetic or moving state. Knowledge is like a rock set up on a shelf. It does no harm, and it does no good, so long as it rests there, but let somebody jar the shelf and let the rock fall off, and then something happens. I believe that the war has jarred this shelf in that the need for making use of our nutritional knowledge is now recognized.

Work carried on by the British Army demonstrates the improvement in health and physique which follows improved nutrition. The army authorities were alarmed at the large percentage of recruits who were rejected on examination. A man by the name of Capon, who was working in a recruiting camp, took 33 men who were considerably below acceptance standards, put them in a special squad by themselves, gave them physical training and fed them a diet containing plenty of milk, butter, meat, fruit and fresh salads. In 6 weeks, 21 of the 33 passed the examination satisfactorily, and 6 more were almost up to the acceptance standards. Near Canterbury, a Physical Development Depot (2) has been established to rehabilitate recruits who are rejected mainly for underweight and deficient chest measurement. Measures for effecting improvement in the health of the unsuccessful recruits include optimum diet, long, sound sleep, physical work and healthful recreation. Milk and fruit are added to a presumably adequate army ration. The men are served four regular meals daily. As a result of this conditioning, 87% of the first 835 young men were subsequently accepted and passed into the army. Only 5% were afterwards discharged on grounds of medical defect.

In our own country, some attention has been given to the study, prevention and cure of occupational disease and accidents. Very little attention has been given to the relation of nutrition to productive efficiency. There is little factual evidence available indicating the true relationship between slight degrees of malnutrition in workers and the incidence of sickness, absence and accidents among them. However, the little that exists is positive in nature, and the importance of the quantity and quality of the diet for the maintenance of good health has been repeatedly demonstrated. It is generally accepted that natural resistance is dependent upon the body's nutritional state. Holmes and others found cod-liver oil to be of value in reducing loss of working time caused by colds and respiratory infections. In a study of absences in one large industrial firm, it was found that the greatest single cause of time-loss, accounting for more than half of the total number of days lost, was respiratory diseases such as colds. The Western Electric Manufacturing Company has used vitamin A therapy as a means of combating retinal or eye fatigue in its color-matching inspectors, with very satisfactory results.

In our own state 1,926 cases of pellagra were reported in 1938 and in the same year there were 540 deaths reported from this disease. The number of cases coming to the attention of the physicians and reported probably does not account for more than 35% of the actual cases of pellagra in the state. If each individual suffering from the disease misses 30 days of work during the year, and this is a conservative estimate, it means a loss of about 175,000 man work days annually from this single food deficiency. The disease pellagra is due to a lack of nicotinic acid and is entirely preventable by proper food.

Under certain severe conditions both civilians and soldiers may need dietary supplements of certain vitamins. An example of this is ascorbic acid; the United States produced 17 tons of the synthetic vitamin in 1940. Vitamin C is destroyed by infection and by a number of industrial and military poisons. It is lost in appreciable quantities in profuse perspiration. One important industrial organization, observing many heat prostrations under very hot working conditions, adopted the practice of giving each worker a tablet containing vitamins C and $B_1$ and common salt. Improvement in general vigor was most encouraging—and there were no more heat prostrations. In Great Britain, the workers in T.N.T. plants are given extra amounts of vitamin C to prevent T.N.T. poisoning (3).

The influence of the quantitative and qualitative restriction of food on the incidence of certain diseases is well illustrated by information coming out of France (4). In 1940-41 the daily food allowance for adults in France provided about 29 grams of protein and less than 1100 Calories. These amounts are less than one-half of the standard set up by our own National Nutrition Committee for the United States. A report presented to the Academie de Medicine de Paris by Dr. Marcel Moine, Chief of Statistics of the Comité National de Défense Contre La Tuberculose, shows a marked increase in the mortality from tuberculosis in 1941 as compared with 1939. In children under one year of age, the mortality increase was 15%. In children from 1 to 9 years, the increase was 28%. For all age groups the deaths from pulmonary tuberculosis increased 20.4%, and from other types of tuberculosis increased 30.4%. Dr. Moine goes on to point out that the march of tuberculosis has become ominously progressive, and that if the restricted dietary regime continues and the consequences increase, the problem of tuberculosis in France will become exceedingly grave.

The major causes of nutritional inadequacy in our country may be listed under four headings: poor food habits, poor commissary, economic factors, and metabolic stress.

*Poor Food Habits.* Poor food habits may be either negative or positive. The negative poor food habits include non-consumption of adequate amounts of the protective foods. This is often due to failure to promote the taste for protective foods, to local food customs, racial antipathies, and economic restrictions. In many instances it is due to faulty social conditioning, as when the adolescent boy stops drinking milk as soon as he dons long trousers. The positive poor food habits include excessive use of candy, sweet carbonated beverages, and alcohol. The amount of candy sold in this country in 1939 was sufficient to furnish 90 calories per capita per day (2). The amount of alcohol consumed in the U. S. in 1938 was sufficient to furnish about 86 calories per capita per day, and probably exceeded 200 calories per person of alcohol consuming age. Data on the amount of calories furnished by sweetened carbonated beverages to our thirsty population are not available. It must be very considerable, and it may exceed the calories furnished per capita by candy and alcohol combined.

A striking example of poor food habits is afforded from a survey (2) in one of our large aircraft construction factories employing over 15,000 people. Many of these people must travel 30 to 40 miles to work, and most of the men arrive without having had any breakfast. The manager of the lunch concession serves these workers breakfasts which consist chiefly of coffee and doughnuts. The typical luncheon meal consists of sandwiches and some sort of soft drink or coffee. This kind of diet falls far short of furnishing the nutrients necessary for good health and activity.

In one Lockheed Aircraft factory deep in the heart of California's citrus and vegetable belt, tests revealed that 77% of the workers received an inadequate amount of vitamin C in their diet, and 62% failed to receive an adequate amount of vitamin A (5). In 50% of the cases vitamin deficiencies were serious enough to affect adversely the efficiency and stamina of the workers, resulting in decreased production, loss of time and lowered morale. Statistics collected from many sources support Mr. McNutt's statement that 80 million working days can be saved annually if employees will eat to keep fit. If that is true, the seventeen employees now needed to back up one soldier at the front can be cut to fifteen, with proper food doing the work of the other two.

*Poor Commissary.* By this term is meant the provision of foodstuffs by producers, restaurateurs, food manufacturers and housewives, from which it is difficult, and sometimes impossible, for the consumers to select foods that will meet their nutritional requirements. Highly-milled grain products and refined sugar have probably contributed considerably to the prevalence of malnutrition in the United States. Housewives, who depend upon "fresh vegetables" which they purchase from local markets to furnish their families with the necessary vitamins, often are not aware that, in many instances, between the time of harvesting and the time of purchase there may be a serious decrease in their nutritional value. Further, considerable losses of nutritional value occur in foods which are improperly prepared for consumption in the home or restaurant.

*Economic Factors.* The role of economic factors in the production of malnutrition hardly needs emphasis. The survey of Stiebeling and Phipard (6) indicated that families spending less than $2.50 per person per week on food rarely obtained adequate diets. A per capita weekly income of more than $8.00 appeared to be essential to insure a satisfactory food budget. These estimates are not applicable to single men and women living away from home whose per capita living costs are apt to be much higher than those of family groups. Since these studies were made, there has been a marked increase in the cost of living, and if a similar study were made today it would undoubtedly be found that they would need to be increased by about 20%. If the consumption of foods of good nutritional value is to be increased, it is important that such foods be offered at a price to provide a good meal at a cost no higher than an alternative meal of poor nutritional value. For example, a campaign to increase the consumption of milk stands an immeasurably greater chance of success if the milk is offered at a price equal to or less than that of the alternative choices of soft drinks, beer and coffee.

*Metabolic Stress.* Conditions such as illness, increased working hours, extremes of temperature, "speed-up" of work, insufficient rest, etc. which increase energy consumption, produce a proportionate increase in the body's nutritional requirements. Such an example has been mentioned in the increased requirements for vitamin C during hard work and where the temperatures are high.

Efforts to improve the nutritional status of the people on our home front can be directed along three lines: education, provision and economy. Under the leadership of M. L. Wilson, Director of the Extension Service, and Assistant Director of the Office of Defense Health and Welfare Services in charge of nutrition, activities of national and local agencies, both public and private, are being tied together into an over-all program to promote better nutrition. In our own state the nutrition program is under the able direction of Miss Horton, Vice-Director of the Extension Service. The State Nutrition Committee has organized county and community nutrition groups. These nutritional agencies and their activities are an essential part of a great job to be done. But the program to preserve and strengthen the nation's health through better nutrition is one that requires the cooperation of all who can contribute to its advancement.

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## Wise Use of Our Hidden Heritage

M. G. CHENEY, Petroleum Geologist, Pres. Anzac Oil Corp., Coleman.

Under our highly competitive economy, the public interest is served by a reasonable degree of governmental control over the production and use of those natural resources which are (1) essential, (2) subject to wasteful methods of production, (3) expendable upon use and (4) for which neither satisfactory substitution nor economical replacement is in prospect.

Fortunately, conservation laws, capably written and administered, can render substantial service both to present as well as future generations and to all interests involved. Conservation may appear highly altruistic to some, yet self-interest is also promoted in the end by the enforcement of efficient production methods. This is especially needed where migratory minerals are being produced from a common reservoir by competing interests, and where waste is created by excessive rates or inefficient methods of production.

In application, conservation infers some degree of public control over production and use of our natural resources. Conservation is opposed alike to wasting and to hoarding. It has been aptly defined as "wise use." This definition may seem inadequate at times for lack of exactness, much being left to individual judgment. However, somewhat flexible definition and interpretation appear necessary in applying conservation measures to various natural resources under ever-changing conditions, although the main objectives remain the same, namely the promotion of general welfare and national security. National defense may in times like the present outweigh all other phases of public interest and justify the extreme waste of resources which wars entail.

Conservation looks toward the general welfare of the future. In doing so it cannot reasonably neglect the welfare of the present. This dual effort of serving both the future and the present represents only one of several conflicts involved in the formulation and administration of conservation policies. Fortunately, economic forces exert much control over use, and technological advances have in the past turned impending crises into mild transitions. Reason and experience dictate that conservation controls by government be applied mainly to essential resources of an expendable nature drawn from limited reserves. Obviously, the substance and administration of conservation laws and orders should evolve from experimentation based on sound engineering and well established economic principles. Both small and large business enterprises, as well as the public, are certain to derive benefits in the long run from firm, equitable enforcement of such laws and orders.

The geologist is generally concerned with the discovery, development and appraisal of mineral resources concealed by a soil and rock mantle, the maximum explorable depth at present being about three miles. His studies should include developmental policies so designed as to minimize waste, both physical and economic.

Geologists, more than anyone else, are cognizant of the limited extent and localized occurrence of many of the essential minerals; of the critical conditions that were requisite to the formation and accumulation of commercial deposits; and of the very extended periods of time, meaning many millions of years, during which exceedingly slow processes brought cumulative results of great importance to man. In the aggregate, these various mineral deposits are beyond comprehension as to quantity, usefulness and, hence, value. They may be regarded as our hidden heritage, upon which modern industrial civilization is in many ways utterly dependent. There can be no doubt that man will develop more and more uses for these various raw materials; also, that synthetics derived largely from products of the soil will in part supplement and replace substances obtained from beneath the soil. The need of conservation of the soil must be apparent to all. This is especially obvious to the geologist who is constantly mindful of the tremendous effects of erosion and of the very slow process by which rock waste materials are converted into soils.

Ever-expanding utilization of our natural resources during this age of invention and industrialization, as well as growth and concentration of population, requires constant study of supply and demand relationships. The need of conservation controls will doubtless increase at an accelerating rate as human needs and wants multiply.

During this 20th century, ardent champions of conservation, Pinchot, Theodore Roosevelt, Van Hise, to name a few of the pioneers, have awakened sufficient public interest to attain impressive results. National and state forests and naval petroleum reserves have been established and huge reclamation and power projects completed. In contrast, it is most depressing to see the tremendous waste which has occurred where conservation has been neglected, such as the erosion of much of the most fertile soils of the "Old South" or the loss of value and productivity of 100,000 acres or more in Southwest Texas where wastage and excessive rate of flow from artesian water wells has led to the present shortages of water and the near abandonment of cultivation in this large area. Government reports indicate that excessive rates of withdrawal of water for Texas' largest city have brought on an impending shortage of serious proportions from underground reservoirs which have a limited rate of recharge.

During the past decade, effective oil and gas conservation laws and regulations have been developed in Texas and nearby states. Conservation seems particularly applicable to these resources which are highly charged with public interest, completely expended upon use, drawn from definitely limited reserves. In recent years about 1/6th of the population of Texas has derived sustenance from the exploration, development, production, transportation, refining and marketing activities of the petroleum industry. The other 5/6ths have also received direct or indirect benefits.

Demand for petroleum and its products is expected to continue to expand because of the several unique advantages obtained, such as its cheap transportation by pipe line or tanker, high energy and heat values, ease of control, highly flexible use for large or small industrial, domestic or transportation units, as well as an ever increasing number of special products of an essential nature. New and expanded uses seem to outstrip gains in efficient use. Present needs are four times greater than during World War I. It is difficult to foresee any important alteration of this trend of doubling of demand over 12 year intervals, unless discovery rates fail to keep pace with demand or discovery and invention bring forth some cheaper source of energy. The latter appears possible but difficult, since at recent wholesale prices one cent has been the cost of ten million to fifty million foot-pounds of potential energy in the form of motor and industrial fuels. Fairly widespread occurrence of petroleum further encourages its world-wide use.

These considerations, which seem to forecast continued high rates of petroleum consumption, should be weighed against probable supply. When expressed in years of supply, only a moderate volume of recoverable oil reserves is known in the United States. This reserve, about 20 billion barrels, is adequate for 12 years' predicted demand. However, if produced only at efficient rates to promote conservation, not 12 but from 20 to 30 years are required for the production of these reserves. Doubtless, large supplies of petroleum lie undiscovered in various parts of the world, although very large areas are known to be highly unfavorable, and fairly large areas have reached or approached the discovery exhaustion stage.

Added to the naturally occurring oil reserves, from which oil may be obtained at moderate cost and at high rates of flow if necessary, are very large reserves obtainable by more costly methods such as mining and retorting of oil shales, coals, lignites, and oil and tar sands; also by secondary recovery methods applied to oil pools in which energy but not oil is largely depleted. The total supply from all these sources appears adequate to meet probable demand (both domestic and world demand) for several hundred years. However, even large-scale operations of these less favorable sources of supply will require prices for the products much higher than the recent average prices for oil and its products derived by direct flow from wells. Hence conservation of oil is largely directed toward the husbanding of our readily producible, low-cost oil reserves, in the interest of our industrial welfare and national safety. For a large part of the nation, the stability of income and industry are important added benefits derived from wise conservation policies.

Present needs for petroleum and its products are so essential and prospective demand is so large that public interest clearly dictates that maximum ultimate recoveries should be produced from known oil pools. This is doubtless true, even though somewhat higher costs and prices are involved due to greater investment and long-term interest charges, the latter commonly adding 10% or more to production costs. Exploration for new fields must proceed in spite of diminishing returns, being localized in areas where the more favorable prospects have been tested or developed and in areas more remote from supplies and pipe lines. Present reserves in this country as a whole fail to provide for efficient rates of production. Discoveries must not merely offset withdrawals but should exceed them in anticipation of higher future demand. High discovery rate is unlikely unless prices cover production costs, replacement costs, plus adequate profit incentive to induce risk of capital in hand in search of hidden resources, hoped for but unseen. During 1942, in spite of nearly normal exploratory drilling, discoveries have fallen short of withdrawals by several hundred million barrels, a trend which has been increasing in severity during recent years.

Prices must inevitably play an important role in conservation efforts. In many ways, low prices induce waste. In the case of oil, a period of low prices inevitably reduces exploration which in time leads to wasteful rates of withdrawal from diminishing reserves. Also, low prices hasten abandonment of numerous small wells with large total recoverable reserves but which are jeopardized because of relatively high operating costs and salvage value. Present prices appear to obstruct and threaten conservation efforts to a very serious degree. Discovery rate has fallen to about ½ the current production rate, and small wells are being abandoned at nearly twice their usual rate.

Texas oil and gas conservation laws prohibit physical waste of natural resources. They specifically forbid regulatory authorities from considering economic waste. This denial of consideration of present welfare while providing for the welfare of the future appears unjustified and contradictory for, as observed above, low prices are clearly opposed to conservation efforts. Fluctuation of prices should reflect supply and demand relationships above fixed minimum figures. In the case of oil and gas, the minimum prices should cover the costs of sufficient exploration to maintain adequate reserves, as well as development costs, operating costs, and a reasonable profit to those who engage in this speculative enterprise. Allowance must, of course, be made for about 25% of the income to cover royalties and taxes. The price should take into account the intrinsic value of the oil and gas in competition with other fuels, although the chemist will foresee many times this value when these raw materials are used as a source of innumerable synthetic products.

No doubt there is now nearly complete agreement that conservation of essential, limited, exhaustible natural resources is a wise public policy which should be judiciously and equitably administered for the promotion of general welfare and national security.

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**Other papers listed on the programs of meetings**

1. The Need of Soil Conservation. Hal P. Bybee, The University of Texas, Austin.

2. Petroleum Reserves in Texas. J. Brian Eby, Consulting Geologist, Houston.

3. Re-Working Old Oil Wells and Gas Wells for New Production Saves Steel. Sidney A. Judson, Texas Gulf Producing Company, Houston.

4. The Resemblance of Exploitation of Petroleum to that of Underground Water, and the Significance of Petroleum Engineering Experience as an Aid to Conservation of Water Resources. Paul Weaver, Gulf Oil Corporation, Houston.

5. The Fisheries. Elmer P. Cheatum, Southern Methodist University, Dallas.

6. The Grazing Ranges. Raymond Price, Director, Southwestern Forest and Range Experiment Station, Tuscon, Arizona.

7. Conservation of Human Resources. T. O. Walton, Agricultural and Mechanical College of Texas, College Station.

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# FOREWORD

In spite of the war and the attendant transportation difficulties, man-power shortages, and the many emotional strains to which all of us have been subjected, the annual meeting of the Academy in November at Austin was well attended, and this volume is as large as last year's. The success of the annual meeting was due in part to the excellent work of the program committee and to a considerable extent to the cooperation of the Gulf Coast, A. & M. College, and East Texas sections of the American Institute of Mining and Metallurgical Engineers which met with the Academy.

President Woolrich and the members of the publications and program committees assisted the editor in the collection of manuscripts; their co-operation is gratefully acknowledged.

This volume appears later in the year than the last. The blame for this must rest on the war and on the editor.

The geophysical contracting companies who made contributions to the publications fund of the Academy last year have helped again; moreover, their gifts were larger this year. The Academy's financial position now rests on a secure foundation; the membership can carry the load in the future. The names of the contributing companies are listed on another page; we thank them and assure them of our appreciation of their support.

The papers and abstracts in the Transactions convey and express the opinions and ideas of the authors; their publication in this volume does not imply endorsement by the Academy and they are not binding on the officers or on the membership. Permission to reprint any material in the volume is granted on the condition that specific reference be made to the source.

*Chairman, Publications Committee*

Oct. 2, 1944

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Papers are published only in English. Manuscripts should be original typewritten copies (not carbon copies), on white paper, 8½ x 11 inches, either double or triple spaced, with wide margins. References should be numbered consecutively, to avoid repetition, and should include author's name, title, journal, volume number, page, date of publication, listed in the order given. Attention should be given to captions for tables and legends for figures. These should be complete in themselves in all cases so as to render the data intelligible to the reader without consulting the text.

Special care should be given to mathematical expressions. Only the very simplest equations may be typewritten; all others should be carefully drawn with pen and ink, for photographic reproduction. Fractional exponents should be used everywhere to avoid radical signs. Extra symbols should be employed to avoid complicated exponents. The solidus (/) should be used wherever possible for fractions.

All illustrations should accompany the manuscript and should always be referred to in the text. Line drawings must be made with India ink on plain white paper sufficiently large to permit reduction to one-half without impairing legibility. Coordinate paper is not desirable, but if used it must be blue-lined with all coordinates to be reproduced drawn with India ink. Lettering should be of sufficient size to be legible after reduction. All captions should be submitted on a separate sheet and not included in the drawing.

In biological papers, underscore all words to be italicized.

Omit all references to persons, incidents, or dates which will not be comprehensible to the reader a few years after publication.

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Texas Entomological Society
The Texas Folk-Lore Society
Texas Nature Federation
University Science Club
The Texas Society of College Teachers of Education
West Texas Historical and Scientific Society

# RESUME OF THE MEETING OF THE GENERAL BUSINESS SESSION OF THE TEXAS ACADEMY OF SCIENCE, ANNUAL MEETING, NOVEMBER 12, 1943, 9:15 P. M., AUSTIN, TEXAS

President Frederick A. Burt, Presiding

1. President Burt complimented the local committee as well as the officers generally for their very co-operative work in making the annual meeting in Austin as well as the Academy year a success.

2. Report of the Secretary, Leo T. Murray. Approved as given by G. E. Potter, Assistant Secretary.

3. Report of the Treasurer, Curtis J. Hesse. This report showed receipts of $1906.00 from all sources, and that the Academy had spent $1346.00 during the year 1942-43. The report was approved as read.

4. Report of the Auditing Committee, Luther Jones, Chairman. The report approved the status of the Treasurer's books and accounts. Approved as read.

5. Report of Publications Committee, L. W. Blau, Chairman. The combined proceedings and transactions was published as a single volume at a cost of $1147.67. Twelve geophysical contracting companies subscribed and paid $760 of this amount, thus making possible the publication in its improved form. The report was adopted.

6. Report of Finance Committee, C. J. Hesse. Adopted as read.

7. Library Committee report, S. W. Bilsing. Adopted as read.

8. Junior Academy Committee report, Greta Oppe. Nine papers presented at present meeting with thirty members present. Two Honorary Junior Memberships in AAAS were announced. These are: (1) *Boy*—Bob Albertson, Lamar Chapter, Houston, and (2) *Girl*—Evelyn Peterson, Ball High School, Galveston.

9. Report of Collegiate Division Committee, C. C. Doak, Chairman. Approved as given.

10. Report of Committee on Resolutions, F. B. Isely, Chairman. Among other things, the City of Houston was complimented on its Natural History Program now under way. The report was adopted as read.

11. Report of the Committee on Necrology, B. C. Thorp, Chairman. Approved as read.

12. The Judiciary and Constitution Board presented proposed amendments to the constitution. There were two principal features. 1. The setting up of an election committee which shall compile a slate of two nominees for each office two months in advance of the annual meeting and send these to all members who may add others or vote for one of those presented. With certain other appropriate provisions to make the election practicable and democratic, this constitutes an election by mail ballot to be completed before the annual meeting. The Election Committee will announce the result of the election at the opening business session of the annual meeting and the officers thus elected shall assume their duties at the close of the final business session of the Academy. 2. Provision was made for electing Honorary Life Mem-

bers, any resident scientist whom the Executive Council may consider as having rendered distinguished scientific service being eligible. Such a Fellow to be exempt from dues. The report was adopted.

13. Report of the Committee on Fellows, C. C. Doak. The names of twenty-eight members were placed as nominees for Fellows. The report was approved and those nominated were elected.

14. It was moved by G. E. Potter that, since a complete list of applicants for membership had not been compiled, the Executive Committee be empowered to receive and canvass applications for membership in the Academy as of the date of this meeting for a reasonable time and declare those, who prove to be eligible, elected. Seconded and carried after some discussion.

15. The Nominating Committee presented the following slate of officers for 1943-44: President, W. R. Woolrich; Executive Vice-President, W. P. Taylor; Vice-President, Section I, E. W. Schuhmann; Vice-President, Section II, Gordon Wolcott; Vice-President, Section III, Spencer Stoker; Vice-President, Section IV, H. P. Bybee; Vice-President, Section V, J. G. Burr; Secretary, George E. Potter; Assistant Secretary, Mrs. Cornelia Smith; Editor, L. W. Blau; Board Member, 3 years, E. P. Cheatum; Member of Constitution and Judiciary Board, J. C. Godbey. This slate of officers and committeemen was duly elected. There being no further business to come before the assembled body, a motion for adjournment was made and carried.

Respectfully,
G. E. POTTER, Secretary.

## ANNUAL REPORT OF THE SECRETARY FOR THE YEAR
November 12, 1942, to November 11, 1943

The Academy held its regular meeting for 1942 in College Station, November 12 to 14 with A. & M. College serving as host. Considering the emergency conditions due to the war, the meeting was well attended. The highlights of the general sessions of the meeting were the addresses delivered by Dr. H. B. Ward, Professor Emeritus of Zoology at the University of Illinois, on the subject of "Utilization and Conservation of Biological Resources," Dr. Chauncey D. Leake, Dean of the School of Medicine of Texas University at Galveston on the subject "Mechanisms of Action of Ordinary War Gases," and Captain H. A. Hammer, Chemical Warfare Service, on "Science in Relation to our Armed Forces." Dr. Ward's address was published in Science, Vol. 98, No. 2544, Oct. 1, 1943, under the title "Warfare and Natural Resources."

Relatively strong programs were carried out by all five sections of the Academy. Papers presented in these sectional meetings numbered as follows: I, Physical Sciences, 6; II, Biological Sciences, 17; III, Social Sciences, 15; IV, Geological Sciences, 6; a joint session of II, Biology, and V, Conservation, 8; a symposium on Utilization and Conservation of Natural Physical Resources, 6; and a symposium on Utilization and Conservation of Natural Biological Resources, 6.

A full account of the committee reports and minutes of the business meeting has already been published in Vol. XXVI of the Proceedings, pages 12-27.

During the year there have been five meetings of the Executive Council: (1) on Nov. 14, 1942, immediately following the annual meeting of the Academy; (2) on July 5, 1943, informal meeting to open the matter of selecting a new Treasurer to fill the place of Father J. E. Norton and to offer nominations; (3) on July 10, 1943, called council meeting to complete the election of Treasurer, C. J. Hesse being chosen, authorize audit of treasurer's books, authorize the dates, November 11 to 13, for the annual meeting to be held in Austin, and to appoint Dr. C. H. Winkler to write a letter of appreciation to Father Norton for his service as Treasurer; (4) on October 30, 1943, to open the matter of bestowing an Honorary Life Fellowship this year, order a poll of the absent members of the council, and offer nominations; (5) on November 5, 1943, to canvass the returns on the poll in regard to the Honorary Life Fellow. Forms used in the election are included.

Minutes of these meetings follow in this report. The minutes of an informal meeting held with the Editor as well as a Progress Report of the President are included. The Academy held no regional meetings during the year.

As of this date, our organization has 505 active senior members of whom 149 are fellows. There are 87 collegiate members and 19 Junior Academy Chapters.

G. E. POTTER, Assistant Secretary.

Nov. 10, 1943

## EXECUTIVE COUNCIL MEETING

November 13, 1943

1. A statement of the duties of the various officers of the Academy was read to the new Council by Burt.

2. It was moved that all engraved plates and permanent property of this nature be deposited with the librarian of the Academy. Seconded and carried.

3. Junior Academy Committee report heard and accepted. It was moved by Burt and seconded by Taylor that Miss Greta Oppe be selected as Chairman of the Junior Academy Committee for the coming year and that the Committee select its own secretary. Motion carried.

4. Bilsing made a motion to accept the nominations and elect Velma Wilson to succeed herself (3 yrs. to 1946), Edna Miner to succeed Jack Sublett (3 yrs. to 1946) and Willie Mae Floyd to succeed Seyman Hayes resigned (1 yr. 1944). Motion seconded by Bybee and carried.

5. Appointment of committees by President Woolrich. The name of Elections Committee was recognized as replacing Nominations Committee.

6. It was moved by Taylor that the Council tentatively accept the invitation from the Chamber of Commerce and Dean Leake to hold the 1944

Annual Meeting in Galveston under the sponsorship of The University of Texas Medical College. The motion was seconded and carried. The Secretary was instructed to write to authorities at Galveston informing them of this decision.

7. C. C. Doak was elected as Chairman of the Collegiate Division. Amy LaViscounte was elected as the other member of the Collegiate Division Committee.

8. Report from C. C. Doak on Collegiate Division progress and problems was heard and accepted.

9. The recommendation passed by the 1942-43 Council on Thursday, November 11, 1943, that the members of Section IV consider separating Geography from Geology contingent on certain provisions included in the minutes of that meeting, was discussed by the new Council and given tacit approval.

10. The Council was informed by Bybee that Paul Weaver had been appointed chairman of a committee to cooperate with the Geology section in preparing a program on Hydrology to be presented at the next Annual Meeting. It was stated that the present plan is to publish two of these papers in their M. & M. journal.

11. After some discussion, it was agreed to continue the Affiliations Committee suggesting that possibly such a committee could help in getting other societies to affiliate with the Academy and put on programs at the same time and place as the Annual Meeting of the Academy.

12. Growing out of general discussion of the function and welfare of the Conservation Section V, Burt voiced the suggestion in which the Council concurred that the Vice-President, serving as Chairman of that Section, attempt to build a broad program dealing with all natural resources.

13. Doak offered a motion to the effect that, as a policy, the stationery provided by the Academy to its officers be printed with only the general letterhead, The Texas Academy of Science, and the same for the returns on the envelopes. He explained that this measure would save paper and money, and any surplus can be carried and used from year to year. Seconded by Hesse and passed.

14. It was moved by Taylor that power be delegated to Pres. Woolrich and Bybee to appoint an assistant secretary in case of resignation of the incumbent who had suggested that this might be possible.

Members present at this Meeting were: Woolrich, Taylor, Bybee, Burt, Potter, Cornelia Smith, Blau, Hesse, Bilsing, Doak, Oppe. Meeting adjourned.

G. E. POTTER, Secretary.

## PUBLICATIONS COMMITTEE

The combined Proceedings and Transactions were published at a cost of $1144.67. Twelve geophysical contracting companies contributed a total of $760.00 to the publications fund; the volume could not have been published without these contributions. Copies have been mailed to all members in good standing, to newspaper editors, and to prospective members.

L. W. BLAU, Chairman.

## TREASURER'S REPORT

The present Treasurer took office on August 1st, 1943, after the resignation of Father James E. Norton, who was called into the armed forces. The accounts were audited by Mr. H. Dulon, C. P. A. of College Station, whose report is appended here.

Father Norton had completed the mailing out of the bills for the current dues for members and for those one year in arrears. Between August 1st and September 15th, statements were mailed to all those who were in arrears since 1940. On September 15th statements were again mailed to those who were in arrears for one year. On November 8th, the Academy had a paid-up membership of 501, including 14 life members, 5 sustaining members, and a Collegiate Division of 72 members. We are carrying on our active rolls all those who have been called into the armed forces. The Treasurer's rolls have been retyped on a specially printed file card and every effort will be made to get the correct and complete information on all members. That these rolls still are in error is quite evident; they should be checked against those of the secretary.

In addition this office has mailed out the President's letter to all active members.

### THE TEXAS ACADEMY OF SCIENCE

STATEMENT OF TREASURER'S CASH RECEIPTS AND DISBURSEMENTS
November 7th, 1942, to November 8th, 1943

| | |
|---|---|
| Cash Balance, November 7th, 1942 | $ 208.19 |
| Receipts: | |
| Dues for memberships | 934.15 |
| Sustaining memberships | 35.00 |
| Publication sales | 22.13 |
| Contributions to Publication fund | 760.00 |
| Total | $1959.47 |
| Disbursements: | |
| Bills from prior year | $ 98.56 |
| President's Office expenses | 10.92 |
| Treasurer's Office expenses | 52.10 |
| Publication Committee expenses | 1144.67 |
| Collegiate Division | 5.00 |
| Library Committee | 25.32 |
| Auditing Committee | 10.00 |
| Total | $1346.57 |
| Two Series U. S. Government Defense Bonds for Endowment Fund | 200.00 |
| Deposit in First Federal Savings and Loan, San Antonio | 25.00 |
| Cash on hand, November 8th, 1942 | 388.46 |
| Total | $1960.03 |

Endowment Fund:

Two Series C, U. S. Government Savings Bonds Nos. C786168C and C786167C, Maturity value 10 years $100 each....................................$ 168.00

Two Series G, U. S. Government Defense Bonds Nos. C1537711G and C1537712G, value $100 each, interest 2½%..................................... 200.00

On deposit in First Federal Savings and Loan Association, San Antonio, Texas........................ 57.18

Total...........$ 425.18

CURTIS J. HESSE, *Treasurer.*

July 29, 1943
The Texas Academy of Science
College Station, Texas

Gentlemen:

At the request of Dr. Luther G. Jones, Chairman of the auditing committee, I have checked the record of receipts and disbursements of your organization for the period from January 1, 1943, to July 6, 1943. As shown by supporting deposit slips, the record of receipts is correct and the disbursements record reflects cash paid out by checks written on the American National Bank, Austin, Texas. All deposits and withdrawals by check have been verified on the bank statements as submitted. The bank account shows clearance by transfer of balance through check written to the order of the new secretary, Dr. C. J. Hesse, of College Station, signed by the former treasurer, Rev. James E. Norton of Austin. The First State Bank and Trust Company of Bryan, Texas, verifies a balance on deposit to the credit of The Texas Academy of Science of $1,540.78. This represents $23.00 more than shown by the books, and Dr. Hesse states that it includes dues received by him since taking over the records of the Academy and which are to be entered in the records as soon as he receives them.

Section 1, Article II of the ARTICLES OF FINANCIAL POLICY provides for a separation of all moneys belonging to the Academy into two funds: (1) Permanent Endowment, and (2) General Fund. There is no evidence that this provision is being complied with.

Although there is an estimate of income as the basis for a budget, there is no list of members available which would show those who are delinquent. Hence, there has been no verification of actual receipts, and no method of internal check exists. This is a definite weakness in the system of accounts. According to the President, Dr. F. A. Burt, there are approximately 550 members of the Academy. At an annual dues figure of $2.00 this would mean a possible income from dues of $1,100. Actual 1943 dues collected to date, according to the record of receipts, is $465. This is less than 50% collection and means that at least $535 of receipts due the Academy from its members has no status in the records.

An examination was made of the assets of the Texas Academy of Science. The two United States Savings Bonds, Nos. C786167C, and C786168C, with maturity values of $100 each were found to have a current value, including accrued interest, of $84. each. Hence, the asset value of the bonds should be stated as $168 rather than as $200.

The First Federal Savings and Loan Association of San Antonio did not answer a letter requesting verification of a balance to the credit of The Texas Academy of Science of $31.70.

The research apparatus listed on the report of November, 1942, at a value of $110.00 could not be found. Your president, Dr. F. A. Burt, states the asset to be non-existent and of no value. Dr. Burt states that this asset was placed on the books over a period of years as a consequence of members carrying on research with funds obtained from the Academy.

When their expenditures were for tangible items such assets were added to the records of the Academy. However, they were never inventoried under the name of the Academy, which could have been accomplished by merely adding a metal plate to the asset or writing upon the asset to the effect that it belonged to the Academy. As a consequence, the organizations at whose locations they were used have merely assumed their ownership and their identity has been lost to the Academy. Of course, in many instances they seem to have merely worn out.

The true assest of the Texas Academy of Science appear to be:

| | |
|---|---|
| 2 U. S. Savings Bonds, Nos. C786167C and C786168C........ | $ 168.00 |
| Savings Account (First Federal Savings & Loan Association of San Antonio)........................... | 31.70 |
| Cash ................................................ | 1,540.78 |
| Total Assets........................ | $1,740.48 |

Dr. Hesse states that the only liability of the Academy is an unpaid amount of $1.39 due Dr. W. H. McCorkle of College Station.

Attached is a statement of receipts and disbursements for the period January 1, 1943 to July 6, 1943.

Respectfully submitted,
H. A. DUNLAN, C.P.A.

## TEXAS ACADEMY OF SCIENCE

### STATEMENT OF TREASURER'S CASH RECEIPTS AND DISBURSEMENTS
January 1, 1943 to July 6, 1943

| | | |
|---|---|---|
| Balance, January 1, 1943.............................. | | $ 208.91 |
| Receipts: | | |
| Funds collected College Station Meeting, 1942....... | $ 164.15 | |
| Southwestern Biological Supply Co. for 3 copies "Proceedings" '36-'37......................... | 4.50 | |
| State Comptroller for 200 re-prints of "Seasonal Condition of Texas Oysters"........ | 6.63 | |
| Sustaining Memberships: | | |
| F. M. Getzendanner........................... | 5.00 | |
| Armstrong Price.............................. | 5.00 | |
| Contributions to Publications Fund................ | 760.00 | |

| | | |
|---|---|---|
| Back dues collected | 34.00 | |
| 1943 dues collected | 456.00 | |
| 1944 dues collected | 4.00 | |
| | $1,448.28 | |
| | | $1,657.19 |
| Disbursements: | | |
| Outstanding obligations from 1942 | $ 98.56 | |
| Expenses Treasurer's office | 40.85 | |
| | 139.41 | |
| Balance, July 6. 1943 | | $1,517.78 |

## PROPOSED BUDGET OF THE TEXAS ACADEMY OF SCIENCE

Passed at Austin, Texas, Nov. 13, 1943

| | |
|---|---|
| 1. President's Office, past year $25.00, this year | $ 25.00 |
| 2. Secretary's Office, past year $25.00, this year | 25.00* |
| 3. Stationery, past year $20.00, this year | 20.00 |
| 4. Treasurer's Office, past year $100.00, this year | 100.00 |
| 5. Local Program Committee, last year $25.00, this year | 25.00 |
| 6. Library Committee, past year $15.00, this year | 25.00 |
| 7. Collegiate Division, past year $10.00, this year | 10.00 |
| 8. Junior Academy, past year $35.00, this year | 25.00 |
| 9. Membership Committee, past year $10.00, this year | 75.00 |
| 10. Auditing, past year $10.00, this year | 25.00 |
| 11. Constitution Board, past year $35.00, this year | 25.00 |
| 12. Publication Committee, past year $464.00, this year | 1000.00* |
| 13. Contingency Fund, past year $100.00, this year | 140.00* |
| Total | $1520.00 |

| | |
|---|---|
| Dues for 1943-44, estimated | $ 800.00 |
| Cash on hand, Nov. 13, 1943 | 550.00 |
| Total | $1350.00 |

*The above is the budget as passed at Austin by the Finance Committee. Several days later Mr. Burt pointed out that we had failed to provide for the new method of election which would cost about $40.00. It was decided to remove $40.00 from the contingency fund, and put it into the Secretary's Office to cover this extra expense. This was voted on by telephone and approved by Burt, Taylor, Potter and Hesse. Corrected copies were then mailed to Woolrich and Murray.

CURTIS J. HESSE, *Treasurer.*

## MEMBERSHIP COMMITTEE

### NEW SENIOR MEMBERS

Alcorn, I. W., The Pure Oil Co., P. O. Box 239, Houston Texas.
Artist, Dr. Russell C., Department of Biology, Amarillo College, Amarillo, Texas.

Barkley, Fred A., P. O. Box 1620, University Station, Austin, Texas.
Bayle, Pierre, 2128 Goldsmith St., Houston, Texas.
Beazley, Mrs. Doris, Box 404, Mary Hardin Baylor, Belton, Texas.
Bell, John, Humble Oil and Refining, Houston, Texas.
Blank, Horace R., Dept. of Geology and Mineralogy, Southwestern University, Georgetown, Texas.
Bock, Morris, Sun Oil Co., Dallas Texas.
Bogusch, E. R., Texas A. & I., Kingsville, Texas.
Bond, John Henry, 706 Augusta St., San Antonio, Texas.
Bond, T. J., 819 James, Waco, Texas.
Bugbee, J. M., 2232 Tangley Rd., Houston, Texas.
Castaneda, C. E., 1001 Mercantile Bank Bldg., Austin, Texas.
Clarkson, Miller B., Physics Dept., Baylor University, Waco, Texas.
Corless, George B., Humble Oil and Refining Co., Houston, Texas.
Culberson, Olin, R. R. Commissioner, Austin, Texas.
Culbertson, James T., Box 53, Southwestern University Station, Georgetown, Texas.
Davis, Lea, 1506 Bois d'Arc, Commerce, Texas.
Elliott, G. R., Produce Dept., Phillips Co., Bartlesville, Okla.
Ellsworth, Agnes Sanders, Box 134, North St. Station, Nacogdoches, Texas.
Ettlinger, Dr. H. J., Dept. of Math., Texas University, Austin, Texas.
Evans, Mr. Glen, Bureau of Economic Geology, Austin, Texas.
Fairbanks, Gordon H., Southwestern University Station, Georgetown, Texas.
Fancher, George H., University of Texas, Austin, Texas.
Ferguson, C. E., Stephen F. Austin State Teachers College, Nacogdoches, Texas.
Floyd, Miss Millie M., 1841 S. 5th St., Abilene, Texas.
Fontaine, E. M., 3724 Ingold St., Houston, Texas.
Fontaine, Pierre A., 5848 Kenwood, Dallas, Texas.
Frances, A. W., 1023 E 36th Pl., Tulsa, Okla.
Friesen, Abraham Penner, 801 Walnut St., Georgetown, Texas.
Garrison, Foster G., c/o Southwestern Alkali Corp., Corpus Christi, Texas.
Giles, D. D., Stephen F. Austin State Teachers College, Nacogdoches, Texas.
Gilmore, J. A., 2044 Richmond Road, Houston, Texas.
Glass, L. C., East Texas State Teachers College, Commerce, Texas.
Hager, Dilworth S., 932 Liberty Bank Bldg., Dallas, Texas.
Hall, Henry E., Incarnate Word Academy, San Antonio, Texas.
Hardt, Henry B., Stephen F. Austin State Teachers College, Nacogdoches, Texas.
Harshbarger, Marjorie, Station A, Abilene, Texas.
Hayes, Charles, 301 Church St., Georgetown, Texas.
Hess, R. M., Shell Oil Co., Box 32, Kilgore, Texas.
Hicks, I. A., 1009 Fish, Brownwood, Texas.
Hubbard, E. P., Gulf Oil Corp., Box 2100, Houston, Texas.
Hubbert, M. King, Room 2109, Shell Bldg., Houston, Texas.
Hurst, William, Shell Oil Co., Houston, Texas.
Jessen, Frank W., 6403 Buffalo Speedway, Houston, Texas.

Jester, Beauford H., R. R. Commissioner, Austin, Texas.
Jones, Arthur W., Box 317, Southwestern University, Georgetown, Texas.
Kellersburger, A. C., 601 W. 13th, Austin, Texas.
Kellogg, Forrest D., Southwestern University, Georgetown, Texas.
Kerbow, A. L., 3220 Rice Blvd., Houston 5, Texas.
Key, C. L., State Teachers College, San Marcos, Texas.
Kinard, Avis, Beckville, Texas.
Kisling, James W., 1811 Esperson Bldg., Houston 2, Texas.
Koepf, Dr. E. H., Atlantic Refining Co., Box 2819, Dallas, Texas.
Langford, C. M., Jr., 505 Esperson Bldg., Houston, Texas.
Larson, Lennart, Baylor University Law School, Waco, Texas.
Lozo, Frank E., Jr., Dept. of Biology and Geology, T.C.U., Fort Worth, Texas.
McFarland, R. S., 1400 Continental Bldg., Dallas 1, Texas.
Meade, Mr. Grayson, Texas Technological College, Lubbock, Texas.
Mendenhall, Raymond E., 911 Walnut St., Georgetown, Texas.
Miller, Colonel K. E., 4949 Swiss Ave., Dallas, Texas.
Moss, F. P., Schreiner Institute, Kerrville, Texas.
Nielsen, Otto R., Texas A. & I. College, Kingsville, Texas.
Parr, Virgil D., 311 Administration Bldg., A. & M. College, College Station, Texas.
Pate, Wilber, Diboll, Texas.
Peterson, Lt. Randolph L., 24th T.C.S., Austin, Texas.
Phillips, E. R., Box 2819, Dallas, Texas.
Power, Harry H., 2600 Wooldridge Dr., Austin, Texas.
Ransone, W. R., 4639 Fairfax, Dallas, Texas.
Richardson, J. T., North St. Station, Nacogdoches, Texas.
Robinson, Ernest Guy, Shell Oil Co., Box 2099, Houston, Texas.
Rowland, Annie N., 2413 22nd St., Lubbock, Texas.
Schwarz, Melbert, Seaboard Oil Co. of Delaware, Dallas, Texas.
Southall, O. C., 2622 27th St., Lubbock, Texas.
Soxman, G. M., 718 Haines Ave., Dallas 8, Texas.
Speer, O. G., 6342 Buffalo Speedway, Houston 5, Texas.
Sterry, Elizabeth, San Marcos, Texas.
Sullivan, Charles A., Box 1115, Wells, Texas
Taylor, Dr. I. T., Co. Supt. of Schools, Edna, Texas
Travis, Miss Pearl, Faculty Club, Edinburg, Texas
Treichler, H. E., New Gulf, Texas
Turner, R. L., Box 206 North St. Station, Nacogdoches, Texas
Wagner, Robert P., University of Texas, Austin, Texas
Warner, C. A., Box 2412, Houston, Texas
Warren, Bertie, Amarillo College, Amarillo, Texas
Watson, Nettie Walton, 2002 Stillman, Corpus Christi, Texas
White, William E., c/o Texas Forest Service, A & M College, College Station, Texas
Whitehead, Miss LaVerne, Box 874, Port Neches, Texas
Williams, E. D., 2044 Richmond Road, Houston, Texas
Williams, Roger J., Chemistry Dept., University of Texas, Austin, Texas
Wisely, 915 Baker St., Nacogdoches, Texas

Wilson, John H., 2015 Ft. Worth National Bank Bldg., Ft. Worth, Texas
Wolf, Albert G., 1009 Second National Bank Bldg., Houston, Texas
Woodward, Horace E., Texas Tech. College, Lubbock, Texas
Wright, K. A., 305 A & M Bldg., Houston, Texas
Wrightsman, G. G., Box 2180, Houston, Texas

## NEW COLLEGIATE MEMBERS

Auge, Helen, Incarnate Word College, San Antonio, Texas
Bennard, Joan, Incarnate Word College, San Antonio, Texas
Brown, Bettye, Incarnate Word College, San Antonio, Texas
Browne, Frances, Incarnate Word College, San Antonio, Texas
Butler, Betty Jean, 2313 Monroe St., Commerce, Texas
Collier, Richard, 1302 Compere, Abilene, Texas
Day, Herman O'Neal, Jr., 1910 Monroe St., Commerce, Texas
Devine, Mary Helen, Incarnate Word College, San Antonio, Texas
Dunn, Floyd, Abilene Christian College, Abilene, Texas
Dwyer, Patricia, Incarnate Word College, San Antonio, Texas
Dyess, Lola Lee, 2104 Nueces, Austin, Texas
Edmondson, Helen, Hardin Simmons College, Abilene, Texas
Elizondo, Margaret, Incarnate Word College, San Antonio, Texas
Garcia, Marie, Incarnate Word College, San Antonio, Texas
Glass, Nell Jean, 2334 Pine St., Abilene, Texas
Hagens, Shirley, Incarnate Word College, San Antonio, Texas
Holland, Mary Loreen, 2570 N. MacGregor, Houston 4, Texas
Kelton, Audrey W., 1611 Campbell, Commerce, Texas
Kirk, Ed, Abilene Christian College, Abilene, Texas
Lozano, Mary Alice, Incarnate Word College, San Antonio, Texas
Maginot, Robert W., 2703 Rio Grande, Austin, Texas
Mart, Eleanor, 3620 McFarlin Blvd., Commerce, Texas
McCann, Catherine, Incarnate Word College, San Antonio, Texas
Mileau, Janet, Incarnate Word College, San Antonio, Texas
Mograssi, Blanca, Incarnate Word College, San Antonio, Texas
Obriott, Imelda, Incarnate Word College, San Antonio, Texas
Paxson, John, 2637 U. Blvd., Houston, Texas
Richter, Rosemary, Incarnate Word College, San Antonio, Texas
Robert, Mary Adele, 2313 Mayo St., Commerce, Texas
Scruggs, Gene, Abilene Christian College, Abilene, Texas
Sikes, James, Abilene Christian College, Abilene, Texas
Vestal, Betty, 1306 E. Chaffin St., Sherman, Texas
Wilson, Jene, Incarnate Word College, San Antonio, Texas
Wells, Guy R., Station A, Abilene, Texas
Yowell, Joe, Station A., Abilene, Texas

## CONSTITUTION AND JUDICIARY BOARD

### Minutes of the 1943 Annual Meeting of the Board at Austin

The 1943 annual meeting was called to order by the Secretary at 4:30 p.m. in Room 816 of the Stephen F. Austin Hotel. The Chairman being absent from the meeting, Dr. Cheatum was named chairman pro tem by acclamation. Board members present: Frederick A. Burt, Elmer P. Cheatum, J. C. Godbey, F. B. Isely, O. A. Ullrich. Members absent: W. T. Gooch, Leo T. Murray.

The minutes of the 1942 annual meeting were read by the Secretary and approved.

In response to a request from the Executive Council meeting at College Station November 6 that the Board draft and present to the Academy an amendment to the Constitution broadening the basis of the HONORARY LIFE FELLOWSHIP eligibility, the following proposed amendment was drafted in accordance with the desires expressed at the Council meeting:

*"Proposed to amend Article III, Section 9 of the Constitution to read:*

"Honorary Life Fellows: Any scientist resident in Texas whom the Executive Council may consider has rendered distinguished service of a research or administrative nature to the advancement of science may be elected by the Council an Honorary Life Fellow. Such a fellow shall have all the fellowship privileges but be exempt from dues."

It was moved by Burt and seconded by Ullrich that the proposed amendment be presented to the Academy for action. Motion carried.

In response to a directive to the Board voted at the final business session of the Academy at College Station November 14, 1942, that an amendment be considered making the election of officers more democratic the matter was taken under consideration. Several suggested plans had been received by the Board Secretary and the following two proposed Constitutional, and one proposed By-law, amendments were drafted in conformity with the combined suggestions received.

*"Proposed change in Article VIII of the Constitution.*

"Add to the article a section as follows:

"Section 5—Method of Election of Officers and Members of the Board of Directors and members at large of the Constitution and Judiciary Board: Two months prior to the annual meeting the secretary shall mail to each member of the Academy in good standing a ballot compiled by the Election Committee for the election of eligible members to fill all vacancies subject to election by the Academy members at large. This ballot shall carry two nominees for each office to be filled, and the names of the nominees shall appear alphabetically for each office except that in the case the Executive vice-president consents to accept nomination for the presidency his name shall be first in his group. The Election Committee shall place no name on the ballot until the candidate's consent to serve, if elected, shall have been received in writing by the committee chairman and his standing shall have been vouched for by the Treasurer. Blank spaces shall be provided on the ballot for the writing in of names other than those printed on the ballot.

"Each member voting shall mark his ballot, enclose it in an inner envelope (provided with the ballot), place his name on the outside thereof, enclose the whole in an outer envelope, and mail to the Treasurer not later than three weeks prior to the annual meeting. The Treasurer shall O.K. those envelopes received from members whose dues are paid for the current year and deliver the unopened inner envelopes to the Election Committee which shall open and count the ballots and announce the results of the election at the opening business session of the Academy. The officers thus elected shall assume their duties at the close of the final business session of the Academy."

*Proposed Change in Article X of the Constitution.*

Change the words "4. Nominating" to "4. Election."

*"Proposed change in Article III, Section 4 of the By-laws.*

"Add to this section as follows:

"The Election Committee shall consist of the three most recent past-presidents in good standing, together with one past vice-president from each of the several sections of the Academy appointed in accordance with the provisions of Section 3 of this article. The President of the Academy may designate which member of the committee shall serve as chairman."

The annual election of the Board's officers was called for and it was moved by Burt and seconded by Ullrich that Dr. Gooch be reelected as the Chairman. Motion carried.

It was moved by Ullrich and seconded by Godbey that Burt be re-elected as Secretary. The motion was carried.

As it was necessary for Ullrich and Burt to leave to attend the 6:00 meeting of the Board of Directors on the University campus it was moved by Burt and seconded by Ullrich that Cheatum, Godbey and Isely be appointed a committee to smooth up the wording of the proposed amendments and present them to the opening business session of the Academy later in the evening and that the Board adjourn. Motion carried.

The meeting adjourned at 5:40.

FREDERICK A. BURT, *Secretary,*
College Station, Texas
November 24, 1943

The following notices, not a part of the minutes, should come to the attention of the Board.

1. As a result of the retirements and elections of the annual meeting the personnel of the Board for 1944 together with the year of retirement becomes: W. T. Gooch 1944, Chairman, Frederick A. Burt 1948, Secretary, Elmer P. Cheatum 1947, J. C. Godbey 1944, Leo T. Murray 1948, George E. Potter 1950, O. A. Ullrich 1946, W. R. Woolrich 1949.

2. The Editor has assured the Board Secretary that he will consider the printing of the Constitution and By-laws in the 1944 Proceedings. Your Secretary will therefore forward a certified copy of the Constitution and By-laws to him for this purpose.

3. Some of the new officers and committee chairmen have requested that they be furnished with typed copies of the committee regulations and Academy, Executive Council, and Constitution Board resolutions regarding

their duties and procedure. To meet this desire the Secretary asked the Finance Committee to budget five dollars to the Board's use. This the Finance Committee has done.

4. Due to oversight in the hurry of work, the fact was missed that the newly adopted method of electing officers provides that an announcement of the new official personnel shall be made at the opening business session of the Academy and that the By-laws allow no place except for very restricted business at the opening session. The matter of amending the By-laws to take care of this is therefore being placed on next year's agenda.

F. A. B.

## REPORT OF COMMITTEE ON RESOLUTIONS

Be it resolved that the Texas Academy of Science express its heartiest appreciation for the efficient work done by the local committees on arrangements and for assistance in the formulation of the program for the 1943 Austin meeting of the Academy;

Be it also resolved that the Academy express its gratitude to President Burt for shouldering so efficiently additional secretarial work due to exigencies that arose through the war program, thus making it impossible for his secretary to carry on all of his many duties;

Be it resolved that the Academy express its sincere appreciation to The Reverend James E. Norton for his effective reorganization of the Treasurer's office, thus making it possible for our present Treasurer to function more efficiently;

Be it resolved that The Academy express its appreciation to Editor L. W. Blau for his excellent work in bringing out the Proceedings and Transactions of 1942 in such good order and on time.

In view of the fact that progress in science through the years is contingent upon the stimulation of young people toward participation in scientific endeavor and a well formulated program in adult education, and, realizing that such an educational program can be motivated largely through a natural history program; be it resolved, that The Texas Academy of Science go on record as approving and congratulating the city of Houston on its Natural History Program now under way, urging that all other large cities participate in a similar program, and that smaller population centers inaugurate programs that have as their goal the same objective.

DR. MARIE MORROW
DR. F. B. ISELY
DR. E. P. CHEATUM *(Acting Chairman)*

## NECROLOGY COMMITTEE

Dr. B. C. Tharp, Chairman of the Committee, made appropriate remarks of eulogy and enumerated the high points of service to science and to the Academy for each member who had been removed by death during the Academy year. He then called upon Academy members to supply, for the record, certain information which had not been available to the Committee. Following the report, the audience was asked to stand in silent respect to the departed members.

F. L. Chase, President Lone Star Gas Company, Dallas, Texas, passed away April 1, 1941.

Wm. B. Connell, Chemical Engineer, Dallas, Texas, passed away July 13, 1942.

Miss Mary Jo Cowling, Teacher, North Texas State Teachers College, Denton, Texas, passed away October 24, 1942.

Edward L. Dodd, Professor, Department of Mathematics, University of Texas, passed away January 9, 1943.

Dr. G. W. Goldsmith, Professor of Botany, University of Texas, passed away October 29, 1943.

H. W. Harper, Professor of Chemistry and Dean Emeritus of the Graduate Faculty, University of Texas, passed away August 28, 1943.

J. G. Kearby, Major, U. S. Army, Wright Field, passed away in 1943.

W. J. G. Land, Emeritus Professor of Botany, University of Chicago passed away August 1, 1942.

Isaac McKinney Lewis, Professor of Botany and Bacteriology, University of Texas, passed away March 12, 1943.

Fred Elmer Rightor, Engineer, Austin, Texas, passed away March 1, 1942.

Robert A. Thompson, Charter and Life Member, Ft. Worth, passed away May 30, 1941.

J. C. GODBEY
S. R. WARNER
B. C. THARP, *Chairman*

## REPORT OF THE NOMINATING COMMITTEE

*President,* W. R. WOOLRICH, The University of Texas.

*Executive Vice-President,* WALTER P. TAYLOR, A. & M. College of Texas.

*Vice-President Section I,* E. W. SCHUHMANN, University of Houston.

*Vice-President Section II,* G. B. WOLCOTT, Southwestern University.

*Vice-President Section III,* SPENCER STOKER, Texas State College for Women.

*Vice-President Section IV,* H. P. BYBEE, The University of Texas.

*Vice-President Section V,* J. G. BURR, Game, Fish & Oyster Commission, Austin.

*Secretary,* GEORGE E. POTTER, A. & M. College of Texas.

*Assistant Secretary,* MRS. CORNELIA M. SMITH, Baylor University.

*Editor,* L. W. BLAU, Houston.

*Board Member, three years,* E. P. CHEATUM, Southern Methodist University.

*Constitution and Judiciary Board,* J. C. GODBEY, Southwestern University.

*Committee,* S. W. BILSING, E. P. CHEATUM, W. T. GOOCH, F. B. ISELY, B. C. THARP, O. A. ULLRICH, H. P. BYBEE, *Chairman.*

## COLLEGIATE DIVISION

The Academy year was marked by uncertainties. Collegiate programs at regional meetings of the Academy were not attempted.

The grant made by the Westinghouse Electric and Manufacturing Company for the previous year was not renewed.

Loss of our young men to the Armed Forces reduced club work at most schools, took some of our officers, and introduced so many uncertainties that planning became almost impossible.

Five sessions were held during the Fall meeting of the Academy in Austin. An informal preliminary meeting permitted the introduction of delegates and sponsors and the formulation of plans for making the most of our visit to the capital city. A nominating committee was chosen at the first meeting in order that its members would have a maximum of time to learn and weigh the merits of possible candidates. The committee consisted of Jeanne Thompson, Incarnate Word College, Chairman; Jim Sikes, Abilene Christian College, and Nancy Salisbury, Mary Hardin-Baylor College.

The second meeting consisted of a conducted trip to the museum for collegiate members and their sponsors. This trip proved to be both a pleasure and a venture in education. Something paralleling it may be made a regular part of our annual program. Plans are already being made for visiting the beaches and the medical school laboratories in Galveston next year.

The third meeting was a joint breakfast at The Commons. The Collegiate Committee consisting of J. C. Godbey, Otto O. Watts, V. A. Greulach, and C. C. Doak used this occasion to get acquainted with the delegates and to discuss Collegiate Division problems.

The fourth meeting was primarily for the reading of papers. Our president having been called to service in the armed forces the Vice President, George Rouser of Southwestern University, was in the chair.

The following program was rendered:

1. Atom Smashers—Frances Elaine Wagner, Our Lady of the Lake College, San Antonio.
2. Accuracy of a Freshman Quantitative Experiment—Mary Earle Fowler, Mary Hardin-Baylor College, Belton.
3. Some Facts of the Life, History, and Distribution of *Phymototricum Omnivorum*—J. B. Paxson, A. & M. College, College Station.
4. Leon River Water: Changes in its Composition—Helen Walker, Mary Hardin-Baylor College, Belton.
5. A New Volcano: Mount Paracutin—Nancy Salisbury, Mary Hardin-Baylor College, Belton.
6. Aesthetic Chemists—Charles Perry Godbey, Southwestern University, Georgetown.
7. A Rapid Determination of Manganese, Chromium, and Molybdenum in Steel by Use of the Photelometer—Jeanne Thompson, Incarnate Word College, San Antonio.
8. Malaria and Quinine—Nancy Landers, Mary Hardin-Baylor College, Belton.

9. Penicillin—Louise Cargile, Mary Hardin-Baylor College, Belton.

A fifth meeting in the form of a business session followed the scientific program. Elections were held and officers elected for 1944 were:

*President,* JOAN BERNARD, Incarnate Word College.

*Vice-President,* HELEN WALKER, Mary Hardin-Baylor College.

*Secretary,* LOUISE CARGILE, Mary Hardin-Baylor College.

*Sponsor,* DR. C. C. DOAK, Texas A. & M. College.

It was decided to discontinue the contest feature of our program for the duration of the war emergency.

C. C. DOAK
Sponsor Col. Div.
Chairman Col. Div. Com.

## JUNIOR ACADEMY DIVISION

*General Chairman:* GRETA OPPE, Ball High School, Galveston.
*Secretary-Treasurer:* ADDISON LEE, Austin High School, Austin.
*Regional Directors:* Velma, Wilson, South Texas; Helen Dumont, Central Texas; Edna Miner, East Texas; Willie Floyd, West Texas.

The annual meeting, 1942, of the Junior Academy was held in College Station. For the report of the annual meeting see the 1942 Academy Proceedings. In lieu of regional meetings, due to present war conditions, spring plans were presented to the affiliated clubs resulting in an inter-club contest. Eight papers were submitted, as follows:

Home Weather Forecasting, Bob Albertson; The Flute, Lore Merten; Types of Inks, Janet Croom; Typhus Fever, Dorcas Sugars; Dehydrated Foods, George Johnston; Medical and Religious Beliefs of the Cherokees, Frances Nesmith; Collecting Butterflies of Houston and Vicinity, Walter Abbott; Common and Uncommon Butterflies of Houston, Graddy Tunnell.

Dr. Chauncey D. Leake of the University of Texas Medical School acted as judge and Bob Albertson's paper, "Home Weather Forecasting" was judged best. He represented Lamar Chapter, Houston. The annual Academy award of a gold pin was presented to the winner, the Chicago Apparatus Company award having been discontinued at the request of the company for the duration.

The other official awards of the Junior Academy of Science are still available, including the honorary Junior memberships in the A. A. A. S.

One new club was added, A. & M. Consolidated High School.

The Junior Academy held its annual 1943 meeting in the Student Union Building of the University of Texas, November 13. Six chapters were represented; namely, Abilene (3), Galveston (3), Austin (7), Houston (6), College Station (6), Commerce (2), Visitors (3).

Number in attendance, 30; number of papers, 11.

It seemed that the Junior Academy of Texas was again at the crossroads of its development, but through the loyalty of most of the sponsors several vital matters were discussed and settled by those attending the Junior Academy Committee meeting prior to the Junior session. Problems solved were:

(1) Personnel of Junior Academy Committee.

(2) Dropping of Contest Director.

(3) Publication of *Tex-Sciana,* the official bulletin of the Junior Academy, by chapters or regional areas.

(4) Cooperation with American Science Clubs of America.

(5) Free subscription to *Texas Game and Fish* to each affiliated chapter.

The present personnel of the Junior Academy Committee together with year of retirement are:

GRETA OPPE, Ball High School, Galveston, *Chairman.*
MRS. EDNA MINER, Lamar High School, Houston, *Sec'y.-Treas.* (1946)
MISS VELMA WILSON, Brownsville Junior College (1946)
MISS WILLIE MAE FLOYD, Abilene High School (1944)
MISS ADDA REID TEMPLETON, Longview, Texas (1944)
MR. ADDISON LEE, Austin High School (1945)
DR. GEORGE E. POTTER, *Secretary,* The Texas Academy of Science

Those attending the business session were:

Greta Oppe, Galveston, Chairman; Mrs. Edna Miner, Houston; Miss Willie Mae Floyd, Abilene; Mrs. Clara V. Matthews, College Station; Miss Helen Boysen, Austin; Miss Esther McClung, Austin; Mr. Addison Lee, Austin.

Recommended to receive the annual award of Honorary Junior Membership in the A.A.A.S. were:

Bob Albertson, Lamar Chapter, Houston.

Evelyn Peterson, Ball High School Chapter, Galveston.

The following papers were presented before the Junior Division:

1. Medical Developments of World War II. John Marshall, A. & M. Consolidated Science Club, College Station.
2. Typhus Fever. Dorcas Sugars, Ball High School, Galveston.
3. Experimenting with the Flying Wing. Jim Richardson, Lamar Chapter, Houston.
4. Maps As a Hobby. Evelyn Peterson, Ball High School, Galveston.
5. Collecting Moths and Butterflies in Houston and Vicinity. Walter Abbott, Lamar Chapter, Houston.
6. Home Weather Observations. Bob Albertson, Lamar Chapter, Houston.
7. Color Photography. Winford Dyer, Ornithology Club, Commerce.
8. Color Blindness as an Advantage in Color Photography. Charles Windell, Ornithology Club, Commerce.
9. The Development of Radio Tubes. William Evans, Star Gazers Club, Commerce.
10. The Steps in Building a Demonstration Spitfire. Joe Groves, Star Gazers Club, Commerce.
11. A Study of Inorganic Compounds—the Jigsaw Way. Conrad Bohn, Y T S Botanical Society, Austin.

The following recommendations were made in writing to the General Chairman of the Junior Division after a poll of the Junior Academy Committee:

1) Keep the standards of the individual chapters high and carry on inter-club correspondence and exchange.

2) Make *Tex-Sciana* the chief medium of exchange for ideas and information for students and teachers.

Much of the accumulated effort of the Junior Academy is being lost through the impetus that has been given to the Victory Corps idea and to the Student Science Clubs of America. Neither of these need conflict with the development of the Junior Academy of Texas. When this world catastrophe has subsided, Victory Corps will no longer exist; but it will be a tragedy indeed if at that time state academies of science should not find in their ranks the resources of a Junior Academy. Against that time every state Academy should be perfecting its Junior and Collegiate divisions by supplying some Science Aids Service. This can be done best by the Division of the University Extension or some college extension bureau as is being done by the Illinois Academy of Science.

GRETA OPPE, *General Chairman.*

# TRANSACTIONS

## Japan's Strategic Minerals

Presidential Address

FREDERICK A. BURT, Agricultural and Mechanical College of Texas, College Station

For two years the country has been filled with guesses as to how long Japan could hold out in a total war against the combined resources controlled by the United States and the British Empire. A large part of the divergence of opinion shown in these guesses is due to their being based on all sorts of views regarding the extent of Japan's resources and her human desires and abilities to utilize them.

The Japanese Empire at the moment consists of the Japanese archipelago, Chosen, occupied China, and Manchuria which together constitute an inner area of relatively short communication lines, large Japanese admixtures in the population, and considerable coal, copper, magnesite, zinc, graphite, and sulphur resources besides some smaller varying amounts of iron, oil, lead, and tungsten. To this empire is appended an outer empire consisting of the Philippines, Burma, Malaya, Thailand, Indo-China, and the Netherlands, British, and Portuguese East Indies, an area of longer communication lines, of a smaller intermixture of Japanese nationals, of large numbers of ethnologically and religiously divergent groups, and of great resources in rubber, fibre, rice, oil, iron, manganese, tin, zinc, lead, chromium, phosphorus, and steam coal and a smaller amount or potential development of coking coal, nickel, antimony and aluminum. Circling this empire on the east and south is a great ring of islands from the Kuriles, through the Ladrones, the Carolines, and Micronesia to the western end of the East Indies. This ring serves as a naval and military bulwark against the outer and inner empires and their communication lines.

Looking at the geologic foundation, the geographic compactness, the agricultural potential, and the strategic outer bulwarks of this empire, we cannot fail to perceive that it is a "Have," rather than a "Have-not," empire. Behind its ramparts we see a quantitatively abundant and qualitatively sufficient supply of food, abundance of coal, oil and water-power potential, and a sufficiency of most essential minerals, fibres and rubber. Some of these resources are not developed to their higher possibilities, but the intrinsic values are there. Of the absolute essentials only aluminum, nickel and mercury seem to be present in deficient amounts.

Strategic minerals have been defined as those that are essential to peace or war industry but cannot be produced at home in sufficient quantity to satisfy demand. In contrast, critical minerals are those essential to industry which are not produced in sufficient quantity to meet the demand of industry, but utilization of stock piles, development of reserves or low grade deposits, or utilization of satisfactory substitutes can tide over an emergency. Viewing the progress of Japanese expansion of the last few years it is seen to have been neither random, nor in a direction dictated by climatic, ethnologic, food source, or export-trade lines but rather in the direction of political control of essential minerals and rubber and the ringing of them about with a wall of air and naval outposts as strategically placed and impregnably developed as humanly possible.

Let us now consider briefly in turn the situation of the empire with regard to each of the mineral resources essential to the conduct of a modern peace and war industry.

Water power is truly a mineral resource and as such it is one in which the Japanese homeland is particularly fortunate. Its availability is a function of climate and topography. The average annual rainfall varies from approximately 100 inches on the southeastern coasts to 30 inches in the far north. The combination of rainfall and relief has produced a large potential of power along both sides of the central island of Honshu, the island in which are located the chief industrial cities of the country. Moreover the contour of the land makes easy the development of reservoirs along the streams capable of supplying hydro-electric power to Tokyo, Yokohama, Osaka and other industrial centers.

The latest official Japanese figures made public placed her next after the United States, Canada, and Italy in total developed hydro-electric horse power. This same release estimated the potential annual horse power as based on minimum stream flow for six months of the year as 14,090,000.

This is a resource of which the government has taken cognizance. According to Japanese law, power-sites are the property of the government rather than of the private land owner and development of the sites may be made by the government or by individuals under government license. Since the opening of the country to industrialization there has been a rapid development of this resource for industrial, transportational, and domestic use. This is strikingly noticeable in connection with the railroad plans for complete electrification and the great rural development as witnessed in the widespread use of lighting and power application to farm, pump, and dairy machinery.

There are three small oil fields in the archipelago, but from what we know of them they have a combined possible production of only about ten thousand barrels per day. The only answer to this small supply, of course, was conquest, and conquest for this resource meant the Netherlands East Indies. To meet the needs of the proposed conquest the Japanese government built huge supply tanks which they filled and required private oil companies to do the same and to maintain the stored supply in an undepleted condition. The last year of reliable statistics shows an import of 40,000,000 barrels and as home private consumption had been cut to the bone the fraction of this importation added to the stores each year must have been considerable. From 1932 until Pearl Harbor the empire is known to have worked feverishly to build refineries and large, fast tankers and to import and manufacture drilling machinery.

The success of the blitz type of warfare on the capture of unsabotaged fields and refineries is evidenced by the fact that Japanese troops struck at the Tarakan, Borneo, fuel oil area, the only fuel oils usable in the raw condition, before any reinforcements could be added to the small garrison, and they took the Palembang area in Sumatra with its refineries and high octane aviation gas by paratroops in an almost undamaged condition. From what we know of the Dutch and British efforts at sabotage there seems no doubt that the East Indies fields and refineries were long ago placed in full operating order, and one of the richest oil provinces of the world with its refineries and adequate fleets of fast tankers is now a functioning Japanese asset.

Coal as a power resource is separate from coal as a requisite for steel manufacture. We will first consider it from the angle of steam coal. Japan proper has a considerable amount of low grade bituminous coal and of good grade lignite, to which should be added a considerable amount of anthracite of the Cardiff type. The country was self-sufficient in steam coal in 1940 but coking coal is very rare. Within the inner empire occur large amounts of Manchurian coal, much of it of high grade bituminous type which was obtained at the close of the Russo-Japanese War. Of these Manchurian mines those of the Mukden district are the most important. The estimated reserves of Japan in 1940 were placed at 60,000,000 tons. These fields are, however, mostly folded, faulted, and intruded, which, from the practical standpoint, reduces the reserve value to a level below that of American coal of the same quality and quantity. In the outer empire is much valuable steam coal which is obtainable without having to utilize the coking coals. Coal-mining was the most important mining industry of French Indo-China. Prior to the Japanese invasion one and a half million tons of anthracite were produced there. This statement may sound more important than the facts, when examined, warrant. The mining industry in Indo-China has been repressed by the French law which prohibited non-French from staking claims, directed that the chairman and two-thirds of the board membership of mining companies should be French nationals, and required no development work on claims. These repressive French laws may now be working to our advantage as they retarded the exploration of reserves, the opening of workings, and the building of collieries, smelters, and metallurgical plants. Much good Tertiary lignite has been exploited in Bataan, Sumatra, and Borneo, some of the latter being metamorphosed to coking coal or anthracite. Much of the Permian and Triassic coal of Sumatra, Ceram, and Timor, is thin, however, and probably cannot prove important.

With regard to two essential nonmetallics the Japanese empire is independent. Indo-China can supply all of the empire's phosphorus needs and Japan proper is self-sufficient in sulphur, the mineral occurring abundantly as the result of oxidation of volcanic hydrogen sulphide. To this home supply the East Indies adds reserves of considerable bedded sulfateric incrustations in the volcanic areas. The largest magnesite deposit in the world is on the Ta-shijh River and rail line in Manchuria.

Coming now to metallic resources one thinks first of iron and the ferro-alloy metals. Of these, iron, manganese, chromium, nickel, and tungsten are essential to contemporary war industry and vanadium and molybdenum are highly desirable. Of these it would seem that there is sufficient iron, manganese, chromium, and tungsten within the controlled area to supply the war machine if the sources are thoroughly worked and Japanese technology can operate the supplies efficiently. There is probably a shortage of nickel and there is certainly a shortage, or from the practical standpoint an almost entire lack, of vanadium and molybdenum.

Japan proper has neither iron nor coking coal in sufficient amount nor of high enough quality to count in present day competition. The only good source of iron is a magnetite deposit in Iwate prefecture in Northern Japan, hence the moves of the country to obtain control of the Manchurian and Chinese resources. The iron ore was in fact the chief reason for the Manchurian episode. Much of this ore, however, is of low grade but when considered in connection with the Manchurian coal fields and the iron deposits acquired by the conquest of Northern China the total picture is an impressive one. The outer ring of the empire adds large iron possibilities, but much of the ore is refractory or presents difficult transportation, economic, and technical problems. In pre-Pearl Harbor days there were four producing areas in the Philippines and a splendid magnetite property was known on Marinduque Island between Luzon and Mindoro but it lies forty miles from tide water over an area in which it is difficult to construct or maintain a road. Large deposits of residual ores of the Cuban type are known to occur in the Central Celebes, Southeast Borneo and the islands of the Strait Laut. Large undeveloped contact deposits of low phosphorus content occur over wide areas in Sumatra, West and Southeast Borneo, and the Southern Celebes. The basic iron industry appears to have no problems except those of long transportation lines and the technical one of handling economically low grade or refractory ores and in some cases of substituting anthracite for coke.

Of the ferro-alloy metals manganese easily comes first. The old empire has two sources of commercial account, one in the north and one in the south. To the possibilities of these Japan added an enormous stock pile before embarking on her career of conquest. With the addition of her outer ring of empire the manganese problem was solved so far as the mere possession of quantity is concerned. There are large potential deposits formed by residual concentration in the Philippines and a known undeveloped reserve of 25,000,000 tons in the northern part of Indo-China. This latter is accessible to rail and can easily be developed. There is a large 75-foot complex of 10% manganese in the Triassic of Portuguese Timor and ore beds containing one- and two-foot seams of nearly pure pyrolusite in the Miocene limestones of Java. In addition to these some of the Celebes iron ores run up to 24% $Mn_3O_4$ concentrates.

The Philippines are a major source of chromium. Production began there in 1933 and became important in 1939. In 1941 about 400,000 tons were exported of which amount Japan took about half, all of which was below the customary metallurgical level. This clearly demonstrates the fact that Japan had developed the technique, under its low living scale, of utilizing below-level ore. Much of the known Philippine ore is of this low-level type, and some of the higher grade deposits are located in country in which it is difficult to operate. The most serious drawbacks to the Philippine ore are its friability and its highly refractory character. Chromium also occurs in the basic iron ores of the Celebes and in considerable amounts in Indo-China.

As to supplies of nickel Japan is undoubtedly deficient. Prior to her entry into the war, the government made a great effort to build up a stock pile but her failure to reach New Caledonia has probably been a severe loss. The one known source of supply is as a by-product at the Bawdwin mines northeast of Mandalay in Burma. Ores of the metal, undeveloped when last known, are associated with the lateritic iron ores of the Netherlands Indies.

The Japanese aggression has succeeded in either capturing or cutting off from the allied nations a considerable part of the world's tungsten supply. The Burma veins and placers were yielding, before the war, about four to six thousand tons annually from areas in which the reserves were estimated to be about 700,000 tons. Production has gone on for many years from placer deposits in Indo-China and there has long been a source of supply as a by-product from tin mining in Thailand and Malaya. In pre-Pearl Harbor days Chosen was mining from 5 to 10% of the world's supply and some of the Chinese deposits have been captured.

The empire has no known adequate molybdenum or vanadium stock pile or ore reserves but the abundance of tungsten resources should offset the lack of molybdenum to a considerable extent.

Of the non-ferrous metals we need here consider briefly only copper, aluminum, lead, zinc, tin, antimony, and mercury. Of these there is hope of Japanese starvation only as far as antimony and mercury are concerned.

Copper mining is an ancient industry in Japan and bronze working was highly developed at the earliest periods of which we have record. In 1940 Japan was producing about 20% of her copper requirements from 110 small mines located largely in the quartz schists of the island of Hondo. The deposits are large and the veins wide and fairly accessible but the ore is of low grade. American engineers familiar with the situation believe that 100,000 tons per year of ore is near the upper limit of possible production. A large stock pile was obtained previous to the break with the British Empire and America, and undoubtedly much copper loot was captured and salvaged in the forward surge of the armies, but these supplies cannot be expected to last long. A considerable amount is obtained annually as a by-product from the lead and zinc smelting of the Bawdwin district. Ores are known to occur in several places in the Netherlands East Indies but they have been little explored and the geologic extent and character is in doubt.

The Japanese islands possess no commercial aluminum ores but ore reduction plants were installed several years ago to handle approximately two-thirds of her requirements at that time. These plants operated on Malaya and Netherlands Indies ores. The latter ores are extensive in amount, of high grade and located conveniently to water transportation. As far back as 1930 major production was beginning, most of the ore being shipped to the Axis. Bauxite is known to occur in Indo-China but the possibilities for its extensive development do not appear promising.

Lead is mineable to a small extent in Japan, and prior to her entry into the World War she was producing approximately 10% of her requirements. This figure probably cannot be increased if what we know of her ores is correct. A considerable smelter capacity, however, was built to handle imported ores. The one possible source of ore production for these smelters within the empire is Northern Burma, and even here the source is mainly from one deposit, that controlled by the Bawdwin Mining Co. The Bawdwin estimated reserves are about 11,000,000 tons. The extent to which stock piles have been developed may be great but is not definitely known.

The principal source of zinc is also from the Bawdwin mines. The concentrate of 58% zinc here produced amounted to 60,000 tons in 1940. There is much zinc in some of the Paleozoic limestones of Indo-China and some production has taken place from the upper oxidized zone but so far as we know little exploration has been done on which to base any estimate of future possibilities.

Tin is a resource in which expanded Japan is wealthy, possessing about 70% of the world's known resources. Lines of granites running across the Malayan peninsula, Thailand and the Riouw Archipelago have tin deposits associated with them throughout their length. This belt continues northward into Burma and Yunan province, China. Indo-China also contains her share of the tin wealth of this part of the world. The ores are of both the lode and placer types and throughout much of the belt tungsten is carried by both types of ore. The world's chief supply in 1939 was from the Malayan mines and the majority of this was from the placers. Smelters are located at Banka, Billiton, Batavia, and Singapore with capacities in excess of the normal production and it is questionable if these were very thoroughly sabotaged prior to the retreat of the British and the Dutch.

Formerly antimony was produced in Japan in sufficient quantities to supply the domestic need but the richer ores are now exhausted leaving only lean workings. There is still a considerable production, nevertheless, on the island of Shipoka. The chief resources are in Indo-China and these were being worked extensively when the war broke out. Although these Indo-China sources are not rich or, so far as known, extensive, they are conveniently located and accessible to tide water. The extensive antimony and mercury deposits of China are not available to Japan and of the latter there are no mineral sources within her political control. Some mercury stock is known to have been built up by Mexican purchase prior to the break of diplomatic relations, but how great the stock-pile was is problematical.

We have reviewed very briefly the status of the Japanese empire of 1943 in respect to its political possession of mineral resources. In the terms of possession of man power, agricultural, and raw mineral wealth the picture is a pessimistic one. Optimism enters it when the possession of technical skills, inventive genius, and moral courage based on intelligent interpretations rather than fanatically directed energy are considered. This group of non-material assets is as important as the preceding group of material assets. The safest way to judge our enemy's potential possibilities is to view them in as nearly an unbiased and neutral manner as is humanly possible. From this viewpoint we believe the Japanese empire is now expanded to the point of as nearly material independence as any empire can expand without, as the British empire has done, spreading over wide expanses hard to defend and involving exterior and vulnerable transportation lines. In short, if I were responsible for Japanese policy I believe I should act on the principle that the boundaries had expanded to include nearly all that was needed and that could be readily assimilated, that a strategically located rampart had been built on the boundary, and that the future called for sitting tight, defending the ramparts, and developing the resources. The only defense against this Japanese position is to break the ramparts, cut the connecting transportation lines, and put the nationals back within their previous bounds before development can be effected.

If Japan breaks down from lack of material resources the break seems most likely to be from lack of such materials as diamonds, quartz of a quality suitable for oscillators, etc., that is materials in which ounces spell wealth, rather than for lack of the heavier and more common materials. Such materials are susceptible to smuggling in sufficient amount to meet essential needs. The weakness in their armor is not in their strategic position or their material resources but in non-material resources, those things that are found in the minds and the hearts and the higher manual skills of the world's democracies. It is here, where our wealth is so vastly greater and so much more complete than theirs, that the certainty of victory lies.

# SECTION I: PHYSICAL SCIENCES

## ABSTRACTS

**Optics of the Electron Microscope**—J. M. KUEHNE, Professor of Physics, The University of Texas, Austin. The purpose of a microscope of any kind is to enable an observer to distinguish between fine details of structure or marking of an object. The ability to show as distinct, i.e. to "resolve" two minute objects, lines, points, or markings is called the "resolving power" of the microscope and is by all odds its most important characteristic. Mere magnification is of no value whatever, unless it is accompanied by fineness of structure of the image. While magnification of image is unlimited and may be made as great as desired, it loses all value, in fact becomes worse than useless, if carried beyond the point that is necessary to separate the finest details in the image sufficiently to render them distinguishable to the eye. Practically, for an image to be seen at a comfortable distance of about 12 inches, the finest detail markings need to be separated about 1/100 inch. Greater magnification will merely spread out and consequently lessen the brightness of the image without adding to the detail.

Owing to the fact that visible light consists of waves of definite dimensions, there exists a very definite limitation to the resolving power of an optical microscope. This "limit of resolution" is found to be about one-half the wave length of the light used, which means that small objects, or markings on an object, that are nearer together than half a wave length of light (roughly about .00001 inch) can not be shown as distinct, since the images partly overlap owing to the diffraction of the light waves. A magnification of 1000 times would separate the images of such marks by .01 inch, which would render them distinguishable by the eye. Any greater magnification would be simply useless.

The electron microscope makes use of beams of high velocity electrons instead of light beams. These electron beams can be deviated, converged, focussed, by concentrated electric or magnetic fields, whose action is very similar to the action of glass lenses on light beams. The principle of combining two such electrostatic or magnetic "lenses" into a compound microscope is exactly the same as that used in the construction of optical compound microscopes.

The great advantage of high velocity electrons over light waves lies in the much smaller "wave length equivalent" of the former. Since it is the diffraction of light waves that limits the resolving power of a microscope, and since diffraction is inversely proportional to wave length, the small "wave length equivalent" of electron beams is an enormous advantage in the realization of higher resolving power, thereby making larger magnifications useful and feasible. Magnifications hundreds of times those practical for ordinary light waves can be utilized.

Although the electron shadows forming the image cannot be directly seen, they can be rendered visible by projecting them on a fluorescent screen. Better still, they can be very effectively recorded on fine grain photographic films, which can then be further enlarged to produce "electron-optical" magnifications hundreds of times greater than would be practical or useful with ordinary light.

(Lantern slides illustrating the construction of electron microscopes, electrostatic and magnetic "lenses," and specimens of electron-optical photograms of objects far beyond the reach of the optical compound microscope were shown.)

**The Anti-Aircraft Artillery Gunnery Problem**—J. C. STEPHENS, Lt. Col., U.S.A. (Retired). The outbreak of war in 1914 found military aircraft being used extensively for the first time. The French had one or two pilot model anti-aircraft guns and a few officers who had worked with them a little. The British anti-aircraft artillery was in the blue print stage, and the German was about on a par with the French. In the early part of the war, a trench was dug around an ordinary field gun to lower its tail so as to give the gun elevation enough to shoot in the air. Firing was by guess. The wonder is that any planes were shot down and not that the ratio was several thousand rounds to one plane downed.

By the end of the war, there had been considerable development in guns, mounts, and fire control equipment. At any instant, a plane in the air has a certain altitude, slant range, horizontal range, and angular height from the gun position. The altitude is taken as the basic element to calculate firing data, and special instruments are set up to measure altitude. At first there were two instruments, one at each end of a measured base line. This required laying and maintaining a field telephone line between the stations. Frequently a cloud bank would obscure the target from the flank station, and there was the added difficulty of locating both stations on the assigned plane with many planes present. To overcome these disadvantages, a one-station height finder based on stereoscopic vision has been developed and adopted. The single station method of altitude measurement is not so accurate, and the observers have to be specially selected and trained.

The first anti-aircraft guns were equipped with sights and were directed at the target by a gun pointer. By getting on the target and following it, the gun pointer introduced into the sighting mechanism the momentary angular height and direction of the target. In order to hit the target, the gun was supplied the leads in the vertical and lateral planes and also a fuze setting to cause the projectile to burst at the proper point on its trajectory. These three elements of firing data are called lateral deflection, vertical deflection, and fuze range and are determined by an instrumnt called a director.

Directors contain two sights—one man tracking the target laterally and the other vertically. There are two methods of determining firing data. One is based on the angular travel and the other on the linear speed of the target. Each assumes that the target continues in a straight line at a constant speed and constant altitude during the time of flight of the projectile. The altitude is supplied the director, and the angular height of the target is introduced by getting on the target, and the rate of traverse of the director laterally and vertically is a measure of the speed of the target.

The director requires several men to operate it by matching pointers, setting the reading under one pointer under another, etc., and it calculates the fuze range and leads in the lateral and vertical planes.

All modern directors transmit these three elements of firing data to the gun electrically, and the guns are given the proper direction and elevation by matching pointers at the gun. This speeds up the rate of fire and reduces the time lost in the transmission and application of data to the gun to a minimum.

Some directors have been constructed to include the various ballistic corrections, but the additional parts make them heavier and less mobile. The present trend is toward greater mobility and a dependence on trial shot corrections for most of the ballistic corrections except the wind, which is included in the modern directors.

The modern directors have an additional telescope for the officer adjusting the fire of the battery. He observes the bursts, noting whether they are to the right or left and above or below the target from his position. He has a direct telephone line to a station on the flank and is getting the spots as they appear on the flank station. The rights and lefts for the flank correspond to overs and shorts along the gun target line. The officer receives these in his headset as the observer calls them—four guns are firing 25 to 30 shots per gun per minute—makes a quick decision and sets in his arbitrary corrections.

In defending a precision target against high altitude bombing, the antiaircraft artilleryman knows the types of planes expected and at what speed and altitude they are likely to attack. This enables him to draw a bomb release line on his map about his target. He also knows that the bombers must fly a straight, even course for from 40 to 60 seconds before releasing the bombs. This gives the artilleryman a critical zone in which to attack the bombers most favorably.

Low-flying planes and dive bombers are very poor targets for guns and must be attacked by automatic weapons. The dive bomber is in an ideal position for attack by automatic weapons stationed at the defended position.

**Modern Aerial Navigation**—WM. J. CARTER, The University of Texas, Austin. American air power planning has long been dedicated to the employment of long range heavy bombardment aircraft. From the inception of this idea by General Billy Mitchell until the present, the goal has always been an air force capable of striking precision blows against strongly defended targets at long range. Toward the end of the 1930's the first of these weapons in the true sense of the term was developed. Along with the procurement of the first B-17 heavy bombers went the training of the specialist crews to man them. Specialist crews they were in the strictest sense of the term, veteran Army pilots of 5000 and more hours flying experience, experienced navigators and bombardiers. These crews, our "first team" of defense, formed the nucleus around which our World War II air forces were developed.

The first problem to be solved in order to expedite the training of combat navigators on a large scale was the determination of the techniques and methods of navigation which would be the most applicable to the peculiar and diverse problems of navigation arising in our wartime flying. Most of these answers were furnished by those of our navigators who fought in the campaigns of the early months of 1942. The navigators of such famous squadrons as the 19th Bombardment Group were able to formulate from their own experience the techniques which had proved most useful in enabling the precision navigation of aircraft under combat conditions. They had learned, for example, that much more dependence must be placed on navigation by celestial methods than had been the case in peacetime training. Many of the radio aids of commercial flying were ruled out for combat use due to the necessity of maintaining radio silence. It was also discovered that the fatigue incident to long range high altitude flight demanded that the techniques employed be as short and as straightforward as possible. The chances of obtaining the correct answer to a relatively simple problem in arithmetic or trigonometry are much less if the solution be made at 20,000 feet in a speeding bomber, than if the solution be made at leisure in the comfort of one's quarters. This axiom dictated that the computations required for all forms of navigation be made in a simple manner and with mechanical aids wherever possible.

The second problem was one of organizing training centers and arranging for the subject matter to be taught in such a manner as to make it possible to train thousands of competent combat navigators in a brief period of time.

**Optical Properties of Liquid Sodium Amalgams as an Index of Intermetallic Compound Formation**—A. P. FRIESEN, Southwestern University, Georgetown. Intimate mixtures of mercury and sodium are called sodium amalgams. When mixed in certain proportions, these mixtures form compounds with specific properties. This investigation shows that plane polarized light reflected from liquid sodium amalgams definitely indicates a change in such properties as refraction, reflection, and absorption at concentrations where compounds are known to exist. Similar changes are also indicated at concentrations where compounds have not been reported, but where they might reasonably exist.

**Some Problems of Oxygen Removal in Polarographic Analysis**—MISS LILLIAN BUTLER. Dissolved oxygen interferes with polarographic analysis and must be removed. Reduction by sodium sulfite has been suggested but has been found to be ineffective in a number of instances. This is believed to be due to the fact that the reduction of oxygen by sodium sulfite is a chain reaction and that a number of substances act as chain breakers or inhibitors. Materials which act as maximum suppressors in polarographic analysis are inhibitors and interfere seriously with oxygen removal by sodium sulfite. The anions of a number of the commonly used buffers interfere in the same way.

**The Near Ultraviolet Absorption Spectrum of Substituted Benzenes**—F. A. MATSEN and N. GINSBURG. Every substance has a unique color absorption. This study attempts to correlate the color absorption of various compounds with the molecular structure of those compounds.

Benzene and its various derivatives are especially interesting because a prominent feature of their absorption spectra is the occurrence of a transition or color absorption which is "forbidden" on the basis of mathematical analysis. This "forbidden transition" becomes allowed when the molecule vibrates unsymmetrically, or when there is a migration of electrons from one part of the molecule to another.

The absorption measurements are being made on the vapors of the various substances at a range in temperature from —50° to 300° C. A grating spectrograph is being used rather than a prism instrument because the wave length of the light absorbed can be measured more accurately.

**Wave Guides**—E. W. HAMLIN. With the development of the magnetron and klystron, the field of centimeter electromagnetic waves is supplied with powerful sources. Hollow metallic tubes of reasonably small dimensions may be used to transmit these waves, and the properties of such wave guides become important. The properties of practical interest have to do with the guide as a transmission line, as a resonator, and as a radiator. This paper discusses briefly the launching of various wave types, the cut-off property of guides, attenuation, dielectric guides, and radiation from guides and horns. Demonstration of these phenomena will be included.

**Iodination of the Acetate, Benzoate and Benzenesulfonate of 4-Hydroxybiphenyl**—HAROLD R. SCHMIDT, CORA MAY SAVOY AND JOHN LEO ABERNETHY. Iodination of the esters of 4-hydroxybiphenyl presents an interesting problem from the standpoint of orientation in the biphenyl nucleus and at the same time offers a convenient route to the 4'-iodo-4-hydroxybiphenyls, which are of interest as bactericides.

Chlorination of 4-hydroxybiphenyl first introduces chlorine in the 3-position. The next chlorine enters the 5-position and, finally, the third chlorine enters the 4'-position. Bromination takes place in an analogous manner. When iodination is undertaken it is found that substitution takes place readily in the 3- and 5-positions but with difficulty in the 4'-position. None of the triiodo compound has been isolated.

When the benzoate and benezenesulfonate of 4-hydroxybiphenyl are subjected to bromination in the presence of iron catalyst, the halogen enters the 4'-position. Steric hindrance has been used to explain this position of substitution. On the other hand, bromination of the acetate of 4-hydroxybiphenyl introduces bromine in the 3-position of the biphenyl nucleus, presumably due to less steric hindrance afforded by the acetyloxy group. Proof of the structure of these substances is given by hydrolysis procedures. The 4-bromo-4-hydroxybiphenyl may be prepared from 4'-bromo-4-nitrobiphenyl.

Chlorination of these same three esters introduces chlorine in the 4'-position of the biphenyl nucleus in each instance. This is surprising in the case of the acetate, if steric hindrance is the predominant factor, as chlorine is smaller than bromine and presumably should enter the biphenyl nucleus more rapidly in a position ortho to the ester linkage. Hydrolyses of these esters give rise to 4'-chloro-4-hydroxybiphenyl. Proof of the position of entry of the halogen was accomplished by synthesis of this substance from benzidine. Esterification produces the same substituted esters formed by chlorination of the esters of 4-hydroxybiphenyl.

It seemed reasonable that iodination of these same esters would offer a convenient means for preparing 4'-iodo-4-hydroxybiphenyl. This is found to be the case. Iodine monochloride is used as the iodinating agent and both glacial acetic acid and carbon tetrachloride may be used as the solvent. Hydroylsis of these iodinated esters gives rise to 4'-iodo-4-hydroxybiphenyl, which may be proved by synthesis from benzidine.

The high dipole moment of iodine monochloride indicates that it is nearly ionized even in solvents of very low dielectric constant. This makes it of value as an iodinating agent in an electrophyllic attack on positions of high electron density in the benezene nucleus. Since there is a considerable amount of double bond character between the benzene rings of the biphenyl nucleus, the esters of 4-hydroxybiphenyl have high electron densities in the 4'-position of the biphenyl nucleus. This, coupled with the high dipole moment of iodine monochloride, enables iodine to be substituted readily in the 4'-position.

PAPERS

## Spectrophotometric Determination of Iron with Sulfosalicylic Acid

MARTHA KENNARD and C. R. JOHNSON, The University of Texas, Austin

The complex of sulfosalicylic acid with iron has been recommended for various colorimetric analyses (2, 9, 10, 11, 12, 16) and has been studied by gradation photometry (1, 14, 15). Investigation of the transmittance-pH curves of the ferric complex in this laboratory with a monochromator spectrophotometer showed flat regions with central pH values of approximately 1.5, 5.0, and 8.2 at concentrations between 0.1 and 2 milligrams of iron per 100 ml. As the pH increases, the color changes from violet through orange-brown to yellow. Within the concentration range studied, the transmittance minima at the pH values given above fall at 500, 460, and 420 millimicrons, respectively. Transmittance-concentration cross-sections taken through these points show that Beer's law is followed in all three cases, in the presence of common anions, with the limitations indicated below. Each of the three transmittance-concentration graphs may thus be used as the basis for a rapid spectrophotometric determination of iron, providing best sensitivity with the yellow solutions, widest range with the violet ones, and a means for detecting and avoiding interferences by measurements made at more than one pH.

The ferrous complex was also studied. At pH 1.5, with excess sulfur dioxide present, all iron-sulfosalicylic acid solutions in the concentration range mentioned above became nearly colorless on overnight standing, although the violet color often remained for some time after the reagents were mixed. At pH 8.2, excess sulfur dioxide had no effect on the transmittance of the yellow solutions. These facts may help to explain certain observations of Alten, Weiland, and Hille (1), criticized by Thiel and Peter (15), and are in agreement with the conclusion of the latter investigators that the sulfosalicylic acid method may be used for determining ferric and ferrous iron present in the same system.

It is a good policy to check any spectrophotometric or colorimetric iron determination by at least two independent measurements with different chromogenic reagents. Used in analyses of foods and biological materials, where the main interfering substance is often phosphate, the sulfosalicylic acid method compares fairly well in accuracy with the 2,2'-bipyridine, ferron, and mercaptoacetic acid methods for iron and sometimes gives correct results when one or another of these fails. The reagent is easily purified by crystallization and is less expensive than any of the other three above.

### Apparatus and Reagents

A Coleman model 10-S-30 spectrophotometer with matched square cuvettes 1.308 cm. in depth was used for the transmittance measurements, which were made between 28° C. and 32° C., with water as the reference liquid.

Fifteen normal nitric acid, 6 N hydrochloric acid, 9 N perchloric acid, 36 N sulfuric acid, 16 N acetic acid, 0.6 N trichloroacetic acid, 4 N ammonium hydroxide, and 1 percent sulfur dioxide were purified by distillation methods. Other reagents were made iron-free by electrolysis or by crystallization with centrifuging (4). Primary standard salts were appropriately dried, usually in vacuum.

The chromogenic agent was a 5 percent aqueous solution of iron-free sulfosalicylic acid. Three primary standard solutions containing 0.2000 mg. of iron per ml. were used in making the more dilute standard and test solutions (5). The primary standard phosphate solution contained 10 mg. of phosphorus per ml. as potassium dihydrogen phosphate. Stock buffers were made by mixing reagents in the proportions indicated below and were adjusted if necessary by further small additions of the reagents so that 5 ml. of stock buffer made to 100 ml. gave the exact pH required, as shown by a calibrated pH meter. The pH 1.5 buffer contained 60.8 g. (55 ml.) of 20.25 percent (constant boiling) hydrochloric acid and 37.3 g. of potassium chloride in 500 ml. One pH 5.0 buffer contained 10.2 g. of potassium acid phthalate and 2.4 ml. of 10 N sodium hydroxide per 500 ml. Another pH 5.0 buffer contained 14.2 ml. of 16 N acetic acid and 70 g. of sodium acetate trihydrate in 500 ml. The pH 8.2 buffer contained 31.4 ml. of 16 N acetic acid and 126 ml. of 4 N ammonium hydroxide per 500 ml. It was found that borate and phosphate buffers could not be used.

## Summary of Calibration Tests

Calibrations were made by the method described below for analyses, except that the test solutions contained known quantities of iron, buffer solution, phosphate, and various common anions. The anions were added as acids, which were then neutralized with ammonium hydroxide. Transmittances were measured 30 minutes after mixing and again after overnight standing. Different combinations of primary standards and reagents were used to eliminate constant errors.

The median transmittances obtained in about 2400 observations made with 300 test solutions are recorded in Tables I, II, and III. These medians are based on the overnight readings. However, readings taken at any time between 20 minutes and 24 hours after color development seldom varied by more than 2 percent, except in the presence of phosphate, which sometimes delayed the formation of maximum color. It is convenient to plot the data on three sheets of Coleman C-202 transmittance-concentration semi-log graph paper for analytical use.

TABLE I

Calibration Data for Iron by Sulfosalicylic Acid at pH 1.5 ± 0.05
(Violet solutions at 500 millimicrons)

| Iron per 100 ml. *mg.* | Phosphorus per 100 ml. *mg.* | Median Transmittances *percent* |
|---|---|---|
| 0.200 | 0 | 81.1 |
| | 25 | 84.0 |
| | 50 | 86.0 |
| 0.800 | 0 | 44.1 |
| | 25 | 50.0 |
| | 50 | 56.6 |
| 1.400 | 0 | 24.1 |
| | 25 | 30.0 |
| | 50 | 38.0 |
| 2.00 | 0 | 13.0 |
| | 25 | 18.1 |
| | 50 | 26.0 |
| 2.40 | 0 | ... |
| | 25 | 13.1 |
| | 50 | 21.2 |

TABLE II

Calibration Data for Iron by Sulfosalicylic Acid at pH 5.0 ± 0.05
(Orange-brown solutions at 460 millimicrons)

| Iron per 100 ml. *mg.* | Phosphorus per 100 ml. *mg.* | Median Transmittances *percent* |
|---|---|---|
| 0.1000 | 0 | 79.5 |
| | 5 | 80.9 |
| 0.300 | 0 | 50.5 |
| | 5 | 52.6 |
| 0.500 | 0 | 32.2 |
| | 5 | 34.0 |
| 0.700 | 0 | 20.5 |
| | 5 | 22.3 |
| 0.900 | 0 | 13.0 |
| | 5 | 14.7 |

TABLE III
Calibration Data for Iron by Sulfosalicylic Acid at pH 8.2 ± 0.3
(Yellow solutions at 420 millimicrons)

| Iron per 100 ml. | Phosphorus per 100 ml. | Median Transmittances* |
|---|---|---|
| *mg.* | *mg.* | *percent* |
| 0.1000 | 0 | 73.3 |
| | 50 | 73.3 |
| | 75 | 73.4 |
| 0.300 | 0 | 40.4 |
| | 50 | 41.6 |
| | 75 | 42.2 |
| 0.500 | 0 | 22.1 |
| | 50 | 24.3 |
| | 75 | 26.0 |
| 0.700 | 0 | 12.1 |
| | 50 | 15.0 |
| | 75 | 18.0 |
| 0.900 | 0 | ... |
| | 50 | 10.5 |
| | 75 | 13.3 |

*These medians apply both to solutions containing no sulfur dioxide and to those containing excess sulfur dioxide.

Effect of Various Anions

*Phosphate Absent.* At all pH values, over the transmittance range from 20 to 80 percent, the test solutions containing (before neutralization with ammonium hydroxide) 3 ml. of 15 N nitric acid, 7.5 ml. of 6 N hydrochloric acid, 5 ml. of 9 N perchloric acid, 40 ml. of 0.6 N trichloroacetic acid, or a 2.3 ml. 15 N nitric-9 N perchloric acid mixture, in a volume of 100 ml., gave transmittances agreeing on the average to better than 0.5 percent with the medians in Tables I, II, and III. At transmittances from 10 to 20 the average deviation increased to about 2 percent. Transmittances for solutions containing 1.25 ml. of 36 N sulfuric acid per 100 ml. were within 0.5 percent of the medians at pH 8.2 and 5.0 but were extremely high at pH 1.5. Sulfate should never be added when the sulfosalicylic acid method for iron is used in acid solution. Transmittance readings on systems made up without extra acids agreed with the medians within 0.5 percent at pH 5.0, but in the other solutions only at low iron concentrations, and for high iron concentrations were about 10 to 20 percent high at pH 8.2 and 1.5, respectively.

*Phosphate Present.* At all three pH values, over the transmittance range from 20 to 80, and at the phosphate concentrations indicated in the tables, the 100 ml. test solutions prepared with the above amounts of nitric or hydrochloric acids, or sulfuric acid (except at pH 1.5) gave transmittance values within 1 percent of the tabulated medians. Deviations increased to 4 percent in some cases at the highest iron and phosphate concentrations listed. Deviations from the medians in solutions made with 5 ml. of 9 N perchloric acid were also less than 1 percent except at pH 8.2 in solutions containing 75 mg. of phosphorus, where they increased to about 20 percent at high iron concentrations. A similar statement probably applies to the nitric-perchloric mixtures, although full data were not obtained for these. Trichloroacetic acid solutions containing phosphate were studied only at pH 8.2 and were found to give transmittances much higher than the medians. All solutions at pH 5.0 containing more than 5 mg. of phosphorus per 100 ml. became turbid, and those containing more than 0.5 mg. of iron gave precipitates on standing.

Spectrophotometric Procedure for Total Iron

The following procedure is based on the experiments summarized above: Add to a 100 ml. beaker a suitable-sized aliquot containing the iron in ferric form, with pyro- and metaphosphates hydrolyzed to orthophosphate (13, 18) and known interfering ions absent (2, 3, 10, 15). The solution should contain, in order of preference, 2 ml. of 15 N nitric acid, 4 ml. of 6 N hydrochloric acid, or in general about half the allowable quantities of the other acids of more limited utility mentioned above. Add 5 ml. of 5 percent sulfosalicylic acid (15 ml., if the pH is to be 1.5) and 5 ml. of the appropriate stock buffer. Slip the beaker over the electrodes of a Beckman pH meter and arrange a glass propeller attached to a motor to stir the solution. Adjust the pH to the desired value, lower the beaker, and rinse the electrodes. Transfer the solution and rinsings to a 100 ml. volumetric flask and make up to volume. If necessary, filter through a crucible rinsed with a portion of the solution, preferably after standing, if much phosphate is present. Make duplicate transmittance readings on two portions of the clear solution at the appropriate wave length, with water as a reference liquid; or use a blank for reference if the reagents are not all iron-free.

Meanwhile analyze a portion of the solution for phosphate (8), and finally read the result of the iron analysis from the appropriate graph, interpolating for intermediate phosphate concentrations.

Comparison with Other Methods

The foregoing method for determining iron with sulfosalicylic acid has been applied in analyses of diets, feces, and urine in balance studies with rats, and the opportunity was taken during this work to compare the method with other spectrophotometric methods for iron. Typical results of measurements made by six different procedures are summarized in Table IV, in which the list of materials analyzed was selected to cover a range of iron and phosphate concentrations for diets including milk, meat and liver concentrates, several common vegetables in dehydrated form, and also such interfering substances as copper, pyrophosphate, and hemin. The feces and urine samples were seven-day collections.

The "extracts" were made with 0.6 N trichloroacetic acid, and were treated by Jackson's method (3) to eliminate this acid, with subsequent solution of the precipitated iron sulfide and phosphate in hot nitric or hydrochloric acid. The residues from the extractions, urine, and diet samples were ashed either with nitric-perchloric acid mixtures or by ignition in electric furnaces in tall 200 ml. fused silica beakers. After evaporation or ignition, the soluble residual materials were taken up with 4 ml. of hot 6 N hydrochloric acid and water containing enough hydrogen peroxide or nitric acid to oxidize the iron. The solutions were then filtered and made to 100 ml.; the phosphate concentrations given are for this volume, not for the 100 ml. test solutions. Five-ml. to 20-ml. aliquots were taken for analysis. The methods used with 2,2'-bipyridine and mercaptoacetic acid are described in references 5 and 6, no correction for phosphate being applied, on the

TABLE IV

Comparison of Spectrophotometric Iron Analyses

| Diet No. | Material Analyzed | Phosphorus per 100 ml. | Milligrams iron in original 100 ml. as found by | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | 2,2'-bipyridine | Mercapto-acetic acid | Ferron | Sulfosalicylic acid | | |
| | | *mg.* | pH 3.6 | pH 9.5 | pH 2.6 | pH 1.5 | pH 5.0 | pH 8.2 |
| 8 | Feces residue | 202 | 26.6 | 26.3 | 25.9 | 27.7 | .... | 24.8 |
| 8 | Same, dil. 10x | 20 | 26.6 | 27.0 | 26.0 | 26.5 | 25.8 | 22.1 |
| 4 | Feces residue | 500 | 19.8 | 18.3 | 17.5 | 20.6 | 6.8 | 11.5 |
| 12 | Feces extract | 0 | 8.52 | 8.0 | 8.5 | 8.2 | .... | 8.6 |
| 12 | Feces residue | 32 | 3.32 | 3.36 | 3.54 | 3.04 | 3.36 | 3.30 |
| 11 | Feces residue | 98 | 2.95 | 3.08 | 2.87 | 3.4 | 3.0 | 2.98 |
| 15 | Feces extract | 40 | 1.78 | 1.78 | 1.85 | 1.90 | 1.65 | 1.77 |
| 18 | Feces extract | 50 | 1.48 | 1.47 | 1.50 | 1.53 | 1.56 | 1.50 |
| 16 | 10 g. sample | 91 | 1.50 | 1.64 | 1.49 | 1.50 | .... | 1.40 |
| 15 | Feces residue | 26 | 0.92 | 1.03 | 1.17 | 1.08 | 1.17 | 1.13 |
| 6 | Extract of 10 g. | 0.4 | 0.73 | 0.69 | 0.78 | .... | 0.70 | 0.71 |
| 17 | Feces residue | 19 | 0.31 | 0.34 | 0.34 | 0.36 | .... | 0.37 |
| 22 | Urine | 45 | 0.176 | 0.15 | 0.177 | 0.176 | .... | 0.20 |
| 20 | Urine | 57 | 0.12 | 0.13 | 0.14 | .... | .... | 0.15 |

usual assumption that the iron complexes formed with these reagents are so stable that a correction is unnecessary. The procedure used with ferron was similar to that described in reference 7, phosphate corrections being applied graphically as described above.

The tendency of the bipyridine and mercaptoacetic acid methods to yield slightly low results is probably due to neglect of the phosphate correction, but the differences are hardly significant enough to warrant making it. In some cases the yellow sulfosalicylic acid-iron complex formed at pH 8.2 adsorbs strongly on any precipitate (such as calcium phosphate) which may form as the solution is made alkaline. This adsorption was very marked in the analysis of the feces residue from diet 4 and, together with the high phosphate concentration, accounts for the gross error at pH 8.2. The adsorption was noticeable in other analyses at pH 8.2, and a similar though less marked effect was often observed in the mercaptoacetic acid solutions at pH 9.5. The error due to the adsorption can be eliminated by re-precipitation techniques, pre-removal of the precipitating substance, or by using a method in which the test solution is acid. The low result obtained for the residue from diet 4 at pH 5.0 is due to a phosphate concentration so high that the error could not be avoided by using a small aliquot. With the above exceptions, the results of the analyses show good agreement among the various methods, considering that the limited size of most of the samples did not permit choice of optimum conditions for all of the methods.

Summary

A spectrophotometric method for the determination of iron with sulfosalicylic acid has been worked out empirically and compared with other methods for determining small amounts of iron. The method takes into account the effects of variations in the extra salt content, the pH, the color, and the phosphate concentration of the test solutions.

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# Applications of Modern Science to Airplane Design

M. J. THOMPSON, Professor and Chairman, Department of Aeronautical Engineering, The University of Texas, Austin.

It is an interesting paradox that in the early development of aeronautics there is found on the one hand a history of a rather unscientific and highly empirical approach to the problems of airplane design and flight, while on the other hand the early literature in this field is replete with many noteworthy contributions by outstanding scientists of the late 19th and 20th centuries. In the first of these divisions is found the barnstorming pilot and the pioneering designer who, because of lack of better methods, based their developments largely on a "rule of thumb" procedure. Although some of these individuals have been romanticized and over-glamorized by application of the Hollywood treatment, much credit is due them for their courage and skill in testing and improving early designs when there was often no sound basis for predicting the success or safe operation of these machines.

The purpose of the present paper is to consider briefly the second aspect of aeronautical history just mentioned, that is, contributions obtained from the whole field of modern science. It is impossible, of course, in a short time to present a complete survey of all such contributions but a few outstanding ones may be mentioned and some detailed discussion given to one or two of the more important problems which are not yet completely solved. The discussion will be primarily concerned with the airplane, although many of the points touched upon are equally applicable to such newer and more experimental developments as the helicopter.

The modern airplane can be subdivided into five major components, as follows:

1. The wing, which develops, by motion through the air, the lifting force that balances the weight of the airplane.
2. The engine, which, with the propeller, develops the thrust necessary to overcome the air resistance and maintain the airplane in forward motion.
3. The fuselage, a body which encloses the pilot's compartment, space for the passengers, crew and cargo, and in many cases provides at its rear a mounting for the tail unit.
4. The tail, a unit necessary to provide for balancing, stabilizing and controlling the pitching and yawing motions of the airplane in flight.
5. The undercarriage, or landing gear, required for the take-off and landing of the airplane. In the case of a seaplane or flying boat, this may consist of pontoons or a boat hull integral with the fuselage.

The United States Navy bases its aircraft identification system on these five major elements, calling the system "WEFTUP," a combination of the initial letters of the names of the five components. The added "P" stands for "peculiarities" and is used in identification to indicate any distinguishing features not covered in the other five items.

Each of the five major elements of an airplane fulfills its primary purpose as just described, but in the case of the wing, fuselage and tail in particular, requirements of strength may have considerable bearing on the type of structure employed. The wing, for example, must support lift loads of an average intensity of forty or fifty pounds per square foot in the case of high performance military aircraft, and it is obvious then that considerable care must be given to the internal structure which makes this possible. The wing is not just a sheet metal covering like an automobile fender which may be stamped out on a high production press at an enormous rate.

In addition to meeting these basic structural requirements, the wing and fuselage must also provide for the enclosure of literally miles of electrical wiring, hydraulic tubing and other items incident to the operation of the airplane control and communication systems. It has been said that some of our heavy bombers contain enough electrical wiring fully to meet the requirements of half a dozen or more modern residential dwellings.

On account of the complex nature of the various components of an airplane, it will be readily appreciated that the talents of scientists and engineers with many types of background and experience can be employed to great advantage. Referring again to the wing as perhaps the major aerodynamic element of the airplane, attempts have been made to rationalize design procedures so as to require a much smaller factor of safety or factor of ignorance than in some other fields of engineering design. The factor of safety is largely replaced by a so-called "load factor" based on the maximum accelerations to be encountered by the airplane in flying through gusts, in dive pullouts, snap rolls, and other types of maneuver. This factor, which may be as large as eight or ten in certain cases, is further increased by a true factor of safety of the order of 1.5 to 2.0. Coupled with this procedure has been the development of refined methods of calculating applied loads and determining the stresses produced by them in the airplane structure. Here, much of the fundamental work in the theory of elasticity developed by such mathematical theorists as Navier, Poisson, Euler, and Love has been put into a workable form by such men as Timoshenko, Karman, Lundquist, Southwell, Taylor, and many others. Problems of elastic instability involved in the failure of columns and the buckling of thin sheet metal coverings under compressive loads have arisen to a large extent in recent years with the development of the all-metal airplane and, in particular, with the introduction of the monocoque or shell types in which the skin may carry a major portion of the load.

Drawn from the closely allied field of rigid body mechanics are many applications to problems of vibration and flutter. The former are usually produced in a portion of the structure which may have a natural period of vibration which brings it into resonance with impulses developed in the engine or the propeller. Flutter problems are generally those cases of vibration caused by some peculiar condition in the airflow and the resulting action on such items as a wing or tail surface. Here the flexibility of the structure involved in torsion and in bending has a good deal to do with the problem.

If rockets may be considered as a type of internal combustion engine, then both our present-day and future airplanes have many problems peculiar to this type of power plant. It might be mentioned in passing that the rocket application is not entirely a Buck Rogers comic strip proposition but may be much closer than we realize in its application to high speed airplanes. Already designers using the conventional gasoline-burning engine are directing the exhaust gases rearward with a considerable gain in propulsive effect, and some new airplanes have been fitted with rockets for take-off which have produced a material shortening of the distance required on the ground.

The present-day aircraft engine is largely the result of painstaking and systematic proof testing and research. Better materials, improved fuels and lubricants, and improved arrangements for cooling are the main items responsible for this development. Here the fundamental theories of thermodynamics and heat transfer serve as the basic physical foundation on which these applications have been made. When it is realized that a modern airplane engine developing from one to three or four thousand horsepower weighs only 1.5 to 2.0 pounds per horsepower, some of the advances which have been made may be more fully appreciated. A single cylinder of a typical airplane engine often produces more power than the entire engine of some of our larger modern automobiles. Special credit should be given here to the chemists who have given us our high octane fuels which represent without a doubt one of our greatest weapons against the Axis. Along with this has been the development of lubricating oils and metals that would stand up under high operating temperatures.

In a field closely related to that of engine design and development is found that of heating and ventilating. This is one of the most important and most difficult problems relating to airplane design and operation, because of the wide range of temperatures and pressures under which the airplane must function. Temperatures in the normal atmosphere may range from 67 degrees below zero in the stratosphere, using the Fahrenheit scale, to considerably above 100 degrees at sea level altitudes in the tropics and desert regions. Pressures continuously decrease from the normal sea level values to a few pounds per square inch in the stratosphere. On account of the low air densities existing at high altitudes, superchargers are usually required for both the engine and the human beings on board. Here another wide range of development problems presents itself which has only recently been solved successfully by the use of our gear and turbo-type exhaust gas driven units. It may safely be said that supercharging has been the secret of the success of our high altitude bombing attacks on Germany and may be one of the major contributing factors in hastening the Nazi downfall.

Electrical and hydraulic systems have already been mentioned and the engineer experienced in these fields can contribute much to the aircraft industry. Specifications are rigid, loads and capacities are high, and the bugaboo of too much weight in structure and equipment is always present. At the present time the aircraft industry is using both systems for the operation of controls, retraction of landing gears, and functioning of controllable pitch propellers. Each system has its ardent advocates, but there does not seem to be as yet any clear cut decision in favor of one or the other.

The application of radio and electrical communications equipment to the airplane has been the foundation, of course, on which our whole air transport system is based. Radio beacons and beams, communications with ground stations and with other aircraft, and the development of equipment for blind flying are among a few of the outstanding applications. One can easily speculate on the postwar possibilities of a combination of radar and television which would enable a pilot to see on a screen in his cockpit a complete picture of the airport he is approaching even though the weather may have completely closed in around him.

Returning again to the wing as the major aerodynamic element of the airplane, nothing has as yet been said regarding the developments which are taking place and will be carried on further in refining its external form. The obvious goal, of course, is to reduce the resistance as much as possible. During the past twenty years, the airplane has changed from an externally braced structure, with excessive parasite resistance in the form of struts and wires, to a clean, sleek object with essentially no resistance except that due to friction of the air moving along its exposed surfaces. The problem today is then one of striving for further reductions in drag by decreasing this frictional element. Notable progress has been made by the introduction of smoother surfaces, employing counter-sunk rivets and butt joints in sheet covering. The boundary layer or film of air close to the wing surface is then capable of remaining in a laminar or non-turbulent condition at much higher velocities than would otherwise be possible. Future developments may call for the use of wing skin materials of sufficient thickness to eliminate buckling because of the wavy roughness that it produces in wing surfaces. A more recent development is the alteration of wing cross-section contours so as to delay the transition from laminar to turbulent flow within the boundary layer. Actual accomplishments in this connection are bound by military restrictions at the present time, but it may be said that the theoretical limit or ideal case shows the possibility of reducing the wing drag at high speed to as much as one-eighth of its normal value under turbulent flow conditions. Since the wing drag of a modern airplane may well represent one-half to one-third of its total drag, it is seen at once that these considerations are extremely important.

All of these developments involving the flow of air are based on the fundamental fluid mechanics developed by Euler, Lagrange, Navier, Stokes, Reynolds, and Lamb and further amplified and extended by the more modern workers, such as Prandtl, Joukowski, Karman and Dryden. In these fields, as in many others in aeronautics, the applied mathematician may have a field day with the wide variety of problems arising. Applications of complex variable theory, Fourier analysis, and differential and integral equations of numerous types, will all be encountered in various aspects of so-called airfoil theory.

The problems so far discussed have been largely in the engineering field with indications of the contributions drawn from mathematics and physics. With aircraft operating at high altitudes, it has been necessary to develop a whole new field of aviation medicine. The effects of accelerations on the human system and the special problems relating to functioning of the eyes and ears in flight have formed a large part of this new field. Here the engineer and the air surgeon can gain materially by close cooperation.

As our world transportation system expands in the postwar era, the bacteriologist may be needed to help control the problem of the transmission of disease and pestilence from now remote parts of the earth either by bacteria or insects through the medium of the airplane. Along the same lines, the effect of the airplane on our sociological development is another problem of considerable significance. It should be emphasized here that the engineers are not Frankensteins who, having created their mechanical monster, are unable to control it. The engineer has not, perhaps, been as vocal as the social scientist or the political economist, but if those who serve as engineers of our political machinery will occasionally give heed to his too often still, small voice, I believe that all will profit.

The future of aviation at present is difficult to predict, because of the newness of the present expansion. First class mail by air, an expanded global air transport system, a helicopter in every garage, and a larger and more permanent peacetime air force, are factors which go on the black side of the ledger. On the other side there is still considerable doubt as to the possibility of utilizing our present productive capacity. From the standpoint of the engineer and scientist, however, the future looks bright since there will be new and ever-increasing demands for development and refinement of present-day designs. The conversion of bombers to transports can be only a temporary makeshift on account of the high operating costs. Increased competition will call for even more attention to design work of the highest caliber. As an engineering educator, I should like, in closing, to emphasize the fact which I hope my discussion has brought out that aeronautical engineering is by and large based on sound scientific principles and these principles are consciously used every day. The high school student proposing to study aeronautics should take special care, therefore, to become thoroughly grounded in the mathematical and physical sciences. Not only must he know these basic principles thoroughly, but he must, as an engineer, develop analytical thinking so that he can apply the principles where they fit, even though the particular problem under consideration is not given as an example in his textbook. In addition to this solid foundation in mathematics and physics, I would also like to emphasize the need for a fuller appreciation of the manual arts and the dignity of working with the hands. All too many of our highly trained engineers can design machines on paper which cannot be fabricated in the production shops. The development of the analytical approach coupled with sound common sense and an appreciation of the practical aspects of manufacturing are the most important attributes of the good engineer.

## The Quick-Freezing of Foodstuffs

LUIS H. BARTLETT, Associate Professor of Mechanical Engineering and Mechanical Research Engineer, The University of Texas, Austin.

Quick freezing is the modern adaptation of a food preservation technique which is older than history. The efficacy of freezing is documented by the discovery (4) of a frozen mammoth in Siberia, which it is estimated has been preserved for approximately five hundred centuries. No other known method could have kept this carcass in an edible state for even a small fraction of this period. Of course, this mammoth was not quick-frozen and it is quite possible that several days may have elapsed before the entire mass was reduced to the freezing temperature.

It has been known, since the classic research of Plank, Ehrenbaum and Reuter (7) that the least damage to the colloidal structure of food is incurred when the freezing is very rapid. Later work by Luyet (5) and by Moran (6) has also shown that rapid thawing is essential to avoid changes in the colloidal structure during the defrosting period.

### The Polyphase Freezing Process

Research conducted at The University of Texas has been directed towards methods of accelerating the rate of freezing without using temperatures which are below the range of commercial practicability. Unusually fast heat transfer is secured by direct contact of food with a chilled medium of high viscosity which is composed of three phases: solid, liquid, and vapor. It is chilled and slowly agitated until a solid phase of finely divided ice particles has formed and is dispersed throughout the liquid. This composition is satisfactorily operated over the range of 2° F. to 10° F. and is metastable at these temperatures.

Articles of food are floated in the cold medium and the slow agitation moves them with respect to the fluid and also to each other so that the individual pieces are prevented from freezing together. Freezing is so fast that washwater or juices adhering to the food surfaces are at once frozen in place and do not dilute the polyphase medium. This film of ice is proof that diffusion of soluble constituents does not occur, solute is not transferred from the freezing medium to the food, nor does the food lose dissolved solids.

The high rate of heat transfer is due to three factors:

1. The extremely high thermal capacity of the polyphase state (1).
2. Increase in the thermal conductivity of the fluid film by the suspended ice particles.
3. Almost complete elimination of food supercooling by the "seeding" effect.

The polyphase medium removes heat approximately twice as fast as a liquid medium under identical operating conditions (1). Polyphase media, composed of water and sugars, may be operated in the metastable state at temperatures as low as —10° F., while syrups employed in food freezing are seldom operated below +3° F. Thus it is possible by employing the polyphase media to chill foods in a fraction of the time required by liquid media under ordinary conditions.

An important advantage of heat-transfer fluids which can be operated at sub-zero temperatures is that freezing is completed in one operation and no heat is removed in the storage room. By eliminating this period of exceedingly slow cooling, less irreversible damage to the colloidal structure occurs, and a more immediately practical result is that the food does not freeze into a solid mass in the container. Each piece retains its individual character so that it may be removed without disturbing the remainder and re-packaging in smaller packages is easily accomplished. Many desirable characteristics of loose-pack frozen foods are emphasized by Flint (3).

After chilling is completed and the food is removed from the freezer, a film of metastable medium remains upon each article. This film will eventually pass to the stable state in storage but it is better to accelerate the change by dusting the frozen product with a minute amount of dextrose. During stabilization, the coating is changed to a plastic material, consisting of finely divided sugar and a viscous syrup, which adheres tightly to the frozen food and serves as an envelope to retard oxidation and dehydration. Tressler and Evers (8) state that sugars markedly inhibit oxidation and other enzyme action in foods.

## The Polyphase Freezing Machine

One basic requirement of any food-freezing process, which utilizes sugar solutions as heat-transfer media, is a type of machine which can successfully handle very viscous fluids. The University of Texas polyphase freezer is such a mechanism. The heat-transfer unit is a refrigerant-jacketed horizontal tube, partially filled with polyphase medium, in which a closely fitting helicoid conveyor operates. This tube terminates in feed and discharge compartments which are connected by a fluid-return conduit. A suitable grid in the discharge compartment retains the frozen food and allows the polyphase medium to return to the feed chamber. Normal rotation of the screw propels the fluid and food, while a superimposed circular oscillation provides agitation. The speed may be regulated to allow complete chilling of articles of various sizes.

Small machines employ one freezer tube and one helicoid conveyer. Food moves in a straight line from the feed end to the discharge compartment grid, whence it is removed periodically to a refrigerated drainer compartment before packaging. The heat-transfer medium flows through the grid and through the return conduit to the feed compartment. Large units have parallel twin freezing tubes, connected at one end by a return bend and at the other end by a junction box which is divided into feed and discharge chambers by a curved grid. Food moves in a U-shaped path to the grid, from which it is removed and propelled through a chilled, perforated drainer tube by an auxiliary screw conveyer before delivery to the packaging equipment. After passing through the grid, the heat-transfer medium repeats its cycle.

The mechanical advantages of The University of Texas polyphase freezer are:

1. Extremely simple design.
2. Compact and light in weight.
3. Low power consumption.
4. Continuous in operation.
5. Small area to insulate.
6. Low maintenance cost.

The desirable operating characteristics are:

1. Very high rate of heat-transfer from the polyphase medium to the refrigerated surface.
2. Highly viscous heat-transfer media successfully handled.
3. Small quantity of medium required.
4. Working temperature quickly attained.
5. Ease of maintaining the freezing medium in a commercially satisfactory concentration.
6. Standard condensing units, without boosters, are used to furnish refrigeration.

The process has been thoroughly tested upon both laboratory and commercial scales. With the exception of leaf vegetables, nearly every important variety of foodstuff which is produced in the Southwest has been successfully frozen in an experimental machine having a capacity of 50 pounds per hour. One large unit, having a capacity of 600 pounds per hour, has been in operation upon snap beans and black-eyed peas in the Rio Grande Valley area of Texas. Meats, poultry, fruits, and vegetables were frozen by the sugar-and-water polyphase medium, while shrimp were frozen in a high-viscosity water-and-salt polyphase medium. The excellence of vegetables frozen and coated with the sugar media has been amply demonstrated (2). Articles from the size of a pea to the limiting dimensions of the freezer tube have been successfully frozen.

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## Short Course Training Now and After The War

C. R. GRANBERRY, The University of Texas, Austin

In ordinary times a discussion, concerning short course training, before this Academy would doubtless be of only passing interest. Realizing that members of the Academy have a general interest in all scientific matters which certainly includes training for technical and scientific fields, it seems that a short period of time might be devoted to an examination of the short course training program now under way throughout the country as a part of our war effort and the probable postwar effects of this program. Those even slightly familiar with the program which has been under way since the latter part of 1940 are convinced that the future holds tremendously interesting possibilities in peacetime living for short course technical training. The experience we have gathered and the lessons we have learned over these war years may go as far as to change radically our thinking with regard to the whole structure of scientific and technical education after the war, and it is because of this possibility, more than anything else, that we must begin to pay attention in wartime to postwar activities.

Let us first examine briefly the beginnings and growth of the short course training in the present emergency. As early as the middle of 1940, those in and close to our government saw the long shadow of war approaching fast. The country was relatively unprepared, certainly, to undertake the enormous task of production needed for defense. In taking stock of the technical manpower for defense activities the alarming shortage of trained production personnel, particularly engineers, was apparent. Because of the length of time ordinarily involved in the training of such personnel it was impossible to expect to obtain an adequate number of engineers within the time then thought available. The only possible alternative then was to resort to short, intensive courses, and this type of program was provided for by the Congress and set into motion in the fall of 1940. Naturally, existing educational structures were used, and the Congress provided funds for expansions in the Training Within Industry, Vocational Education and National Youth Administration programs. None of these however, was adequate to care for college level training, so the Congress provided for such by an appropriation of $7,000,000 through the U. S. Office of Education for the Engineering Defense Training Program. While institutions of higher learning have a great deal of interest in the programs at lower than college levels, the college level program is by far of greatest interest, and for this reason this discussion will be confined to this particular level. Plans for these courses as announced by the U. S. Office of Education, and as followed up to the present time, were for such courses to be offered throughout the country by approved colleges and universities. The courses themselves were to be short, intensive, non-credit, and free; they were to be also both part-time and full-time and were to be both pre-employment and in-service as needs dictated in a particular field or in a particular locality. There were many, including some high in educational circles, who said the job of training as proposed in the short course pattern would not be adequate, but results to date show complete success. During the life of Engineering Defense Program, which lasted for seven months to June 30, 1941, 184 institutions participated and approximately 100,000 persons were trained. To determine the needs for courses, surveys were made in various areas, contacts were made with industry and the state and national employment agencies; and publicity programs, utilizing newspaper and radio advertising and many other available channels, such as selective mailing lists, circulars, and posters, were fully used.

For the Federal fiscal year July 1, 1941 to June 30, 1942, the program was expanded to include, in addition to the engineering training, science, meaning specifically chemistry and physics, and production management. Resorting to the popular method of description, this program became known as the E.S.M.D.T. program—meaning Engineering, Science, and Management Defense Training. For that year $26,000,000 were appropriated but only $16,000,000 used, the plan of operation for the course being the same as before. That year's program was well under way, with a marked increase in enrollment, when the blow fell at Pearl Harbor. As might be expected, the coming of war brought a sharp increase in enrollment for these courses. At the end of the year it was found that 196 institutions had participated and approximately 440,000 persons had been trained. The course offerings were greatly enlarged, several hundred different courses being offered after the outbreak of the war. After Pearl Harbor it became apparent that many women would have to be trained for various positions in industry, so the drive began to bring in, first, women who had some technical training which could be utilized as a basis for more advanced work; later, many women were enrolled for basic courses. During the first months of 1941 great numbers of trainees, both men and women, were obtained for some of the more important fields such as drafting, radio, safety, explosives, personnel supervision, accounting, chemical laboratory techniques, and many others.

The third step in this training program came with the new Federal fiscal year, July 1, 1942 to June 30, 1943. For this interval the Congress appropriated $30,000,000 and the program became known as Engineering, Science, and Management War Training; 215 institutions participated in this year. During this period of time the course offerings were enlarged several times over the preceding year. Approximately 650,000 persons were trained during this period, distributed approximately: 30,000 under the Science Division, 200,000 under the Management Division, and 420,000 under the Engineering Division. During this year there was a marked swing to in-service courses and the number of women enrollees increased many fold; also, there was a dropping off in the number of pre-employment course offerings.

For the current Federal fiscal year, July 1, 1943, to June 30, 1944, the Congress appropriated $25,000,000 for the second E.S.M.W.T. program. To date there have been approximately 200,000 enrollees and the total training for the year will probably be about the same as last year.

Practically all of the leading colleges and universities in Texas have participated in this short course training, some being approved to give only Management courses, some only Science courses, and some all three classifications. These institutions have had as main goals the training of men and women for the several shipyards on the Texas coast; the three or four large aircraft plants in North Texas; the petroleum and chemical plants throughout Texas, which have been major contributors to the war effort; the construction, housing, and sanitary fields, and the large ordnance plants in operation at several points in Texas. In this way Texas institutions have done their part in supplying trained personnel for the manufacture of ships, planes, tanks, and guns for our fighting fronts.

To handle effectively these major training programs it has been necessary for the Engineering, Science, and Management staffs of the institutions involved to take on a great amount of additional work. Much of this work has been done for little or no compensation whatever even though many over-time hours were required for administrative and educational supervision work.

And now about the future. There is little doubt that this type of training will be continued until the end of the war, and prospects for the 1944-45 year, assuming that the war lasts that long, indicate that the enrollments for the many different courses will drop off only slightly, possibly 10 percent. Many women are badly needed, and if the problem can be more strongly brought to their attention they will, no doubt, respond in a bigger way than ever. Many discharged service men are now beginning to appear and every effort is being made to bring them into the short course program at the proper level, depending upon their abilities and previous training. Under the terms of the Act under which we are now operating, the program can extend only two months after the cessation of hostilities.

Before that time, however, it is quite clear that Congress will take some action to set up a continuation of this type of training after the war, probably using the E.S.M.W.T. structure which has proven so efficient. Much thought is being given to postwar educational matters by many agencies. It seems reasonable that the Congress should make provisions for a sizeable short-course training program, lasting a year or two after the war, to re-train men and women for places in the peacetime industries. This is the least that could be done for thousands of men and women who have sacrificed a tremendous amount to train for and to work at occupations necessary to the war effort. No one doubts the importance and necessity of assisting these people, and also the industry of the nation, in reconverting to peacetime activities and schedules. Such a short course training program as we have had during war time would undoubtedly be one of the best means of taking up the slack which is sure to come as soon as the war ends. It would be entirely too much to expect the great majority of these men and women to finance their own change-over, and the amount of money spent from the Federal Treasury for such training would be insignificant as compared with the results of a well-aimed and executed program of education. Certainly, for the period immediately following the end of the war, short courses will be of greatest value because the reconversion period must be kept as short as possible.

When we have settled down to a more or less normal pattern of living after the war, we shall, as a nation, be required to examine our educational methods and structures and see whether or not these methods and structures are at all adequate in view of what we have learned during these past few years and in view of the increased dependence upon things technical. War has a great habit of revolutionizing ways of living, ways of thinking, and ways of doing things. There is little doubt that this country and the whole world will be much ahead of the schedule in technical and scientific developments. We have suddenly found ourselves advanced in time by many years, if we can use these developments as indexes; and whatever training we do in the future must fit young men and young women and, more than ever before, older men and older women, for their places in a changed world. Upon critical examination, will our older educational concepts survive? Shall we find the pre-war patterns sufficient? Already we know that the war has pointed out rather clearly some deficiencies which have existed in most high school curricula. The dilution of high school curricula with many subjects, which we were led to believe were becoming more important than some of the more basic studies such as mathematics, physics, and chemistry, has resulted in a serious handicap to our armed services which are so dependent upon technical training of many sorts. This training could not be built on inadequate foundations. At the college level—shall we still insist that four year moulds should be the only pattern for the production of scientists and technicians, and that there is no point short of this interval where men and women of certain abilities can be turned out as useful citizens in the industrial world? Many colleges and universities gave considerable thought to this problem before the war and certainly they must now give more thought to it. There is no doubt that the four year college program is necessary for the training of persons in the technical professions. In fact, five years would not be too long for such training. There are many men and women who would like to enter the technical fields, who for many reasons can not spend four or five years in pursuit of a professional degree, but who could be well trained in a narrower fashion for specific types of technical and scientific work and thus find for themselves desirable places in the industrial field. These ideas are being studied by many in the technical fields and others, as evidenced by recent parallel activity by educators in the fields of business, in Home Economics, etc.

Considerable thought is being given to longer courses than those we have been giving during the war time. In general, these courses may be described as one or two year terminal courses. They are of the type given by some junior colleges but, to be of greatest value for the trainees, should be given by institutions having available the best possible equipment for training in the various fields selected. Courses for radio technicians and industrial electronics technicians are good illustrations of possible course offerings. Unfortunately, this has not been possible until now in more than a few of the junior colleges over the country and will probably not be different in the future on account of the large cost involved in purchasing needed equipment. Even now, one or two institutions are planning the equivalent of these one and two year terminal courses by offering a sequence of short courses, each lasting 12 to 16 weeks. Upon the completion of a series of these short courses it is proposed to give the student an appropriate certificate.

Finally, the question arises as to the place of the typical short course—8, 12, 16 weeks part-time or full-time—in the future, particularly after the reconversion period. To be most successful from the standpoint of serving men and women, these short courses should undoubtedly be carried to the individual concerned, rather than to be given on the campuses of the institutions involved, unless the institutions are located in major industrial areas. Many institutions will look with disfavor upon any such plan, but if the institution is to be of greatest possible service within its budgetary limitations, the short course field should not be overlooked. Such a program would give a tremendous boost to adult education and, once these courses get under way in various localities so as to serve the everyday needs of men and women to assist them in making a livelihood, additional course offerings out of the technical fields will undoubtedly be demanded and should be given. Surely this is one way in which educational advantages can be carried to more and more people. The great number of short courses needed for war training or reconversion will not be needed for normal peacetimes. The area to be served should be well surveyed and suitable courses selected. With the reduction in number of courses offered will come a broadening of the scopes of the various courses, the very narrow specializations will no longer be necessary in view of an adequate number of trained persons in administrations to direct activities along the many technical avenues. For those of us interested in the present and coming industrial development of Texas, these short courses hold great promise.

Such a program of expansion into the field of short courses of the eight to 16 weeks variety, and also the one to two year terminal variety previously described should be no cause for alarm from the standpoint of competition with the regular four or five year professional courses. The chances are that if more training is done at the lower levels there will be more and more students who will be better trained and who will want to advance into the professional courses in institutions of higher learning. Such institutions will then be able to concentrate, as many now wish to do, upon the junior, senior and graduate years in the professional fields and will as well have more time to devote to professional work to the doctor's degree.

And more in point here, what contribution will these war time short courses have made, and those projected for the future make, to the technical and scientific world? Since by the time the war ends several million persons will have received training along technical and scientific lines, they and their families and their communities will have become more aware of the importance of such training in our new world where dependence, even in every-day life, will be great upon technical and scientific knowledge. The importance of mathematics and basic physics and chemistry will have been re-emphasized over and over again. There can be no doubt that war training and the coming peace training will swell the ranks of men and women who will contribute much, ultimately, to the scientific and technical development of the nation. We should make every possible use of this rising potential and continue in the future to supplement it constantly, so that in the years to come the level of scientific and technical attainment in America will be even higher than that over the half century which has brought some of the most amazing technical developments on earth.

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Other Papers Listed on the Programs of Meetings:

1. Mathematics in Wartime. By H. J. ETTLINGER, The University of Texas.

2. A Study of Earth Tides. By ARTHUR E. LOCKENVITZ, The University of Texas.

# SECTION II: BIOLOGICAL SCIENCES

## ABSTRACTS

***Gangster Sparrows***—F. B. ISELY, Trinity University, San Antonio. Sheer weight of English sparrow numbers has developed an avian situation in many Midwestern home yards where the only year-round birds present are the pestiferous, noisy, litter-massing English sparrows. Added to the fact of numbers is the intrusive gang opposition these sparrows exert to all native birds who may show a neighborly interest in finding nesting sites in close proximity to man's habitation, especially to homes which are surrounded by inviting shrubbery or trees. In our own family experience we have found that, by the use of masses of climbing roses, honey-suckle, and thick-crowned trees, we have been able, at various times, to share our lawn environs with cardinals, mockers, blue birds, lark sparrows, Bewick wrens, blue jays, and other friendly birds. We have shared our property with these birds in five Mid-west towns: Tonkawa, Oklahoma; Fayette, Missouri; Fort Worth, Waxahachie, and San Antonio, Texas.

Only the past July, 1943, however, the house sparrows succeeded in driving a pair of mockers from our front lawn in San Antonio. In early July, a pair of mockers were building a new nest in the thick-crowned top of a Chinese elm sapling, near our front entrance. This we surmised was the second nest for the season, and we were delighted at the prospect of having the happy, energetic mockers near at hand. Contrary to statements in bird literature (Pearson in Educational Leaflet No. 41), the male mocker was quite active in assisting his mate in nest building. No sooner was the nest in process, however, than four to six English sparrows were constantly in the treetop as nuisance observers. The mocker opposition was definite, but the sparrow gang was persistent in its interference. The sparrows were always in the treetop whenever the mockers were at work and, whenever they were away, would investigate the nesting materials and even remove sticks or fibers from the nest. In spite of sparrow interference, in less than a week the new mocker nest took on final form, and the female was busy shaping the nest and turning around and around. Whether eggs were deposited we were not sure. From other evidence, we think that there may have been and that they were destroyed by the sparrows. In a few days after the completion of the nest, the mockers gave it up and constructed a second one in a mesquite tree in an open lot a hundred yards from our front door. In this location no sparrow opposition developed. The first nest was soon pulled to pieces by the sparrows and later was only a tangle of twigs and fibers.

An earlier, unreported observation of the writer leaves no doubt about the evil banditry of the gangster English sparrows. While living at Fayette, Missouri, the juniors in our family placed a hollow tree section, with a suitable hairy woodpecker hole in it, on top of a post near the house. The intent, of course, was to entice a blue bird or wren to use this as a home site. The invitation was promptly accepted and for several years a family of blue birds annually shared our lawn, and the blue bird young grew to maturity in the hollow log nest. One day in early May, 1919, however, the

English sparrows drove the blue bird parents away and dumped all but one of four nestlings out of the nest into the garden. A half dozen noisy male sparrows were noticed around the hollow log nest. The banditry and loot, along with the gangster methods of these English sparrows, were striking. The blue bird parents fought back with vigor and bravery, but they were finally exhausted and forced to withdraw. The sparrows then proceeded with the looting and soon cleared the nest of the four-day-old nestlings. As noted above, only one of the four nestlings was recovered. The little bird was at once supplied with food. It grew to full size and soon left the nest, thus adding one to the bird population.

These observations give a good example of what is happening around many homes and lawns in the Middle West. Native birds, cardinals, mocking birds, blue birds, purple martins, house finches, robins, and others are driven from our homes by these impudent gangsters. We have left only noisy, grain-consuming, litter-massing, looting gangster English sparrows. These indictments are irrefutable. Birdlovers need to recognize the "enemy within our gates." It is really a tragedy that we allow these snipers to bring about the "local disappearance of our native birdlife, a delight to the eye and ear of him who sees and hears." (1)

Further study is doubtless necessary. It may be, however, that a scientific program of ouster and defense should be developed by ornithologists and prosecuted with vigor and persistence. Esthetic, economic, ethical issues are involved, and only united action against these gangsters will even partly avail to protect our songbirds.

**Reference**

1. Grinell, Joseph, pp. vi 238, 1943. Philosophy of Nature. Berkley.

**A Protozoan Parasite, Probably New, from a Triatoma**—ARTHUR W. JONES, Southwestern University, Georgetown. Giemsa smears of the rectal contents of a species of Triatoma occurring in Georgetown, Texas, revealed a single infection by the gametes and sporozoites of a protozoon. This organism resembles somewhat the haemogregarines, many of which are blood parasites of small vertebrates. If a haemogregarine, this parasite's vertebrate host is as yet unknown. The gametocytes apparently undergo a conventional meiosis (indicating the diploid condition in the blood-inhabiting stages), with nine bivalents forming at metaphase I. The isogametes fuse; the zygotic nucleus divides three or four times, and sporozoites of characteristic shape separate from the sporogenous syncytium. Attempts are being made to discover other infections and to isolate the vertebrate host.

**The Natural Nutrition of Two Species of Drosophila**—R. P. WAGNER, The University of Texas, Austin. Decaying fruit of the cactus, *Opuntia Lindheimeri* were collected in the field and carried to the laboratory in sterile bottles. Samples of the microorganisms present in the fruit were then immediately isolated. Eight different yeasts and several different bacteria were found to be present. The fruits were kept for several weeks and the flies emerging from them were collected and identified. Only species of the family Drosophildae emerged from the fruits and of these, two species, *Drosophila mulleri* and *D. aldrichi,* predominated.

A sterile cactus juice agar was prepared from fresh cactus fruit and sterile eggs of both *mulleri* and *aldrichi* placed on it. The larvae hatched from the sterile eggs did not develop on this sterile medium. When the yeasts and bacteria were added separately to the medium, complete development of the larvae to the adult stage resulted with the yeasts but not with the bacteria. All of the eight yeasts tested were sufficient for the complete development of *mulleri*, but only five were complete for *aldrichi*. In the case of *mulleri* the different yeasts gave different rates of development and different percentages of imagos. Some of the bacteria isolated were made complete for both species of flies by supplementing the cactus medium with cholesterol. An unsuccessful attempt was made to make the three yeasts, which were deficient for *aldrichi*, complete by supplementing them with B vitamins.

**Spice and Drug Culture in the Austin Region**—C. C. ALBERS, The University of Texas, Austin. The desire for spices and drugs from the Far East at a price within the reach of the populations of Europe played an important role in early geographical discovery and exploration. Almost all of the important spices and many valuable drugs came from the East Indies, the Malay Peninsula, Indo-China and India. Very few important and widely used spices are native to the New World. Among these few the following are probably the most important: Allspice (Pimenta), Capsicum (African Chillies), and Chocolate (Cacao).

In normal times, therefore, our drugs and spices are imported; but when foreign trade is disrupted by a war, local commercial sources are sought and steps are taken to overcome the resulting shortages. However, the prospective grower should take into account, in considering the possibilities of home cultivation, the probability of foreign imports after the war with strongly competitive prices. Moreover, such spices as cinnamon, clove, nutmeg, etc., are produced from trees which require many years to bring into productivity. Furthermore, these and many other spice plants are strictly tropical plants and could not therefore be produced in our climate. However, there are many spice and drug plants native to or cultivated in temperate climates which, therefore, might be brought into productivity in our own community. Fortunately, also, many of these are annuals or biennials, or even perennials that can be brought into quick production and are adapted to many kinds of garden soils. Among this latter group, the following plants, arranged by families, have been found to grow successfully in experimental plots in the Medicinal Plant Garden of the University of Texas:

Ginger family: *Zingiber officinale*. The rhizome is the part used; although the overground plant freezes in winter, the root survives the Austin winters.

Rue family: *Ruta graveolens*. The leaves and flowering tops are used occasionally as a spice and often in domestic medicine. The plant is perennial.

Parsley family: Fennel, coriander, parsley and dill. Anise, caraway and cumin are more tender and do not thrive in the excessive heat and drouth. Coriander is an annual and it is possible to produce two crops in one season. Fennel and parsley, both perennials, continue productive throughout seven or eight months of the year.

Mint family: Spearmint, peppermint, Japanese peppermint, hyssop, thyme, sweet marjoram, wild marjoram, sweet basil, lemon balm, lemon mint, garden sage, clary sage, chia, perilla, catmint, rosemary, lavender, summer savory and mock pennyroyal are among the many mints which thrive in garden soils.

Nightshade family: Capsicum species, tobacco, Datura species (Jimson weed and Angel Trumpet), Belladonna (Deadly Nightshade).

Figwort family: *Digitalis purpurea* and *Digitalis lanata.* The first of these, purple foxglove, does not thrive well in the excessive heat and drouth. The latter appears to withstand our climate much better.

Sesame family: Sesame seed. This is an annual that produces abundantly. The seed and oil are widely used in the culinary arts and in pharmacy.

Thistle family: Wormwood *(Artemisia absinthium),* American saffron *(Carthamus tinctorius),* and Tarragon *(Artemisia dracunculus).* The latter does not thrive well in the excessive heat.

Finally, it should be pointed out with emphasis that in the cultivation of many drug and spice plants much hand labor is involved which tends to add materially to the cost of production.

**Some Notes on the History of Leprosy in Texas**—J. V. IRONS, Sc.D., Texas State Health Department, Austin, Texas. Since the establishment of the National Leper Home at Carville, Louisiana, in 1921, lepers have been taken there for care and treatment. Admission records at the National Leper Home suggest that leprosy in recent years has been a problem mainly in the Gulf Coast states, principally Louisiana and Texas. Leprosy apparently never gained a foothold in most parts of the United States. While more cases have been found in Louisiana during the existence of the National Leper Home, it appears probable that this infection is beginning to die out in that state.

Although undoubtedly there were many earlier cases, the first medical record of leprosy in Texas concerned a case at Galveston in 1886. In 1920, Mark Boyd at the University of Texas Medical School reported in some detail on the leprosy situation at Galveston during the previous thirty years. Boyd's report primarily concerned 45 cases with bare mention of 15 others. His information was obtained in the main through personal interviews; according to Boyd, in 1920 there were at least 26 lepers living at Galveston. In connection with his examination of rats at Galveston for possible evidence of plague, Boyd mentioned finding seven leprous rats in 23000 examined; however, he was not impressed with the likelihood that human leprosy in Galveston was acquired from rats. The majority of cases apparently gave a definite history of contact with another or other cases. Infections were more numerous among those of foreign- or of mixed-foreign-native-born parentage, particularly those of German lineage.

Cameron, Bexar, Nueces, Jim Hogg, Hidalgo, Webb, and other counties of Southwest Texas were the home counties of nearly all of the recent cases of leprosy in Texas. While Latin-Americans have contributed a disproportionate number of cases in recent years, it seems probable that most infections were actually acquired in Texas. The development of the infection somehow or other seems to be associated with low living standards, in some respects paralleling the situation regarding tuberculosis in Texas. Even though it appears that leprosy will probably persist longer in Southwest Texas than anywhere else in the United States, this disease constitutes only a minor public health problem in Texas as contrasted with syphilis and tuberculosis.

**Responses of the Avena Coleoptile to Mechanical Stimuli**—A. R. SCHRANK, University of Texas, Austin. The growth curvature responses in the Avena coleoptile are the result of unequal rates of elongation of the opposite sides. That these unequal rates of elongation are dependent upon unequal concentrations of the growth hormones on opposite sides of the plant has been well established by experimental work; but neither has the mechanism by which these hormones have such pronounced effects on the rate of growth been explained, nor have any experiments been performed that conclusively demonstrate the nature of the transverse polarization which is responsible for the lateral transport of the auxins. Our experiments show that when the apical 10 millimeters of one side of an intact coleoptile in the upright position are mechanically stimulated by means of an electrical vibrator at five minute intervals, the coleoptile bends toward the side that was stimulated. These experiments further show that before any curvature can be detected, this mechanical stimulation induces a transverse electrical polarity in the coleoptile such that the stimulated side becomes electronegative to the unstimulated side. This electrical polarity is established immediately after the first stimulus is applied and maintained for 75 minutes. The orientation of this transverse electrical polarity with respect to subsequent curvature is the same as the orientation established by the coleoptile in response to gravity. In both instances the concave side is the negative side. Since this transverse electrical polarity in the upright coleoptile is established immediately after the first stimulus is applied, it is possible that this induced electrical polarity could be the transverse polarization necessary for the lateral transport of the auxins.

**The Effect of Population Density on the Productivity of the Parasite *Microbracon Mellitor* Say (Hymenoptera Braconidae)**—JOHN M. CARPENTER, Clayton Foundation for Research, Cotton Investigation & Research, Biol. Lab. 9, The University of Texas, Austin. *Microbracon mellitor* is an insect parasite valuable in various cotton growing areas of the United States for its part in the natural control of the boll weevil, *(Anthonomus grandis)*. Hosts are paralyzed and a single parasite egg per host is normally deposited externally.

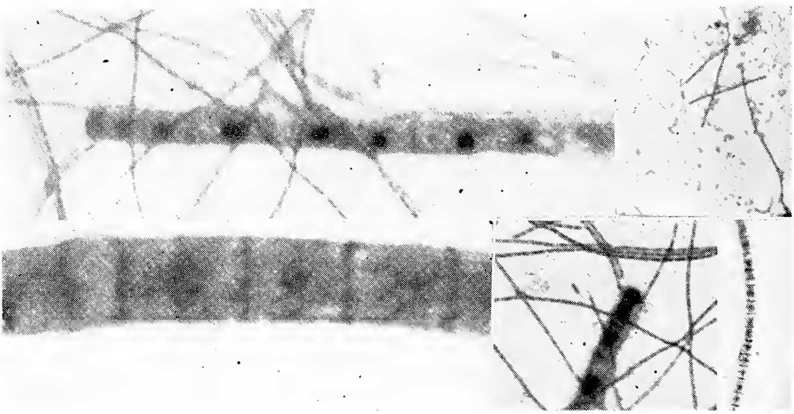
Confined in the laboratory for 72 hours in a volume of 420 $cm.^3$ at a constant temperature of 85° Fahrenheit and furnished with 20 host individuals upon which to oviposit, a single fertilized parasite female produces an average of 7.50 imagoes. As the density of parasite population is increased, other conditions remaining constant, individual productivity decreases, being 2.85, 1.92, 1.47, .74, and .41 at densities of 5, 10, 15, 30, and 60, respectively.

This decrease is believed to be brought about by at least two factors: (1) as density of parasites is increased, competition between parasites for host material upon which to oviposit becomes keener, and (2) as hosts are parasitized, searching by parasites for unparasitized hosts is prolonged so that fewer eggs are laid.

**Sulphur Bacteria and Bluegreen Algae**—FRED A. BARKLEY AND F. B. PLUMMER, The University of Texas, Austin. Three samples of freshly deposited travertine in the Luling oil field with their associated microorganisms were brought into the laboratory, March 16, 1943. By the first of July all three had developed dense growths one to two millimeters thick of bluegreen algae, mixtures of *Phormidium tenue* Gom. and *Oscillatoria chlaybea* Gom.[1], over the surface of the travertine. Under the growth of bluegreen algae a layer of purple sulphur bacteria, *Chromatium* sp.[2], about a millimeter thick developed; this developed also where the travertine came into contact with the glass containers. Since in the past the growth of this purple bacterium has usually been associated with green bacteria (c.f. C. B. van Niel. On the Morphology and Physiology of the Purple and Green Sulphur Bacteria. *Arch. f. Mikrobiol.* **3**: 1-112. 1931.) which we have been unable to find here, its association with bluegreen algae seems worthy of mention.

Since the collection of these specimens the same association has been observed abundantly in a stream of oil waste waters in the Luling oil field on the north side of the San Marcos River.

[1] Determined through the courtesy of F. Drouet.
[2] Probably *Chromatium Warmingii* (Cohn) Migula.



Upper left. A trichome of *Oscillatoria chalybea* Gom. and several of *Phormidium tenue* Gom. X600. Upper right, *Chromatium* sp. and trichomes of *P. tenue*. X200. Lower left. Trichome of *O. chalybea*. X1600. Lower center. Trichomes of *Phormidium tenue*. X1600. Lower right. Trichome of *O. chalybea*. X200. (*Chromatium* stained by Gram method; *Oscillatoria* and *Phormidium* stained by the Lewis modification of the Robinow technique for staining nucleoid bodies in bacteria.)

**Microorganisms Associated with Travertine Formation**—F. A. BARKLEY AND F. B. PLUMMER, The University of Texas, Austin. In the course of a study of oil field waters in relation to the permeability of oil sands into which contaminated water is introduced and the related problem of travertine deposition, a series of microorganisms has been collected and some of these grown in the laboratory for further study.

In a previous paper (Plummer, Merkt, Power, Sawin, and Tapp, Effect of Certain Microorganisms on the Injection of Water into Sand, 16 pp. mimeographed. A.I.M.E., Dallas meeting, May 8, 1943), the history of bacteriological studies on oil field waters was discussed. The bacteria isolated from the oil field waters were, among the iron bacteria, *Gallionella, Siderocapsa, Leptothrix,* and *Crenothrix*, colorless sulphur bacteria, *Beggiotoa, Thiothrix,* and *Thioploca,* colorless sulphuric acid producing bacteria, *Thiobacillus thioxidans* and *Thiospirillum,* sulphate reducing bacteria, *Microspira,* and *Vibrio thermodesulfuricans,* and the purple and green sulphur bacteria, *Chromatium* and *Chlorobium.*

The types of algae concerned were not considered in the paper mentioned above.

As representative samples of travertine deposition four stations were selected: The oil field waste waters from the tanks east of the San Marcos River in the Luling (Caldwell County, Texas) field, the waters running into the San Marcos River from the west side of the field, the sulphur springs in Palmetto State Park (Gonzales County, Texas), and the travertine springs in San Saba County, Texas.

The mineral content of the waste water as it flows out of the tanks is given elsewhere (cf. Plummer Tapp.). The elevation of Luling is 178 meters above sea level. The average annual rainfall at Luling is 101.34 mm. The daily fluctuation in temperature was as high as 22° C. in August. The annual fluctuation in 1943 was 49° C. The mean temperature varied from 15° C. in February to 31.1° C. in August.

Samples from this station were taken at intervals beginning from inside of the outlet pipe, down the stream to the settling pool, down the main stream to the dam about 300 yards below the settling tank. Specimens from inside the outlet pipe and the travertine deposit showed no algae. Travertine which had been removed from the stream for two years showed no trace of algae. On the damp soil along the stream *Oscillatoria articulata* Gardn. and *O. brevis* Gom. were abundant in shady places. On the travertine fan below the settling tank where the fan was intermittently covered with water *Oscillatoria brevis* Gom. and *Phormidium tenue* Gom. were found. Wherever travertine was being formed below the outlet pipe, in the stream leading to the settling tank, from its outlet, on the wet portions of the travertine fan, in the stream bottom where travertine was forming in 'wavelet' formation, and on the dam in the stream *Phormidium tenus* Gom. was abundant. In rapidly flowing water, on the dam, in a small pool off from the stream, and from a sluggish portion of the stream, *Oscillatoria chalybea* Gom. was also found.

The authors are indebted to Dr. Francis Drouet, Curator of the Cryptogamic Herbarium Field Museum of Natural History, for the determinations of the algae.

Various cultures raised in the laboratory from this vicinity show an abundant growth of *Phormidium tenue* Gom. and *Oscillatoria chalybea* Gom. under which the purple sulphur bacteria grow in great profusion.

From the salt and sulphur water from the oil water waste of a single well on the west side of the San Marcos River which flows from an outlet pipe around which travertine has deposited to a depth of about five feet in six years down about a hundred yards below the settling tank into the San Marcos River another series of specimens was taken May 22, 1943. In the dry prairie near the outlet stream *Microcoleus lacustris* Gom. and *M. vaginatus* Gom. were found. Collections from the outlet stream, still uncomfortably hot, down through a series of pools, from the travertine in a six foot falls, on the wet soil by the river bank near the outlet stream *Phormidium tenue* Gom. was found. In the still pools along the stream bed, removal of the surface layer of this algae showed a layer several millimeters in depth of purple sulphur bacteria. In one place in one of the larger pools *Oscillatoria acuminata* Gom. was obtained. In the upper portion of the stream where the water was quite warm *Oscillatoria chlorina* Gom. was abundant but was not obtained in the cooler water. *Beggiotia alba* (Vauch.) Travis was abundant along the edge of the stream.

In a waste-water stream near the Smith-Allen lease in the Luling oil field, *Phormidium tenue* and *Oscillatoria chalybea* were obtained in abundance. *Phormidium treleasei* Gom. was also present.

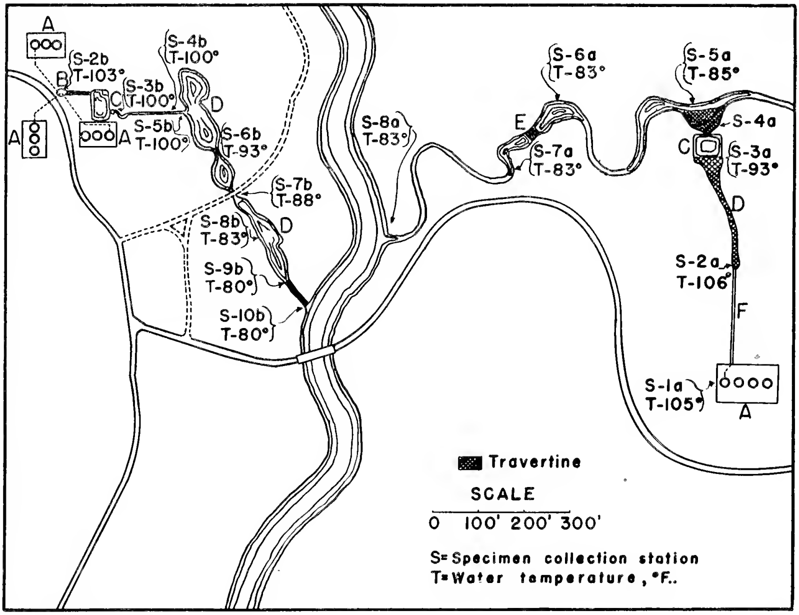
It will be noted that all of the algae in these oil water outlets are blue-green algae of the *Oscillatoriaceae*.

From the vicinity of an artesian sulphur well in Palmetto State Park (Gonzales County, Texas) a series of specimens was taken on May 22, 1943. Inside of the opening of the well *Phormidium valderianum* Gom. was abundant, forming a thick matting, while on the travertine outside of the mouth of the well *Phormidium tenue* Gom. and *Symploca tenue* Gom. were abundant. *Phormidium laminosum* Gom. and *P. valderianum* Gom. were abundant in the stream formed from the wells a few feet below the openings. From a sulphur spring in the rocks above the stream a few yards below the artesian well, a series of collections showed *Phormidium valderianum* Gom. present in all the samples, with *Oscillatoria formosa* Gom. present in three. *Beggiatoa alba* (Vauch.) Travis was very abundant on the *Phormidium. Aphanocapsa grevillei* (Berk.) Rabenh. and *Chroococcus refescens* (Kütz.) Nag. (Chroococcaceae) and the epiphytic *Pleurocapsa Kerneri* (Hensg.) Dr. (Pleurocapaaceae) were found. Representing the Chlorophyceae *Pithcphora* sp. and *Rhizoclonium hieroglyphicum* (Ag.) Kütz. were obtained. In the stream below the spring and well the following were found: *Beggiatoa alba* (Vauch.) Travis, *Chroococcus rufescens* (Kütz.) Nag., *Phormidium laminosum* Gom. *Spirogyra* sp., and *Rhizoclonium hieroglyphicum* (ag.) Kütz.

In the moist travertine of the travertine falls which were drying up June 25, 1943, due to diversion of the water for irrigation, on the McDowell farm, San Saba County, *Phormidium autumnale* Gom. and *P. papyraceum* Gom. were found. In the stream immediately below the falls *Oscillatoria tenuis* Gom. was found.

It is interesting to note that in each of these cases *Phormidium* is associated with travertine formations except where the oil waste water flows out of the outlet pipe. The presence of these blue-green algae seems to accelerate travertine formation, but they are responsible only in part for its formation. The chemistry of travertine formation will be discussed elsewhere.

One exception to the presence of a species of *Phormidium* where travertine was being deposited was in a small falls eight miles southwest of Austin. Here *Sebyiothrix coriacea* Tom., *Scytonema alatum*, *S. figuratum*, *S. myochrous*, and a species of *Symploca* were found associated with travertine deposition.




Map of the area near the San Marcos River in the Luling oil field showing stations where collections of microorganisms were obtained and the temperatures (Fahrenheit) of the water (October, 1943).

## PAPERS

### Biology as An Approach to a Sound Philosophy

C. C. DOAK, A. & M. College of Texas, College Station

It is not Yankees or Southerners alone, not Democrats or Republicans alone, not Americans or Asiatics alone, not Axis or Allied nationals alone who constitute society, but, for the purposes of this paper, human society consists of the entire complex of interrelations of the genus *Homo*.

It is admitted at the same time that in a narrower sense a society, or sub-society, may be any group of organisms bound either by instincts, common training, provincialism, or any other tie into a cooperative working unit.

The more conflicting elements that are thrown into the cauldron of interrelations, the more numerous become the possible reactions in the society. Since in the over-all society the reacting elements are infinite in number, all of us find reason for being provincial in one way or another. In fact all our institutions, including The Texas Academy of Science, are organized with a view to limiting the reacting elements to those which have such a common hold upon their members that they will be held together in an effective sub-society. Our provincialisms, therefore, differ only in degree.

All will agree that our world, at this troubled period, is muddled beyond anything known before in all history. Hates and war psychology we have had before, but never in such proportions; migrations, invasions, and mass transport of peoples we have had before, but rarely have they come with such suddenness in such numbers. Inventions, technical advances, secret weapons, and even industrial revolutions we have had before, but with us these have been multiplied. And so it has been in every field.

In the field of health it has been vitamins, sulfa drugs, penicillin, blood plasma, and a host of others, the total of which has opened the tropical frontiers to white men and has raised the question of who will inherit their riches.

In the realm of nutrition, it has been refrigeration, quick-freezing and dehydration, together with new techniques in synthesis which will make food from nearly anything from yeast to sawdust.

In the military realm it has been dive bombers, block busters, bazookas, walkie-talkies, rocket guns, and a daily quota of secret weapons until the proverbial conservative mind of the military man has been forced to become most versatile.

The realms of politics, religion, and education have also come in for a large number of reverses, upheavals, and new points of view, any one of which is sufficient to produce a minor revolution. The more complexities these things bring to our society, the more urgent becomes the need for some common approach to a unifying philosophy.

It is axiomatic that men cannot live together in a cooperative common society unless there is a dominant philsophy in which all share. The boys' gangs to which we belonged in our youth, the late Zoot Suiter's band, Al Capone's former followers, the Republican party as it used to be, the pre-Pearl Harbor Isolationists Block, the League of Nations, and the Rome-Berlin Axis each constituted a limited society, and each quickly disintegrated as soon as the aims and standards of conduct which bound its members together had been either *outgrown*, as in the case of the boys' gang; or *outmoded* as in the case of the Republican Old Guard; or *made ridiculous* as in the case of the Isolationists Block; or *surrendered to outside forces* as the Roman half of the Rome-Berlin Axis. In like manner, any of our sub-societies be they *fraternal, religious, economic, political, educational,* or *military,* will fall apart if not provided with a binding warp and woof of ideas and ideals toward which the society directs its efforts. It is imperative that the members consider these worth all the risks, cost, and efforts involved. Just as the League of Nations fell apart for this lack, so will the proposed new world order disintegrate unless bound by strong common ties. It is important that the members in the rank and file of any society comprehend the standards by which the conduct of members will be judged, for when the common philosophy is lost, the society comes to an end. The Texas Academy of Science will cease to exist if and when the members decide that the values received are not worth their costs.

There are certain people who look to religion to furnish the binding tie for World Society, but there is no body of religious experience common to all men. Rather, there are hundreds of religions, each with its own account of creation and its separate path to salvation. If we may draw our conclusions from the records of history, religion, or what goes under the name of religion, is more likely to wreck our efforts at common action than it is to assist to that end.

Language cannot serve the purpose, for there are thousands of languages each with its own limitations, and for that reason the new organization cannot be held together on linguistic grounds. However, the new techniques of teaching languages, coupled with the new and urgent need for an international means of communication, hold out more promise for the success of a universal language than has obtained at any time in the past and certainly deserve consideration for the postwar period. As important as such a language may become, however, it is not, and cannot become, available in time to serve as an initial tie in the postwar order.

Racial and national grounds are equally impotent, for all mixed groups among us fly apart at the mere mention of them.

Judged by the fight now going on between the ideologies, we can place no hope in them as a basis for world wide cooperation. The ideologies are not only clashing around the globe, but they remain at war even after their proponents, from sheer physical exhaustion, have laid down their arms, as in France and Spain.

Men are dying by the thousands in support of each of the ideologies and, among the supporters of more than one of them, biologists and other scientists have been persecuted for bringing in data not in accord with the immediate needs of political incumbents.

Even in America it is a little dangerous to be completely honest with scientific data. Witness, for example, the man who concluded from experiments that Oleo, when fortified with vitamins, was in all respects equivalent in food value to butter.

What cowardice it would be if the sub-society of biologists should sanction the spilling of blood and treasure abroad, to fight the false science of the Axis, and then remain indifferent to such tyrannies at home. If freedom is worth fighting for *anywhere,* it is worth fighting for *everywhere,* and all of it is worth fighting for in the sub-society of science.

Society's excuse for leaving biologists on their present jobs should be that she has thus placed us in order to utilize our highest skills to the benefit of the greatest number. Our government recognizes the fact that biology furnishes the means of saving and prolonging life. It has plasma for a reminder. Biology heals the sick, and there are the sulfa drugs to prove it; it clothes the naked and there are the new fabrics and dozens of improved fiber-producing plants and animals; it houses the homeless, and we have as evidence our improved forest techniques. It becomes our patriotic duty as biologists, therefore, to see that *our* people, and *all* society, have life and have it more abundantly through the things that our laboratories have provided and can provide. But man does not live by bread alone. Mental food is also needed.

The material things of life the public accepts greedily, and unquestioningly, from our hands, but unfortunately the wares which biologists hold out to the mind of man are not accepted with the same readiness. The food which we put in his mouth he devours greedily and while asking for more he grows in health, stature, wealth, and in arrogance until his newly found energies can no longer be contained. He then begins to make trouble for himself and for his fellows and most of all for biologists. Without the necessary mental discipline which training in science would bring, he eschews science and runs after quackeries, and we see increasing numbers joining health cults, ascribing to astrology, and falling for the false science of propaganda and modern advertising. He neutralizes the good effects of our teachings by making positive responses to detrimental stimuli, and we see increases in addiction to tobacco, alcohol, and drugs. He breaks the biological ties, which we teach should bind him to his family and, as a result, divorce, juvenile delinquency, and venereal diseases are on the increase.

Man lowers the biologists' wages, laughs at their findings, withdraws their subject from the school curricula, classifies the biologist as a crack-pot, repudiates his debt of gratitude for vigorous health and tries to pass laws against all but the purely physical bill-of-fare which biologists have furnished him. The weapons which we give him for the defense of his body he appropriates without so much as making an effort to understand either the scientific method by which they were acquired, the principles upon which they operate, or the human sources from which they have emanated.

These facts should lead us to demand an addition to the four freedoms. Freedom from ignorance is more than a crying need. It is a necessity. The restoration and the revitalization of both high school and college science, to say nothing of the science of pulpit and press, is imperative. We must recognize the fact that no man is equipped to live out his life to the fullest unless he has some training in scientific method, and no society can coordinate its behavier in a scientific age unless its members have given some thought to biology, which, after all, is but the science of life. This statement is not meant to lessen in any way the importance of the other sciences for they, like biology, have been poorly taught, neglected, and impoverished. It is a little embarrassing to me to have my country in the heat of the world's fiercest battle say in effect, "Take your product back. He is worthless to us with his brain in its present untrained and muddled condition. Quit pampering him; give him a man's assignment; leave off the mushy, easy courses and give him enough basic science to permit him to use and appreciate the scientific weapons necessary to win a scientific war."

Certain facts lead some biologists to an inward consciousness of the greater value of the *mental* as compared with the *purely physical* aspects of our science. In the heat of life's battles, the weapons which have been placed in the heart and mind of man often prove of more value than those placed in his hands. The soldiers who are found after each battle wandering dazed, and without weapons, because under pressure their inward mental conflicts took charge of their minds, give us daily reminders of this fact. Modern biologists have shown that shell shock is cured when the mental conflicts are removed and the seemingly conflicting elements in the patient's society are again fitted together into a pattern that makes sense. Shell shock is a biological reaction to a psychological state. I am not astonished, therefore, that those responsible for morale in our army are finding that a good grounding in the fundamentals of modern science is equivalent in stabilizing value to an abiding religious faith, and that most of the crack-ups come among men who have neither. Recognition of these facts and the application of the appropriate remedies are returning to service, and to normal life, hundreds of men who, under the treatments current in 1917-18, would have remained forever hopeless mental cripples. This ought to prove that the findings of biology have some values beyond the purely physical.

For these reasons it becomes our duty as biologists to speak out boldly where the truths, revealed to us by living things, will count for most, to guard zealously the interpretation placed upon our science, to strike back with vigor at any attempt either to throttle our free speech or to lessen the effectiveness of our work. It is a part of our duty also to teach, with vigor, the philosophical as well as the purely biological conclusions to which the facts of our science drive us. If we are not to be charged with cowardice, we must not shirk even when personal dangers are encountered.

In that phase of our science bordering on chemistry, we have seen the molecules linked to form complex compounds such as vitamins or hormones. We have seen these react to produce marvelous coordinations in healthy animal and plant bodies. We have seen thousands of kinds of competing, but interdependent, plants and animals strike a biological balance in nature to form an ecological society. We know full well that all organisms, man included, are bound on the wheel of life, which we call the organic cycle. We have the bones of dinosaurs and the remains of early civilizations to prove that all who stand for the *status-quo* in a changing world are doomed. We have the record of history to show that social evolution has closely paralleled biological evolution. Individuals preceded families, and families preceded tribes, and tribes preceded small city states, and scarcely a modern nation exists that has not been produced by the union of smaller nations. Large nations in their turn have demonstrated the advantages of harmonious cooperation as well as the deadly effect of its lack. The free flow of men and materials within a large geographic area such as obtains within this continent at this time contrasts so sharply with the inefficiency of a coerced and Balkanized Europe that the difference leads us daily nearer to victory.

At each step in social evolution the social organism has been enlarged as the means for communication, transportation and military control have permitted effective coordination of a larger area of peace and harmony. Contrary to popular belief the total amount of war in terms of conflict leading to combat is inversely proportional to the size of the social organism.

We all know that the means for communication, in the form of radio, now extends around the globe, that the means for world transportation is speedy and sure, and the reach of effective military power now spans continents and oceans and is growing by the hour. Another way to say it is that modern inventions have produced the necessity for further extending the frontiers of peace and harmonious cöoperation here and now. Yet another way to say it is that the whole idea of a Balkanized world of completely independent and self-sufficient states without coordination, intercommunication, and international trade is as hopeless as a human body devoid of nervous and circulatory systems.

It is surprising to some people to learn that all of the conflicting elements in this war agree in that all hold it desirable to extend the sphere of economic and political cooperation. The Germans and Japanese seek to accomplish it by force and invasion. Russia sought (or still seeks unofficially) to convert the world to her ideology, and belatedly we encountered the Good Neighbor Policy.

Latecomers though we were, our solution has in its support the whole background of biological evidence. Living systems have continuously prevailed against disorganizing forces of nature, thus increasing their orderliness and organization; so must we prevail. In the course of individual development, an organism passes from relatively homogeneous egg to highly differentiated adult, and so in the whole mighty sweep of evolution from a microscopic blob of protoplasm to the magnificently elaborated organisms of our daily experience; living things show a steady and seemingly irresistible trend toward increasing order and nowhere are their organizing forces static. As complex as the individual organisms are, their ecological interrelations are all the more so, and what is more significant, suggesting a nation's place in an international order, is that the success of the ecological society in no way interferes with or prevents the success of the constituent sub-societies.

* The achievement of animate beings is itself in dynamic equilibrium, like the hovering of a bird in flight, lifting itself by continued action against the forces forever striving to drag it down. A small breakdown in the living machinery, a single false move in behavior, a brief remission of control, and the individual, the species, plummets down to death and oblivion. The path of living things is strewn with failures; the forces of disintegration are continually eroding its ranks, but the parade of the living marches on—and up.

For the social organism, likewise, "eternal vigilance is the price of freedom"; and, though our present forms of civilization now look discouraging, they are after all a manifestation of that same life process which has pulled itself up by its bootstraps, through tribal background and medieval states to modern nations. Mutual cooperation and integration into a larger whole have always had survival value, for as organisms have improved in such organization so have they prospered. Mutual helpfulness of individual units and sacrifice of the lesser for the good of the greater are real biological virtues. It is no accident that they are also social virtues. Many of the present primitive species of society will not permanently survive, but others may appropriate their good points before they pass on. The weight of

* Most of the ideas and some of the wording in the closing paragraphs have been taken from Gerard's work on Unresting Cells.

biological experience gives us a strong hope that civilization is not doomed to destruction but, rather, will survive and improve.

To me this is the biological approach which, in accepting the invitation to speak before this body, I felt it my duty to hold up as one of the approaches to the world's biggest and most difficult problem, the problem of what to do about postwar social organization.

## Effects of Photoperiodicity on Egg Production by Female Quail

BRYAN P. GLASS and GEORGE E. POTTER, A. & M. College of Texas, College Station.

For a number of years several investigators have been making studies of the effect of the relative periods of light exposure on the reproductive activities of birds and some other animals. It has been found by Bissonette, Burger, Clark, Rowan, and others that in certain birds the maturation and production of germ cells can be brought about by controlling the daily light ration. This has been accomplished by placing normal birds on a ration equal to that of the shortest day of the year (about 9 hours) at seasons other than the normal breeding season and then increasing the amount of light exposure weekly until the daily ration is approximately 16 to 17 hours. In starlings and crows the tests have been brought to mature breeding condition during early winter. Bissonette has caused pheasants which normally breed and lay eggs only in the spring to lay a few eggs in a snow bank in December.

Two sets of experiments have been carried out in studying the effect of controlling the daily exposure of the female quail to light. The quail in nature has ordinarily only one breeding season during the year and in Central Texas it occurs in April and May with the eggs being laid in the latter part of May. However, it is occasionally reported that a second clutch is laid in late August or early September.

The first set of experiments was planned to determine whether or not the quail could be induced to lay eggs in the late fall and winter as had been done by Bissonette with the pheasant. To test this, three female birds (and incidentally two male birds) were introduced to light treatment on November 10, 1941. Paralleling this group, two females and two males were kept in normal daylight exposures under identical food and temperature conditions as controls. At this time the normal daylight period is approximately eleven hours and is decreasing each day. The experimental animals were placed on an increasing light diet with a thirty minute increase each week. This was kept up through the remainder of November and all of December by the end of which the birds were on a daily ration of 16 hours. On December 24 these birds began to lay and during the next two weeks the three of them had laid twenty-two eggs. However, these eggs did not develop when placed in an incubator and apparently were infertile even though the males had been with the hens throughout the experiment. No eggs were laid by the controls nor was there any indication of sexual activity among them. During the previous year a similar experiment was performed with male birds and the testes examined histologically to check for changes in the structure of the seminiferous tubules, but the results were quite uncertain.

The second phase or set of experiments constituted an attempt to do the reverse of the above but at the normal breeding season, that is, to suppress the normal egg development and production at the natural breeding season in the spring. To do this, two females which had been with the general stock of birds (males and females) in normal daylight conditions were placed in a light control chamber[1] on April 6, 1942, with the daily light exposure set at 12 hours. Four other females were kept in the stock cage under identical conditions except for the light control and the presence of two males with them. The daily light exposure on the experimental animals was reduced one half hour per week until on May 20 the daily ration was nine hours while the exposure of those in the control cage had steadily increased until it had reached a daily period of more than 14 hours. The experimental birds were continued in the light control chamber at nine hours exposure until July 15 when they were removed. Neither of these experimental birds had laid any eggs during this entire season.

The females in the control cage had begun laying on May 24 and by June 22, when one of them died, the four had laid a total of 48 eggs. The other three continued to lay until July 15, when the total number laid had reached 81 eggs. Two different settings of 22 eggs from each of these were incubated and five hatched from each group.

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[1] 6′ x 4′ light tight chamber with internal lighting connected to a ventilator and controlled by a timing clock. This chamber was built from funds supplied by a research grant from The Texas Academy of Science.

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## The Mesa Region of Texas: An Ecological Study

B. C. THARP, The University of Texas, Austin.

The studies which form the basis of this paper were made during somewhat more than two months in mid-summer of 1943.

The Mesa Region of Texas centers in Pecos County with margins in Crane, Upton, and Crockett counties. It is composed of flat-topped hills of varying size separated by valley "flats," also of different widths. Canyons of varying size and ruggedness head in the sides of the mesas and broaden out into the intervening valley flats. Roadways, both public and private, for the most part follow the margins of valley flats. Sometimes they climb the more gentle mesa slopes to the table-land tops.

*Vegetational Areas*

The composition and appearance of the vegetation follows closely the topography—the valley flats, the slopes between these flats and the mesa bases, the mesa slopes (lower, middle and upper), the caprock, the mesa margins, and the interior of the mesa tops each having its own characteristic type of vegetation. These types are conveniently designated by names embodying the names of their most abundant and conspicuous components plants. Many such plants have common names by which they are well known to ranchmen and to other laymen. Many do not. In so far as is possible these common names will be used in this summary of the results of the summer's investigations. Accordingly, the correlation between the several vegetational areas and the topographical units they cover follows:

| *Vegetational Area* | *Topographic Unit* |
|---|---|
| 1. Mesquite-Buffalo Grass | Well watered inter-mesa valleys and rarely similar situations in the interior of large mesas. |
| 2. Blackbrush | Broad valley flats and the interior of large mesa tops. |
| 3. Creosote bush (or grease-wood) | Low valley ridges and the interior of large mesa tops. |
| 4. Short grama—Acacia | Lower mesa slopes. |
| 5. Hairy grama—Needle grass | Middle and upper mesa slopes. |
| 6. Persimmon—Buckeye | Base of cap-rock. |
| 7. Mixed grama—Lechuguilla | Mesa margins atop cap-rock. |
| 8. Same as 3, above | Mesa tops. |
| 9. Cedar—Walnut—oak | Large, deep canyons leading from mesas. |

It should be clearly borne in mind that these various vegetational areas frequently shade one into another along more or less sinuous lines of contact, producing "transition zones" which represent various blendings of the components of the adjacent areas.

*Range Value*

Obviously the value of a range is directly proportional to the number of pounds of beef (including hides), mutton, wool and/or mohair it will produce per section. These, in turn, depend upon the character and abundance of the vegetation. Plants that are available to grazing or browsing domestic animals, and are palatable and nutritious, are of value in proportion to their abundance. A plant may be both palatable and nutritious, but, if it is too scant to produce an appreciable quantity of forage or if it be not within reach of livestock it can have little value. On the other hand, a plant may be ever so plentiful and within easy access and yet, because of unpalatability and/or low nutritive content, have little value. A further complication stems from the fact that by choosing forage which is palatable and nutritious and rejecting that which is unpalatable and probably also low in nutritional content, the most valuable plants are held more or less in check by overgrazing, to be crowded out by those of little or no value. This tendency is present, even under moderate stocking during good seasons; but when a sustained drouth strikes a region the situation becomes critical. Under these conditions the range cannot support the number of stock it easily carries in normal seasons; the palatable plants are grazed to the roots; less palatable plants are taken through the urge of hunger; and only the worthless ones are left free to grow, unhindered by browsing or grazing. It is then that ranges become destructively overgrazed. The ranchman not only is unable to ready his stock for market; he cannot even keep it alive without excessive expense for feed.

*Composition and Evaluation of Vegetational Areas*

1. *Mesquite-Buffalo grass.* Areas comprising these dominant plants are relatively fragmentary and scattered. They occur only on those valley localities that are best watered by reason, (1) of being comparatively level, (2) of having a considerable volume of water spread over them by run-off during rainy seasons, and (3) of character of soils which, while compact and fertile, at the same time absorb and hold water effectively. On such areas mesquites attain their best growth. Varying in density of stand and in the degree of admixture of other woody "brush" species, they are always accompanied by a ground cover of buffalo grass whose density in turn depends on the density of canopy of the woody growth above. Situations in which the mesquite stand is open and the presence of other brush species is negligible show the best carpet of buffalo grass—the most valuable single range grass in all of North America.

Mesquite itself, in its beans, produces a very palatable and highly nutritious food, especially for cattle and horses. A drawback lies in the fact that mature unchewed seeds pass unharmed through the animals to be dropped widespread and scatter the plant over all areas adapted to its growth. Density of its stand, moreover, is increased through the habit of cattle to seek the protection of the shade it affords, so that dense thickets have developed on choice areas that in the absence of dense mesquite would support rich carpets of buffalo grass. Such thickets are almost invariably invaded by other brush with the result that the grass is progressively crowded out with increase in the density of brush. The ideal condition for greatest production in these areas is one in which a sparse stand of mesquite, unaccompanied by other brush, affords protective shade for stock without decreasing the value of the grass. This condition is fairly well approximated in certain exceptional localities; but the very presence of cattle and horses during the season when mesquite beans are shed insures its further spread with consequent further range deterioration. This is one reason why many choice areas exhibiting ideal range conditions have now been largely taken over by mesquite and its accompanying brush. Other reasons will be discussed in connection with general range practice.

While buffalo grass is the most abundant and most valuable grass in the mesquite flats, it is by no means the only one. Others that, collectively, provide valuable range are: side-oats grama, drop-seed, sprangle-top, sweet blue-stem, wild millet, grape-vine mesquite, wild rye, white *Triodia,* bush muhli, Reverchon's muhli, and wild rye. Grasses of little range value are burro-grass, triple-awn, and tobosa. All three of the last named group have some value when young and succulent; but when old they become tough and unpalatable. In times of excessive drouth they are taken by stock under desperate hunger urge and thus function to delay death from starvation.

Browse plants (weeds and brush) which are of some value to sheep and goats (there being few goats) are: (1) shrubs; *Ephedra, Celtis* (hackberry): (2) herbs; *Acuan, Hoffmanneseggia, Abutilon, Sphaeralcea, Galpinsia, Haplopappus, Selloa, Simsia, Viguiera.*

Shrubs and herbs that are rejected by livestock and tend, under overgrazing, to crowd out desirable species: (1) Shrubs; *Coldenia, Flourensia* (blackbrush); (2) herbs; *Croton, Asclepias* (milkweed), *Krynitzskia* (borage), *Marrubium* (hoarhound), *Solanum,* (nightshade), *Gutierrezia* (broomweed).

In so far as mesquite-buffalo grass flats are concerned, the ground carpet of buffalo grass is normally quite dense and stable even under intensive overgrazing. The result is that both browse plants and rejected plants are a potential rather than a real danger to the ranges at the present time.

2. *Blackbrush flats.* These flats are quite extensive over the poorly watered areas which lie topographically just above and areally just outside the lower, better watered mesquite-buffalo grass flats. The growth of blackbrush is frequently so dense as to crowd out valuable plants to such an extent as materially to decrease the value of the areas these flats cover. All livestock except goats reject blackbrush as browse. One small pasture lies just outside Ft. Stockton on the Marathon road. It is practically covered with blackbrush, and in it a large herd of goats had been kept two or three weeks. The brush inside the pasture had been entirely denuded both of its twigs and foliage, so that it had the aspect of winter, while outside, on the road right-of-way, it had its typically green and flourishing aspect. This indicates beyond question that blackbrush is potentially valuable as browse for goats, at least where the number of animals is excessive and little except blackbrush is available. It also suggests the possibility of using

large herds of goats to hold in check a plant that is a definite menace on ranges stocked with cattle and sheep.

As suggested above, plants other than blackbrush are frequently so sparse of stand as to have their value quite reduced. Some of these which, if the blackbrush were held in check, might become sufficiently plentiful to have their value materially increased are: (1) Grasses: *Triodia,* Reverchon's muhli, tobosa, buffalo grass, *Leptoloma,* grapevine mesquite, wild millet, sweet bluestem, triple-awn, and burro-grass. (2) Shrubs: *Ephedra;* (3) Herbs: *Hoffmanneseggia.*

It is apparent that a large majority of the potentially valuable forage plants listed are grasses. Of these the most abundant under present conditions are burro-grass, triple-awn, and tobosa. These three are themselves taken with reluctance by all livestock and only under the urge of hunger. All three are adapted to the soil and water conditions prevailing on blackbrush flats; they tend to spread at the expense of the more valuable grasses as the latter are overgrazed in preference.

Since the area as a whole lies just above the mesquite-buffalo grass flats, it is to be expected that the more valuable grasses which require somewhat more water, and which comprise the remainder of the list, would be found in depressions that hold some water for a time after rains. This is the case.

An important corollary is to be found in connection with the construction of numerous spreader dams, built with government aid across rather broad drainage troughs leading into the blackbrush flats from adjacent slopes. These produce artificially, and frequently on a much larger scale, the impounding conditions found in natural depressions. In all cases buffalo grass (and frequently one or more of the other valuable sorts) has begun to form a turf behind the dams, indicating that a slight hindrance to run-off will allow a sufficient quantity of water to soak in to swing the balance in favor of valuable rather than valueless grasses.

Many large spreader dams have been built across wide stretches of blackbrush valleys. The longest of these large dams observed is some half a mile, with a height of six or seven feet. It stretches across a central mesquite-buffalo grass flat with bordering zones of blackbrush and impounds considerable water for short periods following heavy rains. Buffalo grass is abundant, together with sweet bluestem, side-oats grama, wild millet, *Triodia* and muhli.

A drawback to the benefit derived from the increase of buffalo grass lies in the fact that blackbrush and other brush also grow more dense and luxurious, thus tending to crowd out the desirable grasses.

3. *Creosote Bush Slopes.* These areas occupy low slopes leading from the mesa bases to the blackbrush flats as well as low ridges between such flats. Along contact lines between creosote-bush and blackbrush areas the two outstanding plants are typically mixed along rather broad zones, each shading out as the other becomes more dense. In other words a few scattering individuals of blackbrush first appear on the lower margins of creosote slopes and ridges. The creosote bush becomes less dense until, on the opposite margin of the mixed zone, it disappears, shading into a pure stand of blackbrush. Creosote bush is apparently rejected by all livestock, in-

cluding goats. It derives its name from its abundant production of an apparently oily secretion in the twigs and leaves. This secretion, especially following summer rains, has a characteristic odor suggestive of creosote. It seems possible that this substance, while apparently the cause of creosote's rejection by livestock, might have some economic value as a gum, wax or oil. Material of the plant is now under chemical investigation to determine this point.

Several other shrubs in addition to blackbrush are found scattered over the creosote bush areas. Among these are *Ephedra, Acacia,* sumac, midget buckthorn and allthorn. None of these is of any browse value except *Ephedra,* which is never sufficiently abundant to be of importance.

Weeds present that are refused by livestock are broomweed, *Perezia,* and hoarhound; all of these may be potentially a liability under conditions of intensive grazing.

Weeds that are readily browsed and hence of value in proportion to their abundance are yellow wild bean, spurge nettle and Indian mallow.

Valuable grasses, in the order of their range importance are buffalo grass, short grama, hairy *Triodia,* grapevine mesquite, Hall's panic grass, *Leptoloma,* muhli, wild millet, tobosa, needle grass, burro-grass and *Pappophorum.*

In general, all the above are relatively sparse in stand. In consequence, the creosote bush areas have perhaps the least value for ranching purposes.

4. *Lower Mesa-slopes.* These slopes, as the name indicates, lead upward with an increasing gradient to the steeper middle slopes, while at their lower margins they fuse with the creosote areas. While appearing almost bare to the observer as he drives along an adjacent road, they are really good grazing lands as grazing lands go in this region. The two most important grasses, because of their abundance and high nutritive value, are short *Triodia* and short grama. Both are short in stature, but their abundance, together with the fact that they are practically indestructible either by intensive grazing or by extreme drouth and that they put out quick growth after rains, makes them outstandingly valuable. Other grasses of value are black, blue and hairy grama, buffalo, muhli, drop-seed, triple-awn, wild millet, Hall's panic grass, and *Leptoloma.*

Shrubs that are of some value as browse are *Chrysactinia,* ceniza, *Ephedra,* catclaw, midget buckthorn, guayule and *Krameria.* Worthless shrubs that are a definite detriment are ocotillo, sotol, allthorn, lechuguilla, cedar and creosote bush. Browse weeds are so eaten back that few of them are now sufficiently abundant to be of any appreciable value. Representatives are *Acuan,* yellow wild bean, wild flax, spurge nettle, mallow, evening primrose, *Verbena,* bluet, white daisy, yellow aster, cone-flower, and Indian-blanket.

Weeds that are rejected are thistle, senna, *Croton,* borage, heliotrope, hoarhound, horse-nettle, wild gourd, broomweed, gumweed, *Zinnia,* false guayule, *Dyssodia,* and squaw-weed.

The definitely poisonous weed, *Psilostrophe,* is occasionally found locally in sufficient abundance to preclude the running of sheep during its season of growth.

5. *Middle and Upper Mesa Slopes.* These are also valuable grazing lands, supporting many of the same range grasses as are found on the lower slopes, but with brush growing somewhat more thickly, especially as the slope approaches the base of caprock. Valuable grasses comprise mostly short and tall Triodias, four kinds of grama, muhli, dropseed, speargrass, sprangletop, *Leptochloa, Leptoloma,* panic grass (two kinds) and wild millet. The only relatively worthless grasses are five kinds of triple-awn grass. Opinions differ as to the value of triple-awn; some ranchmen hold it to be of considerable value, others well nigh valueless. The writer is inclined to hold the latter view, based on observation of its utilization by livestock.

Burro-grass and tobosa, dominant on the blackbrush flats, do not occur on these upper slopes and are too rare on the lower slopes to be of any consequence. Browse shrubs include *Ephedra,* catclaw, *Krameria,* lignum-vitae, *Bernardia,* midget buckthorn, ceniza, and guayule. Worthless, rejected shrubs include cedar, sotol, lechuguilla, creosote bush, *Ocotillo* and Wright's bee-brush. Browse herbs include *Eriogonum,* umbrella-wort, *Boerhaavia, Paronychia, Acuan, Parosela,* wild flax, milkwort, spurge nettle, mallow (several sorts) *Verbena,* paintbrush, bluet, white daisy, yellow aster, and *Thelesperma.* Rejected herbs, or weeds, are *Tidestroemia, Acleisanthes, Cyphomeris, Wedeliella,* gumweed, senna, *Croton,* pursley, false guayule, mercury, milky spurge, horse nettle, borage (several sorts) gourd, broomweed and *Chrysactinia. Psilostrophe* occurs sparsely and does not at the present time appear to be on the increase.

6. *Cap-Rock.* The area included under this caption includes both the uppermost slope where it joins the base of the rock and the perpendicular face of the rock itself, as well as its bare and exposed edges. The base of the rock is thickly beset by dense brush growing from the top of the slope where rich soil and humus have accumulated in the broken rocks and soil that have come from the weathering and erosion of cap-rock. The water supply is more than usually abundant, humus content high, and the consequent growth conditions good. The result is a dense tangle of brush such that it becomes difficult for one to make his way through it. Grasses and weeds are all but crowded out; and the shrubs, even such as are palatable, grow too tall to serve as browse. Oak, hackberry, catclaw, Texas mountain laurel, shrub spurge, shrub *Croton,* two kinds of sumac, Mexican buckeye, *Condalia,* midget buckthorn, *Cissus,* Mexican persimmon, white brush and *Viguiera* are all found variously intermixed.

A few grasses occur sparsely, including muhli, wild millet and sprangletop. Herbs that can endure excessive shading also occur scatteringly. Examples are *Cyphomeris,* wild flax, *Acalypha,* milky spurge, several mallows, passion flower, hoarhound, climbing snapdragon, wild balsam, gum weed, *Thelesperma,* and *Viguiera.*

Ferns, a few herbs, and some scrubby brush grow in cracks and crevices in the perpendicular walls of cap-rock. Most of these are out of reach of any livestock and are, moreover, too scant to be of any value.

7. *Mesa Margins.* This designation includes the areas extending from the immediate edge of caprock across the strip of marginal land subject to

erosion by run-off water as it approaches the edge. The width of these strips varies, but it is usually some 500 to 600 feet.

Vegetation is usually about the same as found on the mesa slopes. At the very edge, the bare rock is typically exposed in an irregular broken-block pattern. In the cracks between blocks, and in surface cavities, soil accumulates in sufficient quantity to support a vegetation of ferns, club-mosses, bluets and other growth. These are almost all freely browsed, so that they become closely cropped off almost even with the rock surface. While the quantity is nowhere abundant, its total is considerable, thus contributing a material portion of nourishment, especially for sheep and goats. Behind this narrow strip, surface soil becomes increasingly deep, supporting range plants in increasing abundance. The most important grasses are short *Triodia* and short grama, muhli of several kinds, buffalo grass, black and hairy grama, tall *Triodia,* and triple-awn.

Browse shrubs are: *Ephedra, Fendlera,* catclaw, bush *Parosela,* lignum-vitae, ceniza and *Viguiera.* Rejected shrubs: cedar, sotol, cacti of several kinds, lechuguilla, sumac, Mexican persimmon, ocotillo, Mexican buckeye, Wright's bee-brush and mesquite. Browse herbs: *Eriogonum, Allionia, Boerhaavia, Paronychia, Acuan, Parosela,* wild flax, milkwort, mallows of several sorts, *Menodora, Gilia, Verbena,* paintbrush, snapdragon, *Carlowrightia,* bluets of several kinds, white daisy, blue aster, *Thelesperma* and spurge nettle. Rejected herbs: *Cyphomeris,* senna, *Croton,* milky spurge, mercury, *Mentzelia,* hoarhound, wild mints, wild tobacco, ground cherry, horse nettle, gum weed, false guayule, and *Perezia.*

Bitterweed, the poisonous weed dreaded by ranchmen farther east, occurs rarely and does not yet appear to be a menace.

8. *Mesa Tops.* The mesa tops in their central regions beyond the marginal portion vary considerably in their vegetational cover. On most small and medium-sized mesas the creosote bush type of vegetation is most common. On larger mesas, where the surface shows flats intermixed with low ridges, the flats support blackbrush while creosote bush occupies the ridges. On very large mesas, flats may become so extensive and so filled with alluvium as to show typical buffalo grass sod with sizeable mesquite and prickly pear growing scattered about.

In general, except for the buffalo grass flats just mentioned, the margins of the mesas are more valuable as range land than are the interiors. Creosote bush and blackbrush are accompanied, of course, by essentially the same vegetation as when they occur in the inter-mesa valley flats, and their grazing value is essentially the same on the tops as on the low grounds between the mesas.

9. *Canyons.* Canyons vary in size from small short "header" canyons to those which cut back nearly as much as a mile. These latter as a rule have steep, almost precipitous slopes leading to the base of cap-rock, which itself frequently constitutes perpendicular cliffs fifteen to forty feet high. Toward the plain the canyons widen out and the slopes became less precipitous. During heavy rains the volume of water that is carried down one of these larger canyons is tremendous, rolling large boulders down the stream channel and sweeping away everything that could be classed

as soil, except as this type of material finds lodgement in spaces between boulders bordering the channel.

Much more abundantly supplied with ground water and much better protected from the desiccating effects of dry hot winds than the surrounding regions, these canyons support a good growth of sizeable but brushy trees so dense as to make progress slow and laborious as one tries to work his way along the canyon floor. Indeed the growth is so thick and the ground shade so dense that few grasses or herbs, excepting shade-enduring sorts, are to be found. Most of the trees and shrubs are the same kinds as are found at the base of cap-rock. Three trees which grow along the canyon streamways but are not encountered at cap-rock base are Ashe's cedar, wild china and western redbud. Ashe's cedar is apparently restricted to canyons throughout its range (on both sides of the Pecos). It attains a trunk diameter of two feet and a height of perhaps thirty feet. Wild china, usually found along streamways well out on the inter-mesa flats, occasionally grows in canyons as well. In one deep canyon a dense stand of slender graceful trees forty feet high was found. Redbud, frequently found along hillsides farther east in the Edwards Plateau, is in the mesa country restricted to streamways in the larger canyons.

Oak, walnut, hackberry and Mexican persimmon, all grow to appreciably greater size in the canyons than at the cap-rock base. This is also true of such shrubs as Texas mountain laurel, white-brush, Mexican persimmon, sumac and catclaw. Only two grasses were noted along the heavily wooded canyon floors; pale *Triodia* and wild rye, both of which tolerate a considerable degree of shade. A few shade-tolerant herbs occur: wild flax, milkwort, spurge nettle, a mallow and a night-shade. Climbing herbaceous vines belong to the passion-flower, milkweed, morning-glory, snapdragon and wild balsam families. These are able to reach the light by clambering over the shrubs among which they grow.

What has been said above concerning canyon vegetation applies to the streamways at the bottoms of the canyon troughs. It will be apparent, upon reflection, that above these trough bottoms the steepness of the canyon walls will have a profound effect upon the character and composition of the vegetation. Toward the confluence of a canyon with the adjacent flat the declivity of the slopes approaches that of mesa slopes in general and they support the same type of vegetation as has been described for those slopes; toward the canyon head the slope becomes ever steeper and thus approaches that of the perpendicular faces of cap-rock itself. The result of this increase in steepness is to produce an ever increasing abundance of the shrubs that occur both along the streamways and at the base of cap-rock.

10. *Valley Streamways.* As lateral stream channels make their way from canyon mouths down the relatively gentle slopes of valleys to join the main drainage channels, shrubs of many of the canyon species follow along the water course toward the mesquite-buffalo grass flats that usually mark outspread main water courses. Oaks, Ashe's cedar, mountain laurel, Mexican buckeye and Mexican persimmon seldom form any part of the plant population beyond canyon mouths, while mesquite becomes more and more abundant. Desert willow, a rather showy-flowered shrub or small

tree, seems to occur only on these laterals. It is not found either in canyons or on mesquite-buffalo grass flats. The shrub strip is confined to the immediate stream course, in a narrow conspicuous "timber" line standing out conspicuously above the low creosote bush and blackbrush which mark the adjacent valley slopes.

*Present Range Condition and Range Practice*

It is a fact well known to students of climate, based on analyses of rainfall records, that average annual rainfall fails utterly to give a comprehensive picture of conditions within any region from year to year. Such averages are computed by dividing the total rainfall, over the period covered by rainfall records, by the number of years covered by such records. The rainfall records for Ft. Stockton, except for 1886 to 1894 inclusive, and four other years scattered over the period, date back to 1870. Based on these records the average annual rainfall for that station is 14.46 inches. The highest on record is 33.76 inches for 1880, when 13.66 inches fell during September alone. The lowest was 4.07 inches in 1910. The high in 1880 was preceded by a near-low of 5.12 inches in 1879. The all-time low of 4.07 inches in 1910 was followed by 20.24 inches in 1911. The second highest, 29.29 inches, came in 1941 and was followed by only 8.69 inches in 1942.

If these "fat" and "lean" years alternated with each other with any consistency it would not be difficult to plan a stocking program to fit the conditions—but they do not. For example, the six year period of 1880-1885 inclusive had only one year (1881 with a rainfall of 12.65 inches) in which less than 20 inches fell. On the other hand the ten year period of 1908-1917 inclusive had only two years in which the rainfall reached the average: 1911 with 20.24 inches, and 1914 with 22.88 inches. Three years (1910 with 4.07 inches; 1917 with 5.86 inches and 1916 with 7.95 inches) have less than eight inches and the other five years have less than normal rainfall. It is this hazard of such wide variation in rainfall that the ranchmen have to face.

It is only natural for a ranchman, especially if he be a lessee, to wish to utilize all the range production. Therefore, during a series of "fat" years, he has the urge to stock his range to its carrying capacity during those years. When such a period is followed, as it sooner or later must be, by a series of "lean" years it catches him with his range overstocked. His stock cannot be readied for market without his incurring the excessive cost of large quantities of feed. Hope that "next year" will bring a return of more rain and better range causes him to carry over the stock which should have gone to market, together with the calf, kid or lamb crop of the current year. When the next year proves to be repetition of the previous lean year his plight becomes desperate. Then, or during a third such year, he sees his stock begin to die of starvation. He thus incurs terrific losses. For example: 1919 with a rainfall of 24.79 inches and 1920 with 21.39 inches at Ft. Stockton were both good range years; 1921 had only 10.32 and 1922 12:11 inches. During the summer of 1922 numerous skin and bone carcasses of cattle were to be seen lying about on the apparently bare ground in Pecos, Brewster and Presidio counties, after the starving beasts had eaten to nubs the large bunches of slender beargrass (locally called sacahuiste) whose toughness causes it to be entirely rejected by stock on a range in good condition. The range looked as if it were irreparably ruined. That it was not was demonstrated by its comeback during the succeeding four years, all but one of which (1924) had above normal rainfall. It is this marvelous ability of the range grasses of the region to maintain life in their roots, even under the most adverse rainfall and grazing conditions, that constitutes the salvation of ranching in the region.

To look at the picture of conditions following a succession of drought years: the ranchman has either lost a large percentage of his stock by starvation, he has had to make great sacrifice to buy sufficient feed to keep it alive, or he has had to sell it in very inferior condition and at a great loss. Thus, with his stock depleted, a return of wet years finds him again with excellent range but insufficient stock, without any nearby source from which to procure it, and in no financial position to pay for additional stock, even if it were available. All his neighbors are in the same plight.

Intensive overgrazing also tends directly to increase the quantity of unpalatable growth of weeds, grasses, and brush. Perennial broomweed is the outstanding such weed, having come to dominate thousands of acres of land all over West Texas. A sort of false guayule is becoming dangerously widespread and dense in stand. It, like broomweed, has a perennial root, so that once started it tends to persist for years. Neither is palatable, apparently, even to goats. Creosote bush and blackbrush are the most prominent worthless brush plants—blackbrush not altogether so, as has been pointed out on a previous page. Others have been mentioned in discussing the vegetation of the various ecological provinces of the area.

The inevitable result has been a universal increase in worthless or near worthless vegetation over the whole ranching country, not only of this region but throughout Texas and the Southwest. That it is a serious condition is recognized by all ranchmen. Successful ranchmen in the vicinity were all agreed that "brush and broomweed" are crowding out forage plants more and more as time goes by.

*Suggested Lines of Improvement*

1.) Spreader dams. These have been discussed in connection with blackbrush flats, where it was pointed out that, while a definite increase in the quantity of buffalo grass always results, an increase in density and size of brush species is equally apparent.

2.) Terracing. Small terraces have been locally constructed along contour lines, especially in the vicinity of Texon. The extent of beneficial results is in some instances encouraging, in others not. Increasing the size (height) of the terraces and thereby further slowing down run-off would doubtless increase benefits; but it would also increase construction expense, perhaps to a prohibitive degree.

3.) Decreasing the quantity of blackbrush and creosote bush. Both these shrubs have such brittle stems as to suggest the feasibility of breaking them off at the ground by dragging a railroad iron or other heavy drag behind a heavy truck or a tractor. While this would leave the roots largely intact, thereby enabling them to grow new shoots, their slow growth might make the operation worth while. At least this seems sufficiently probable to warrant the suggestion of trying it out on picked experimental areas within both the blackbrush and creosote bush areas.

4.) Decreasing the quantity of mesquite and other brush larger and tougher than blackbrush and creosote bush. Frequently, as has been pointed out in discussing mesquite and blackbrush areas, these two overlap at their margins. It has also been pointed out that buffalo grass is a common and valuable grazing component in the overlapping strips. Now mesquite is not susceptible to being controlled by the drag suggested above: young plants would bend in front of the iron and, while they would certainly be injured, there is little prospect that the extent of the injury would be serious. Older mesquites are too large and strong to yield to any ordinary power. It seems pertinent to call attention, therefore, to an available device which apparently offers an economical remedy for mesquite infestation. Briefly, this device comprises a five or six foot circular saw keyed to a perpendicular shaft so that the saw is paralled with the ground. The shaft is suitably mounted on a frame on wheels so that it may be attached to any farm tractor and adjusted in height from the ground surface to any desired elevation. The device is said to cut several acres of dense mesquite or other brush per day. It is sold all over the United States and has been demonstrated to be successful on large trees, a six-foot redwood having been felled in eight minutes in California (according to the manufacturers). Farther east where mesquite is a general menace it would seem worth investigating as a practical means of control.

5.) Broom weed. A drag may possibly be of some value in control. This can be demonstrated only by trying it out on small test plots.

6.) Grazing practice. Rigid restriction of the number of head of livestock should be practised by all ranchmen. During "fat" years this will result in an accumulation of a surplus of forage to tide over any short period of "lean" years and give the ranchman a better chance to dispose of his stock without loss. It will also save the range from the destructive degree of over-grazing which has heretofore been the rule during dry periods in this region. Several exceptional ranchmen have followed this practice for some years and have clearly demonstrated its value.

## Termite Growth and Nitrogen Utilization in Laboratory Cultures[1]

R. E. HUNGATE, The University of Texas, Austin.

Although termites in nature are notorious for their destruction of wood, these insects usually show little or no growth when brought into the laboratory and fed upon sound wood. They may survive for a long period, lay eggs, and produce a number of young, yet it is usually found that there has been no increase in total nitrogen. Cannibalism is common and such colonies finally die.

In order to study the problem of termite nutrition seventeen cultures of *Zootermopsis nevadensis* were started at the Hopkins Marine Station in

[1]This research was aided in part by funds from The University of Texas Research Institute and in part by the Hopkins Marine Station of Stanford University.

1937, using the culture method which has recently been described (1). Fifteen of these were terminated after two or three years and the results obtained from them have been reported (2). The two remaining cultures, one with soil and one without, showed growth of the termites at three years, but there was still plenty of wood available so they were left until August, 1942, five years after they were started. At that time they showed a much greater growth than had been obtained with the other cultures. They were terminated* and analyses performed on them to ascertain the nitrogen relationships in the culture.

*Culture With Soil*

In culture 194 two pairs of alates of *Zootermopsis nevadensis* were placed with 5584 grams of wood (wet weight) and 1400 grams of soil. Except for examinations at yearly intervals the cultures were not disturbed. After five years the following termites were present: the queen; 144 alates; 10 soldiers; 127 nymphs which would shortly have molted into alates; and 180 other nymphs.

The gravimetric data for this culture are presented in Table I, and the nitrogen data in Table II.

Table I
Gravimetric Data for Culture 194 with Soil

| | Beginning | End |
|---|---|---|
| Weight of wood | 3774 gm. | 2345 gm. |
| Weight of soil | 1372 | 1390 |
| Weight of termites | .045 gm. | 2.587 |
| Weight of pellets | | 160 |

Table II
Nitrogen Content of Materials in Culture 194

| | Beginning | End |
|---|---|---|
| Wood | 1.717 gm. | 1.348 gm. |
| Soil | 1.228 | 0.956 |
| Termites | 0.0025 | 0.217 |
| Pellets | | 0.410 |
| Total | 2.9475 | 2.931 |

There was some mixing of wood, pellets, and soil at the end of this experiment, so the figures for the weights of these materials and the nitrogen in them are only approximate. The nitrogen in both wood and soil decreased and this nitrogen appeared in the termites and in the pellets. The total nitrogen did not change during the experiment. The weight of the soil changed very little and most of the apparent increase was due to inability to separate the pellets and wood completely.

*Due to wartime transportation difficulties it was not possible for the author to go to Pacific Grove to terminate these cultures; all of that work was performed by Miss Dixie Lee Ray. The author wishes to express his great appreciation for her painstaking and capable work. He is also indebted to Dr. W. K. Fisher and Dr. C. B. van Niel for harboring the cultures during the five years of the experiment.

Some of the wood at the close of the experiment appeared to be very rotten. Action of fungi was also indicated by the relatively great loss in weight of the wood. In many experiments it has been found that the termite pellets constitute 40-60 percent of the wood eaten. The 160 grams of pellets recovered in the present experiment indicate that the termites consumed only about 320 grams of wood. Since the total loss in weight of the wood was 1400 grams it is evident that more than 1000 grams disappeared due to the action of agents other than the termites, presumably the fungi.

Inspection of Table II shows that of the nitrogen consumed (nitrogen in the pellets plus that in the termites) about one-third was assimilated into termites, the remaining two-thirds appearing in the pellets. Much of the pellet material was intimately mixed with wood or soil but the termites had neatly piled many of them in certain parts of the culture where little mixing with other materials had occurred. These pellets were found to contain 0.288 percent nitrogen. Assuming that the wood lost fifty percent of its weight due to digestion by the termites, it can be calculated that the wood from which the pellets were formed must have contained about 0.216 percent nitrogen.

The wood of the culture was separated into several portions which were analyzed separately. The percentages of nitrogen in these various fractions are shown in Table III.

Table III

The Percentages of Nitrogen in Various Fractions of the Wood of Culture 194

| Material | Percent Nitrogen |
|---|---|
| Original wood | 0.046 |
| Unattacked wood at the end | 0.045 |
| Wood slightly attacked by fungi and termites | 0.050 |
| Wood heavily attacked | 0.145 |

The data of Table III show that the most decayed wood contained the greatest percentage of nitrogen. This portion of the wood also contained the most termite burrows and was evidently used as food by the termites. Its average nitrogen content (0.145 percent) is much nearer that calculated for the termite food (0.216 percent) than was the original wood or the unattacked wood at the end.

Two factors were concerned with the increased concentration of nitrogen in the decayed portion of the wood. First, the decomposition of the non-nitrogenous constituents caused the percentage of nitrogen to be higher, even though the absolute amount remained the same. Second, nitrogen was transported from the soil into the decaying portions of the wood. During the experiment the nitrogen in the soil decreased from 0.090 percent to 0.053 percent. The latter value was obtained with soil which was not mixed with any wood or pellets.

These data show rather clearly the quantitative changes in the nitrogen in the culture. The nitrogen in the soil is transported into the wood. The termites feed on the parts of the wood in which the nitrogen content is greatest.

Although it is somewhat speculative to draw conclusions from the foregoing data as to the nature of the nitrogenous materials eaten by the termite, the most reasonable interpretation seems to be that the fungus protoplasm is an important food. The transport of the nitrogen must come about by its assimilation into the fungus filaments which carry it to the vicinity of the termite burrow. It is unlikely that a secondary decomposition of the fungus body occurs before it is eaten by the termite though on the basis of the present data such a possibility cannot be entirely eliminated.

The fact that the termite burrows are most numerous in those portions of the wood with a higher nitrogen content indicates that the termite seeks out the decayed portions of the wood. However, it is also possible that the activities of the termites exert an influence on the direction in which the fungus filaments grow. The high humidity and the termite wastes may cause the fungi to accumulate in the vicinity of the termite burrow.

*Culture Without Soil*

This culture (No. 198) was similar to culture 194 but very little soil was present. Ten grams of soil were added in the hope that any necessary microorganisms would be present to inoculate the wood. Since this soil contained only 8.8 milligrams of nitrogen it did not materially influence the nitrogen relationships in the culture. Wood in the amount of 672 grams (dry weight) was used. It was obtained from a fallen tree in the forest on the 17-mile Drive near Pacific Grove, California, and was relatively sound, though the sapwood showed signs of incipient decay.

After five years this culture contained a king and a queen, 7 soldiers, 67 nymphs with wing pads, 78 large nymphs without wing pads, and 26 small nymphs. No alates were present, in contrast to culture 194, and none of the nymphs with wing pads appeared to be preparing for the last molt. However, a very considerable growth and increase in nitrogen occurred.

The gravimetric data for this culture are assembled in Table IV.

Table IV
Gravimetric Data for Culture 198

| | Beginning | End |
|---|---|---|
| Weight of wood | 672 gm. | 392 gm. |
| Weight of soil | 9.8 | |
| Weight of termites | 0.045 | 0.614 |
| Weight of pure pellets | | 21.4 |
| Weight of mixed soil and pellets | | 17.5 |

Since some of the pellets were mixed with the soil it was not possible to weigh all of them directly. However, the weight of the soil changed very little during the experiment and by subtracting the weight of the soil at the beginning from the weight of pellets and soil at the end a value of 29 grams is obtained as the weight of the pellets formed. From this weight of pellets it can be calculated that the termites consumed approximately 60-70 grams of wood. But the decrease in the weight of the wood was 280 grams. As in culture 194, this additional loss in weight indicates that fungi were active. Decay was noted in the wood in the vicinity of the burrows at the end of the culture period.

Analyses were run on the nitrogen content of the several parts of the culture and the results are collected in Table V.

Table V
Nitrogen Content of Materials in Culture 198

| | Beginning | End |
|---|---|---|
| Wood | 308.5 mg. | 211.5 mg. |
| Soil | 8.8 | |
| Termites | 2.5 | 56.4 |
| Pure pellets | | 33.1 |
| Mixed soil and pellets | | 22.8 |
| | 319.8 mg. | 323.8 mg. |

It is clear from Table V that there was no fixation of atmospheric nitrogen in this culture. The termites grew at the expense of the nitrogen in the wood. This result is of considerable interest since it shows that wood alone serves as an adequate diet to support growth. However, it should be pointed out that sound wood did not serve as the source of food but rather wood which had undergone a considerable fungus attack. As in culture 194, the wood near the termite burrows contained a greater percentage of nitrogen, 0.065 percent as compared with 0.052 percent for the remaining wood. The initial nitrogen content of the wood was 0.046 percent.

As calculated from the nitrogen in the termites and in the pellets, the food consumed by the termites contained about 100 milligrams of nitrogen. Using 70 grams as the weight of wood eaten it must have had an average nitrogen content of 0.143 percent. This is a good deal higher than the 0.065 percent found for the wood near the burrows. A small part of this wood (that nearest the burrows) probably contained a good deal more nitrogen, or it is possible that fungous hyphae grew into the burrows and that the termites grazed off them. In the latter case the fungi would serve as a relatively rich nitrogenous supplement to the wood diet.

One of the most striking features of this culture is the great efficiency with which the nitrogen was assimilated. Over one-half of the total nitrogen consumed was synthesized into the bodies of the termites. This compares favorably with the efficiency of nitrogen assimilation in higher vertebrates.

Although this culture without soil showed definite growth of the termites and a 22-fold increase in nitrogen, the growth was not as great as in culture 194 which showed an 87-fold increase. Also the culture with soil showed a greater degree of maturity in that large numbers of winged forms developed.

*Laboratory Cultures on Wood Inoculated with Fungi*

Since all the information obtained thus far had indicated that wood-decomposing fungi were important in the nitrogen nutrition of the termite a number of fungi were tested for their influence on termite growth. The fungi studied were *Poria incrassata, Trametes serialis, Lenzites trabea,* *Lenzites sepiaria,** a *Collybia* species isolated from a natural colony of *Amitermes* (probably *A. minimus* Light), an unidentified fungus isolated from a laboratory colony of *Zootermopsis,* and a gill fungus isolated from *Pinus taeda.* Test blocks of western yellow pine (*Pinus ponderosa*) were obtained from the Brooks Scanlon Lumber Co., Bend, Ore., and used in all the cultures. Hubert (3) has found this wood very favorable for growing wood-decomposing fungi in laboratory cultures. Samples of the wood with and without soil were sterilized by autoclaving and inoculated with the test fungi. Four months later many of the cultures showed definite growth of the fungi and at that time ten termites from a laboratory colony of *Zootermopsis nevadensis* were added to each. All were kept in a humid cabinet at a temperature of about 20° C. They were inspected at intervals to observe the growth of the termites and the fungi.

*Lenzites trabea, L. sepiaria,* and *Trametes serialis* showed the most active growth and wood decomposition, particularly in the cultures containing soil. Percentages of nitrogen in the wood of the soil cultures increased from 0.048-0.073 to 0.115-0.178 during the culture period. Yet the termites did not survive in any of the cultures with these fungi. They were dead in five months in most of them. The maximum survival was ten months in a culture of *Lenzites sepiaria* without soil.

Relatively little wood attack occurred with any of the other fungi. With *Poria incrassata* the wood attack was slight even where soil was present. The termites survived only seven to eight months in the two cultures with soil. In two cultures without soil they were alive when the experiments were terminated after 12 months. Seven of the original termites were alive in each culture but no young were present and the nitrogen content of the survivors was less than that of the initial termites.

With the *Collybia* from the *Amitermes* colony one culture with soil showed survival of nine of the original termites. Seven survivors were present in another culture without soil. In two cultures, one with and one without soil, the termites were dead after five months.

Out of four cultures using the mold isolated from the *Zootermopsis* colony, one showed survival of seven of the original termites and presence of three younger ones. Their total nitrogen did not equal that in the initial termites. This culture contained soil. Another with soil and two without soil failed to show survival beyond nine months.

In two cultures using the fungus from *P. taeda* the termites were dead at five months.

Three cultures without soil and three with soil did not receive any fungus. Four termites survived for 12 months in one of these cultures without soil. Another culture without soil survived for nine months and the others were dead after five months.

*Discussion*

The failure of the termites to grow in any of the experiments with fungi indicates that none of the fungi tested is important in the nutrition of *Zootermopsis.*

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*The author is indebted to Dr. C. Audrey Richard, Forest Products Laboratory, Madison, Wisconsin, for pure cultures of the first four fungi used, and to Dr. Marie B. Morrow, the University of Texas, for the gill fungus.

The early deaths of the termites in the cultures with the active wood-decomposers suggest that very rapid growth of fungi is inimical to termite survival. *Trametes serialis* and the two species of *Lenzites* caused a loss in weight of more than half the wood, and the nitrogen concentration in the residue was greatly increased, yet survival of the termites was poorer than in the cultures with the relatively inactive fungi and in the controls.

Whether rapid decomposition by fungi is always harmful to termite growth cannot be definitely ascertained with the available experimental data. However, there is some evidence in favor of this hypothesis. The fungus attack in cultures 194 and 198 was relatively slow as compared with that of *Trametes* and *Lenzites,* and the growth of the termites was also slow, five years being necessary for the maturity of the colony. The observations of Heath (4) indicate that natural colonies develop at about this same rate. This relatively slow termite growth may explain why termites are not dependently associated with fungi which decompose wood with great rapidity. Extremely active fungi would outstrip the termites in their growth and would oxidize a major part of the cellulose and other constituents of the wood. Since the termites depend not only upon a source of nitrogen but also on the presence of cellulose, such wood might be expected to be inferior to wood which was more slowly attacked.

Field observations are in agreement with the explanation that rapid fungus growth is not usually favorable to termites. Extensive collections of *Zootermopsis angusticollis* were made along a branch of San Francisquito Creek near Stanford University. Numerous alders in this vicinity had died during the previous year or two, and most of these had undergone rapid decay so that the wood was soft and spongy. Termites were almost never encountered in such logs, but colonies were frequent in sounder wood.

Also, colonies of *Zootermopsis* on the Monterey Peninsula, California, and of *Reticulitermes* at Bastrop State Park, Texas, have been found to occur less frequently in wood which has undergone rapid and severe decay, though the differences are not so sharp and the age of the colony must be taken into consideration, the wood of older colonies showing more decay than that of young ones. Although these observations do not provide direct evidence on the postulated relationship between the termites and fungi they are at least in agreement with it.

Since the length of time required for the development of *Zootermopsis* in nature is approximately the same as that required in the laboratory, it is probable that the conclusions based upon experimental cultures are applicable in nature. This is particularly true since the experimental culture conditions were selected to approximate closely those in nature. Applying these results to the natural colonies it may be concluded (1) that nitrogen fixation does not account for growth of *Zootermopsis,* (2) that the growth of these insects depends upon suitable fungus activity, and (3) it is not necessary for soil to be present as a source of nitrogen for termite growth.

## SUMMARY

Laboratory colonies of *Zootermopsis* have shown growth comparable to that occurring in nature. One culture with added soil matured in five years. It was started with a pair of alates and numerous alates were pro-

duced at the fifth year. Nitrogen balances for the cultures show that there is no fixation of atmospheric nitrogen. The nitrogen in the wood and that in the soil are the source for termite growth. But these nitrogenous materials are acted upon by fungi and the available evidence indicates that this action is necessary for termite growth. The nitrogen eaten is utilized with great efficiency, as much as fifty percent of it being assimilated into termite protoplasm.

Several fungi were tested to see if they aided the growth of the termite, but no helpful ones were found.

*Trametes* and *Lenzites* exerted an unfavorable influence on the survival of the termites. This was thought to be due to the rapidity with which they decompose the wood. Field observations suggest that rapid wood decomposition by fungi hinders the growth of termites in nature.

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## Photoperiodic "Induction" and "After-Effects"[1]

VICTOR A. GREULACH, University of Houston, Houston.

The terms "photoperiodic after-effect" proposed by Maximov (4) and "photoperiodic induction" proposed by Chailakhian and Aleksandrovaskaia (2) are generally regarded as synonyms, as indicated by Garner's review (3) and Murneek's paper on terminology (5). Murneek defines photoperiodic induction as "The carry over effect of a photoperiod conducive to sexual reproduction to one opposite to it and vice versa. Also the transfer of photoperiodic stimulation to a non-treated part of the same plant." He defines the photoperiodic after-effect as "The same as photoperiodic induction."

The writer contends that the two terms should not be synonymous and that they refer to two distinct things which require separate names. Dictionary definitions are often inadequate for scientific usage, but in giving a term a specialized scientific meaning it is only logical to consider its general meaning. The following definitions are from *Webster's New International Dictionary*:

*after-effect*—1. An effect that follows its cause after an interval. 2. Med. A secondary result, esp. in the action of a drug, coming on after the subsidence of the first effect.

*induct*—3. To bring in, to introduce, hence, to initiate.

*induction*—2b. Act of bringing on or about; causing, production.

[1]Contribution No. 85 from the Division of Sciences of the University of Houston.

The phenomenon under consideration has two distinct aspects: the initiation of reproduction (or other processes) under the influence of the photoperiod, and the continuation of such processes or development after these photoperiods have been replaced by other photoperiods which do not initiate them. Considering the definitions just given, it appears that the term "photoperiodic induction" should be restricted to the first of these aspects and the term "photoperiodic after-effect" to the second. Induction occurs even if a plant is maintained under the initial photoperiods, but here an after-effect is obviously impossible. Induction without after-effects also occurs when an entire plant responds to the photoperiod, even though only part of it is exposed, and when a plant not exposed to the effective photoperiods responds in unison with one which is so exposed and is grafted to it.

The following definitions of the terms are proposed:

*photoperiodic induction*—The initiation of reproduction or other processes or development under the influence of the photoperiod.

*photoperiodic after-effect*—The continuation of reproduction or other processes or development after the photoperiods favoring their initiation have been replaced by photoperiods not favoring such initiation.

The suggestion by Purvis and Gregory (6) that photoperiodic induction be considered a phase of vernalization lacks validity, since they were not dealing with true photoperiodic induction. The short photoperiods which hastened blooming in rye when applied during early growth actually inhibited reproduction but did speed the development of the terminal meristem. Such phenomena may be referred to as "photoperiodic vernalization" as distinct from photoperiodic induction.

In 1937 Chailakhian (1) proposed that the terms "photoperiodic charge" and "photoperiodic accumulation" would be more in conformity with the hormone theory of photoperiodism than the term "photoperiodic induction." If the charge theory of photoperiodic induction is eventually established this proposal may have some merit, but it seems unwise to attempt to replace the much more widely used term "induction," especially when we can readily state that during induction a hormone charge accumulates and in no way do violence to the definition of the term.

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## The Colloidal Complex as a Factor in Plant Nutrition

H. E. HAMPTON, A. & M. College of Texas, College Station.

The soil and plant root interactions, commonly spoken of as plant nutrition, are very complex. Soil behavior as studied by chemical methods to measure its stock of plant nutrients is widely different from soil behavior when in contact with plant roots. Of necessity, we must design experiments in plant nutrition in a manner which will limit the number of variables to as few as possible. The attempt is made to study one variable at a time but, whether or not we are aware of the fact, several variables usually exist.

The heterogeneity and complexity of soils complicate their use as cultural media in plant nutrition studies. Inasmuch as soils are essentially involved colloidal systems, plant nutrition under the natural environment is not a simple intake of ions from water solutions. The soil solution has long been found an inadequate explanation for the relatively generous delivery of nutrients by the soil to the plant. Jenny (5) has presented evidence to show that roots are able to absorb nutrient ions directly from the ionic atmosphere of colloidal particles by exchange. This adsorption complex, the colloidal particles of which may be of mineral or biological origin, permits of a large supply of adsorbed nutrient ions, with low solubility, while still maintaining almost constant physico-chemical conditions. The adsorptive capacity of colloidal particles brings about the removal of those injurious substances classed under the cause-concealing term of "toxicity." The utilization of aqueous nutrient cultures has given us important information but has largely failed to solve intricate soil-root relationships. The simple solutions demand controlled concentrations, osmotic relations, and other physico-chemical conditions which are thrown out of balance by only partial removal of ions by the plant.

Our knowledge of the adsorption of cations and their exchange by colloids has given us a clearer concept of the mechanisms involved in plant nutrition. Graham's study* of anionic exchange by positively charged colloids has demonstrated the plant's ability to utilize nutrient anions which are held by adsorptive forces. We must await further investigations to learn the importance of anionic exchange in soils.

The nutrient delivery of a colloidal clay-sand culture is limited to the ionic atmosphere of the colloidal clay particles and the ions present in the soil solution. In this we are concerned with a colloidal system which represents one phase of the soil-root relationships. In the uptake of nutrient ions, we must consider likewise the plant cell protoplasm which is itself a colloidal system—chiefly proteinaceous bodies of colloidal dimensions suspended in an aqueous medium. These two colloidal systems are separated by the wall of the root hair functioning as a membrane. The concept of plant root and colloidal clay interactions may be simplified by presentation in the form of an ordinary equation of a chemical reaction at equilibrium (1):

$$\text{Colloidal clay with exchangeable ions} + \text{Solution} \underset{\text{(Cell wall)}}{\overset{\text{Membrane}}{\rightleftarrows}} \text{Colloidal cell contents of plant} + \text{Solution}$$

*Unpublished data, E. R. Graham, University of Missouri.

Inasmuch as the composition of the solution on the left of the equation is dependent in the case of colloidal clay cultures upon exchange from the known ionic atmosphere of the clay particles, we may conveniently eliminate this solution phase from consideration. We may, likewise, imagine the elimination of the solution phase from the right side of the equation. Then we may visualize the soil colloid and the plant colloid in close contact on opposite sides of the cell membrane of the root hair. The complex system may be considered at equilibrium although, in the actively growing plant, the condition is undoubtedly a dynamic one and a state of equilibrium is never attained.

A constant exchange of ions is occurring. Not only do nutrient ions move into the plant, but, at least under certain conditions, they may migrate from the plant to the soil (2, 3). The absorption of nutrient ions by the plant may be modified by physico-chemical relationships in the cultural medium, by the colloidal nature of the cell protoplasm, or by the character of the root cell wall. It is reasonable to expect that a modification of any one of the three parts of the equation will result in a change in any one or both of the others. There is evidence to show that such is the case.

Several factors relative to the soil colloidal fraction may modify nutrient absorption by the plant. The chemical and physical nature of the colloidal particles will certainly be a factor, as will be the amount of colloidal material in the medium. Intake of nutrient ions by the plant will be determined in part by the relative saturation of the colloids by these ions. The ease of replacement of the adsorbed ions follows known physico-chemical laws. Legume plants, growing in colloidal clay cultures supplied with variable amounts of calcium but at different pH levels, point to calcium deficiency rather than excessive hydrogen ion concentration as the problem of "acid" soils. Later work has demonstrated a similar beneficial influence of other basic nutrient ions and indicates the desirability of a balanced nutrient level for optimum plant growth as well as confirming the desirable influence of colloidal particles in cultural media.

Previous investigations in plant nutrition have been concerned chiefly with conditions in the root environment. Few tools are available for a comprehensive study of the colloidal nature of the cell protoplasm of the living root and we know little about the properties of the plant colloid *in vivo*. Thus conditions which prevail on the right side of the equation are little known. The interrelationships of several nutrient ions are indicated. For example, an adequate supply of magnesium increases calcium mobilization and utilization in soybeans. Likewise, a greater absorption of calcium occurs in plants supplied sufficient potassium. The greater intake of calcium by plants supplied with increased amounts of potassium adsorbed on the colloidal clay, in violation of the results from most aqueous solution studies and opposed to our ideas of physico-chemical behavior of adsorbed ions as studied in the test tube, points to a modification of the nature of the cell colloid by the additional potassium. Cell protoplasm is largely proteinaceous and, when we consider the numerous kinds of proteins, many of which are amphoteric in nature, the importance of the plant colloid in nutrient absorption is certainly indicated.

Not only soil conditions but factors associated with the plant may modify nutrient absorption. For example, the presence of legume bacteria was found to modify nutrient uptake from colloidal clay by soybeans (4). The nodulated plants contained not only more nitrogen but also more calcium, magnesium, and potassium than the non-nodulated plants; apparently the character of the cell protoplasm was modified by the organisms which resulted in greater absorption of ions from the colloidal clay.

The influence of certain chemical substances, among which are calcium and potassium, on the permeability of cell membranes has been reported.

A time factor must likewise be considered. During the growing season of the plant, the equilibrium expressed by the equation may be displaced considerably to the right. Plant growth, unlike many ordinary chemical reactions, is not an instantaneous performance.

Because of our knowledge of the properties of colloidal clay, we are given a more simplified approach to the study of conditions on the left side of the equation. Measurements of plant growth behaviors and determinations of plant compositions, with their story of the movements of nutrient ions into or from the plants, help to interpret what has occurred on the right side of the equation. It is from such investigations, perhaps utilizing techniques and tools not yet described, that we may learn whether plant nutrition may not eventually follow the commonly accepted principles of physico-chemical behavior.

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## The Relation of Beliefs to Physiological and Pathological Reactions

C. ELMER FREY, M.D., Houston.

In this paper it is not my purpose to present anything especially new, but I wish to call your attention to a very practical and helpful point of view which I have not seen presented previously.

In order to exist, an individual must be able to adapt himself to his environment. In order to adapt himself to environment he must have information about it. The human animal has five senses by which he acquires information, and the only information he can ever get about his environment, or, let us say, *reality,* is through his five senses.

The individual bits of information acquired by the various senses are abstract and they would be useless by themselves; therefore, we have a brain which is the great coordinator of the impressions received by the sense organs. The brain takes these impressions and from all of them forms a composite which we call a concept or *belief* about the nature of environment.

This composite belief about the nature of his environment is all that the individual has on which to base his adaptation to environment. It is the basis, therefore, of all his behavior, as behavior is his method of adaptation to environment. When any new bit of information is acquired it is added to and blended in with the composite belief already held, and henceforth behavior will be modified in accordance with the latest composite. We are constantly acquiring new information and, accordingly, our behavior is varied constantly.

This process of forming beliefs about reality begins before birth and continues till death. The nature of these beliefs accounts for all of our behavior from the first cry and for all of our ideas, imaginations, emotions, thoughts and other mental qualities.

We do not form correct beliefs about reality from the information received by the five senses; in fact, they are incapable of giving us accurate information. We know that the eye inverts the image which it receives; therefore, reality is actually inverted from the position it appears to have. We know that if one or more of the five senses are absent our information about reality will be different than otherwise. Furthermore, the acuity of our sense organs varies in different individuals, and in the same individual from time to time, and our perceptions are changed accordingly. Also, we know that our sense organs acquire very different information for our brains than those of animals and insects acquire for their brains. We have no idea, therefore, how reality actually is; we know only how it seems to us as human beings and we know that it seems different for each of us. But we know that our sense organs and our brains have come to be so constructed, through a process of evolution, that we can form the kind of beliefs about our environment which are best for us, as human beings, to use as a basis of behavior or adaptation to that environment. In turn the ant, for example, has the kind of sense organs and coordinator of perceptions which are best for it, as an ant, to use for its adaptation. We could not adapt ourselves to the reality as the ant conceives it, nor could the ant adapt itself to the reality conceived by human beings.

We have every reason to believe that there is a reality even if it is very different than it seems, but for all practical purposes it makes no difference how it actually is so long as we can form beliefs as to its nature which are such that we can best adapt ourselves to it.

A mass of impressions is constantly coming to the brain from the sense organs. We have learned to choose those impressions which we can use best for adaptational purposes and largely to ignore the remainder.

This is where the matter of emotion comes in. Emotion is *feeling*. From all of the bits of information which come to the brain from our sense organs we choose, for addition to our composite of belief, those we like or feel best about and disregard the others. We like to believe what we do believe or we would not believe it; we like our way of thinking. True, that way each of us has of thinking, the particular composite of belief we build up depends upon our particular heredity and the particular environment to which we are exposed. We can say that the nature of the brain tissue, the arrangement of the association pathways, is what it is for each of us because of our heredity and because our environment has caused us to establish the particular pathways by repetition or the habit factor. We do not like to change an association pathway, we like those habits we have formed, and nations go to war, and individuals die, rather than change their composite of belief.

Now you will say, "Since we know that our five senses do not give us correct information about reality, and since we cannot know that any belief is absolutely true, what criterion can we use in determining which beliefs are best for us to accept?" To answer this question, I have developed the rule that the belief which is best for the individual *and* for society in general is the best one to accept and the best one to guide our behavior.

Now, what relation does this matter of belief have to physiological and pathological reactions? All involuntary functions of the body are directly or indirectly under the influence of the autonomic nervous system. Through its control over the size of the blood vessels in every part of the body, it controls digestion, metabolism, growth, repair of wounds, recovery from illness, etc. In addition the autonomic nervous system sends fibers which exert direct control to the individual cells of many of the glands including those of the endocrine system and other involuntary structures. In this way the autonomic nervous system, to some extent, controls the composition of the blood.

The cerebral cortex, or that part of the brain which is intimately related to the ideational processes of the mind, has a very definite influence over the autonomic system. This is explained as follows: The individual cannot voluntarily speed up his heart or make his face blush but he can, by being frightened, speed up his heart almost instantly, or, by being embarrassed, he can cause his face to blush. Fright and embarrassment are emotional processes and the emotional processes can influence the autonomic nervous system. Every thought has some emotional shading, of course, but our emotions are not subject directly to voluntary control, even if we can to some extent control the thoughts we think. It is necessary that the autonomic system be influenced by the emotions, because the individual could not adapt himself to his environment if the perceptions of the environment by the cerebral cortex could not cause the physiological functions to respond accordingly. For instance, if it were not for this mechanism there would be no outpouring of adrenalin in the face of danger which would cause fright and might demand fight or flight.

Our emotional reactions are subject entirely to our beliefs. The thing which will frighten or embarrass one individual may be soothing or amusing to another according to their respective beliefs about it.

The anatomical route, by which cerebral cortex influences can get over to the autonomic nervous system in an emotionalized form which will bring about the proper physiological functions for the best adaptation to the environment, is now well recognized. The literature, by excellent authorities, including numerous experimental data and many clinical observations on this point, is very voluminous and anyone interested is referred to the bibliography attached hereto.

It is well established that every thought we think, in so far as it has an emotional shading or feeling tone, has a physiological reaction which is measurable by laboratory methods in many cases. We have shown in the earlier part of this paper that the thinking is what it is as a result of the beliefs which the individual has acquired about reality. It would appear to be obvious, therefore, that physiological reactions, the functions of the autonomic system, the endocrine system, the size, weight, in fact the whole personality, are what they are very largely as a direct or indirect result of beliefs.

It is not within the province of this paper to discuss the relation of heredity, and many unchangeable factors in the environment, to physiological reactions, but of course they, too, play a large part.

*The Relation of Beliefs to Pathological Reactions*

We all recognize that fright causes an outpouring of adrenalin due to impulses from the cerebral cortex which stimulate the sympathetic portion of the autonomic system and this, in turn, has an extensive effect in further stimulating the formation of more adrenalin, liberating glycogen, etc., to prepare the individual physiologically for fight or flight.

Fear is a form of prolonged fright and has an effect similar to fright. Worry and anxiety are forms of fear and have similar physiological influences. Mental states which cause a predominence of influence of the sympathetic system also, by the well recognized process, cause a decrease of parasympathetic influences with the consequent loss of appetite, decrease in secretory and motor function of the gastro-intestinal tract, alteration in the blood chemistry, etc. These in turn result in constipation, often of the spastic type, blood-pressure changes, etc. They are pathological reactions which result from a certain mental state. The cause of the mental state of anxiety or worry is entirely an individual matter; one will develop anxiety or worry on account of factors in environment which would not so affect another at all. The difference between individuals in their reactions to the same factors in environment is due to a difference in their beliefs. Whether or not specific thoughts or beliefs can cause specific pathological effects is not settled entirely. I shall not try to discuss the point but merely mention some factors which influence our conclusions.

Consider the simple physiological process of blushing. It requires a certain type of emotion to produce it; this type of emotion is the result of the particular beliefs which the individual has acquired. Therefore, blushing is due to the influence of the cerebral cortex or, let us say beliefs, upon a specific part of the body and is influenced by a part of the autonomic nervous system. While this is a physiological reaction it shows that connection fibers must exist which make it possible for cortex factors to influence bodily reactions specifically.

I might cite some interesting examples: I have had two unmarried patients both of whom had previously had children and who were again exposed to possible impregnation at a time when pregnancy would have been a serious hazard to their social status. One of them had twice had almost the same experience I am about to relate. In both cases the women were "certain" that they were pregnant and greatly upset about it. I counseled with them to the effect that it would be best to wait until they had at least missed a menstruation before jumping to conclusions. They missed their next menstruations but due to the earliness of the possible pregnancies I could not be sure from examinations whether or not they were pregnant. One of these cases came prior to the Aschheim-Zondek test, so I suggested that we would have to wait several months before we could be sure beyond a doubt. She developed all the classical symptoms of pregnancy, morning sickness, the characteristic nipple sign, tenderness of the breasts with some secretion, and she was certain that there was enlargement of the abdomen although there was no enlargement of the uterus. This continued until after the fifth month when I assured her that she was not pregnant. She believed me and about a month later menstruated normally. In the next similar experience this same patient missed four menstrual periods before I could convince her that she was not pregnant, but about one month after being so convinced she menstruated. The other patient mentioned had almost the same experience except that she missed only three periods before I could convince her that she was not pregnant. These women were apparently physically normal, and I believe that their beliefs of being pregnant seriously disturbed their endocrine functions. Missing of one menstruation due to fear of pregnancy is not at all unusual and we have all heard of the cases of false pregnancy in which women have actually developed the first stages of labor before they were convinced of not being pregnant.

The psychic factor in peptic ulcer is well recognized and is an instance in point.

Psychogenic rhinitis is a common observation. I well know of one man who would start to sneeze and develop a marked rhinitis if he believed a certain door was open, allowing a draft to blow over him. Not infrequently the door had been quietly closed but he believed it had been left open and developed as definite a rhinitis as if a draft had blown on him.

I would not say that a large proportion of colds are psychogenic but I desire to call your attention to the fact that the organisms involved in colds and pneumonia are frequently on the respiratory mucosa, ready to cause infection when the resistance is lowered, and beliefs may in some cases be no small factor in lowering resistance sufficiently to allow infection to take place. I know a man who always developed heart irregularity and pain when he took Aspirin. He came in one day very happy in the fact that he had found a tablet which relieved his headache without causing the heart symptoms which Aspirin caused. When asked what it was, he said he had told the druggist that he could not take Aspirin; the druggist had told him that he had a new tablet called Acetyl Salicylic Acid (the chemical name for Aspirin) which would not cause any heart effect, and so it did not.

Hysterical paralysis is a pathological process, localized in nature, which is the result of beliefs.

Physiological and pathological changes are recognized as physical and chemical changes and the question arises: how can physical or chemical effects be the result of mental processes which latter are immaterial and indefinite and, in fact, their exact nature is not known? There is not sufficient space to discuss this subject at length, but I may call your attention to some facts which speak for themselves. We know that every impulse that travels over a nerve produces a chemical change. You can easily move your arm, if you will to do so, and the *will to do so* is strictly a mental process, but moving your arm is physical. (The whole subject of the relation of the mind to the body, the socalled magical, spiritual, supernatural, metaphysical and other phenomena of cause and cure of diseases, etc., is so well and clearly explained on a purely physical and chemical plane that I can see no reason whatever to try to use nonterrestial explanations.)

The reader may have been wondering why I have included all of the types of mental phenomena which cause physiological and pathological reactions under the head of "beliefs," or, as the psychologist may prefer to say, "concepts." (Concepts and beliefs are not exactly the same, but in the sense that I have used them the reader may use either word without changing my general point of view.)

As previously said, the only mental influences which can affect the body through the autonomic nervous system are emotional factors, and beliefs are emotional in nature. As soon as we accept an idea as a belief we have a *feeling* of satisfaction about it, a feeling of relief from having any doubt about it. So long as it remains only an idea, it seems incapable of having any marked physiological effect, but as soon as it is accepted as a belief it does something to the individual which affects all of his future activity. If the belief be in the realm of major importance to him, such as love, religion, etc., it may completely change his whole future life.

The extensive implications of beliefs in our behavior in every phase of life cannot be overemphasized. One could not do the most simple task if he did not believe he could do it, and on the other hand all the great accomplishments of the human race are due to the beliefs of someone that they could be done. An idea must become emotionalized by being accepted as a belief before it can serve any purpose in directing behavior. We are not what we are because of our thinking but because of our believing. Thoughts must become beliefs before they materially affect us, but when they become beliefs they may be powerful enough to make us do anything in the whole range of what is humanly possible and many, many things usually considered impossible.

In closing I would not do justice to this great subject if I did not deviate sufficiently from the limits of the title to point to some practical applications and implications. Our composite of belief is made up of a myriad of little beliefs and our composite activity is based on the composite belief, but each little activity, each little thought we think, is based on the appurtenant belief. The beliefs we hold about the beauty of a flower, the usefulness or harmfulness of an insect, the right or wrong of any act will determine our thinking and acting in so far as they are related to those particular things. Even the errors we commit, the dishes we drop unconsciously, are the result of incorrect beliefs. Neuroticism, maladjustment, social disorder, political blunders and the fall of nations are all the result of incorrect beliefs. Therefore, the acquisition of correct beliefs about our environment is most vital. The function of all science is to approach truth. We need to know how to think logically so that we can recognize truth when we see it.

Most of the fundamental beliefs are acquired during the first few years of life, and on these we predicate all of our future thinking and acting. It is vital indeed, therefore, that those dealing with children understand their responsibility and realize that they have in their hands the future of the child, and that they know how to impart correct beliefs which will serve as firm foundation stones on which the individual can build a happy, successful and useful life.

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## The Vitamin A Effect of "Vita-Yam" (Dehydrated Sweet Potato) Cookies and Candy as Shown by Biological Assay and Dark Adaptation Tests with Humans

FLORENCE I. SCOULAR, MARY LOUISE JOHNSON, RUBY HERD AND LORETTA LEWIS, North Texas State Teachers College.

We are being admonished to eat more of the green and yellow vegetables in order to provide more foods which will increase the vitamin A value of our diets. It is common knowledge that the vitamin A value of these foods is due to an inactive form of vitamin A which the body is unable to convert completely into the active form. The activated form of vitamin A is found in fish liver oils and to a lesser extent in liver, egg yolk and cream. Consequently, a study was made to see if the addition of a "Vita-Yam" product furnishing equivalent to 1000 I. U. of vitamin A could be utilized by the human body with an improvement in the individual's dark adaption. Also, a biological assay study was undertaken to show the amount of vitamin A value present in each of the two products prepared from the "Vita-Yam."

This paper reports these two studies undertaken to show the vitamin A value of "Vita-Yam," dehydrated sweet potato flour, when foods containing it were fed to vitamin A depleted rats and to humans as a daily dietary supplement. One study grew out of the other due to the fact that one of these prepared foods appeared to provide more vitamin A value than the other, although the only source of vitamin A was the "Vita-Yam" and it was incorporated in the recipes to furnish the same amount of vitamin A value to each food.

Dark adaptation studies abounded between 1933 and 1941 when several methods were introduced and tested to prove their validity or superiority.

The Hecht-Schlaer adaptometer and Jean's biophotometer are the two instruments most frequently used. The biophotometer measures chiefly the rod functioning while the Hecht-Schlaer measures cone and rod functioning. The difference in the results obtained with these two instruments was shown by Eckardt and Johnson (1) to be due to the difference in the length of the recovery period used following the exposure to the bright light. When the biophotometer's recovery period was increased to 20 minutes, the results were the same as those obtained with the Hecht-Schlaer instrument. The biophotometer has the advantage of being a simple test to administer.

A brief review of dark adaptation studies and techniques is given first. Vitamin A is necessary for the regeneration of the visual purple of the retina. To measure the speed of regeneration several adaptometers have been developed. Briefly, the test includes exposure to a bright light which is followed by a recovery period of ten minutes or more. Therefore, since the biophotometer is a simple and valid test for dark adaptation, it was used in the present study.

Neither the biophotometer nor the Hecht-Schlaer adaptometer have been used successfully to show a relation between blood vitamin A or β-carotene and the individual's degree of dark adaptation. From such studies some investigators have concluded that the biophotometer and the adaptometer do not measure vitamin A deficiency. However, much work is yet to be done, since we do not know the normal values for blood vitamin A, nor do we know the significance of β-carotene in the blood stream. Baum and McCord (2) have shown that the ratio of vitamin A to pro-vitamin A, carotene, varies in the blood of humans. Nevertheless, improved dark adaptations resulting from vitamin A therapy (cod liver oil, halibut liver oil, β-carotene in oil, etc.) have been demonstrated under controlled conditions by numerous investigators. Consequently, the biophotometric method was used in determining the dark adaptation of the college girls who served as subjects in the present investigation.

Previous surveys and studies at North Texas State Teachers College, with both college men and women, in addition to studies with younger and older age groups, indicate that either the vitamin A intake is low or that the individual is unable to digest and absorb vitamin A and its precursors since 2/3 to 3/4 of every group tested has sub-optimum dark adaptations. Furthermore, over 90% of these cases showed improvement in dark adaptation when given vitamin A concentrates. The children usually respond more readily than the adults; some of the adults never reached the norm during the period of the study, while all of the children, thus far tested, attained it. Booher (3) found that her adults receiving β-carotene were able to convert only 50% of it into vitamin A and recommended that two times as much of the vitamin A precursors be given in order to obtain results similar to those obtained with active vitamin A.

Vitamin A refers to the activated form of the substance. The vitamin A values of the precursors, alpha, beta, and gamma carotene, and cryptoxanthin, are inactivated forms until the body transforms them into the active vitamin A. Yet, nutritionists are urging the use of more green and yellow vegetables (which carry the vitamin A precursors chiefly) because of their high vitamin A values. The sweet potato is known to be a rich source of the pro-vitamin A, carotene. It is now available in dehydrated form which makes it ready for use throughout the year. With this in mind, together with the availability of such vitamin A precursors, it was decided to feed some of this dehydrated sweet potato, "Vita-Yam," in prepared products such as one might consume in the home. Two such products, "Vita-Yam" cream candy and "Vita-Yam" cookies, could be prepared in quantity and kept several days.

The previously mentioned studies administered large or massive doses of vitamin A concentrates. This is not feasible when the substance to be tested is in a more diluted form, such as candy and cookies. Consequently, it was planned to add a reasonable amount as a supplement, an amount which one could be assured would be consumed daily during the study. The candy and cookies were made fresh every other day and the amount of each serving calculated to provide 1000 I. U. of vitamin A daily. Water was substituted for milk and egg white for the yolk in the cookie recipe in order to limit the source of the vitamin A to the "Vita-Yam." Likewise, water was used in place of the milk and non-enriched oleomargarine substituted for butter in making the cream candy.

From 166 college students who gave a poor dark adaptation response in the preliminary testing, 109 signified their willingness to participate in the study. They were divided into three groups: (1) the controls received no supplements and were given only two biophotometric tests, one at the beginning and the other at the end of the three weeks period; (2) received "Vita-Yam" cookies daily for three weeks and were given biophotometric tests at weekly intervals as were group three; (3) received "Vita-Yam" candy daily for three weeks.

The subjects were distributed in each group so that the same number of students represented each food enviroment. These food enviroments included the college dormitories, college owned houses, boarding houses, light-housekeeping, and living at home.

The two groups receiving supplements were given either two cookies or one cube of sugar candy containing the equivalent of 1000 I. U. vitamin A from "Vita-Yam." The vitamin A value of the "Vita-Yam" had been determined previously by the biological assay method. A ten percent loss of vitamin A from butter cookies had been reported by Parsons, et al (4). What effect, if any, the moist heat might have in preparing candy was not known.

The subjects were asked to eat the supplements following the same meal each day in order to have a uniform time for the ingestion of the supplement throughout the study.

The dark adaptation tests showed that the controls, as a group, did not improve, whereas some improvement was made by both of the groups receiving the "Vita-Yam" supplements. Of the two test groups, those receiving the "Vita-Yam candy made more improvement than those receiving the "Vita-Yam" cookies.

In order to determine if this difference was due to a greater loss of vitamin A value during the baking of the cookies than that occurring during the boiling of the candy, these two supplemental products were fed in both the raw and cooked state to vitamin A-depleted rats and their growth compared with that produced by graded amounts of vitamin A reference oil. Nine groups of six rats each were used. The technique used by Parsons (4) was followed in feeding the cookies to the animals, both raw and baked. The former were stored in a tightly covered glass jar in the electric refrigerator while the latter, when baked, were cooled for 15 minutes, then pulverized in a mortar and stored in a tightly closed container in the electric refrigerator. In this way a new "batch" of the cookies was made each two weeks. The candy was cooked at a higher temperature than the recipe called for because it was necessary to pulverize it, too, and this was impossible at the usual temperature for cream candies.

This higher temperature required 14 minutes of cooking; the cookies had been baked for eight minutes at 400° F. The weight of the ingredients and the methods of preparing were so perfected that the difference in vitamin A value was constant from time to time due to the fact that the candy dose did not vary more than a plus or minus 0.02. grams for the same reasons.

The amounts of the raw and cooked candy and cookies fed were equivalent to one gram of the dry "Vita-Yam." All of the animals receiving supplements gained in proportion to the amount of the supplement fed. The groups of animals receiving the raw candy and the baked cookies gained more in proportion to the dose fed than the groups receiving an equivalent amount of the cooked candy and raw dough. However, the groups receiving the candy supplement, both raw and cooked, showed more gain in weight than any of the groups receiving the raw or baked cookies.

The raw cookie dough did not equal the raw candy in the amount of gain in weight, which suggests that the digestibility of the dough may be a factor in determining its vitamin A value. This is further emphasized by the fact that the baked cookie gave a higher vitamin A value, 19 percent, than the raw dough while cooking decreased, by eight percent, the vitamin A value of the candy mixture.

The difference between the gain in weight of the raw and baked cookie dough animals of this study and Parsons' (4) may be due to the form of vitamin A present. "Vita-Yam" represents the inactive form, while Parsons' butter cookies contained both the active and inactive forms of vitamin A. Dry heat destroys the active form which could account for Parsons' baking loss of ten percent of the vitamin A potency of butter cookies. The inactive forms must be digested and absorbed before they can be activated. As previously stated, as little as fifty percent may be converted into the active form. Hence, the more complex mixture represented by the "Vita-Yam" cookies gave poorer gain in weight when fed the vitamin A-deficient animals and also less improvement in the dark adaptation of the college students receiving them as a daily supplement.

## SUMMARY

A daily vitamin A value supplement of 1000 I. U. as "Vita-Yam" candy or cookies improves the dark adaptation of college students with sub-optimum tests.

Food supplements carrying the same vitamin A value differ in their

effectiveness. The readily digested and absorbed foods are more effective in alleviating poor dark adaptation.

The availability of the vitamin A of raw and cooked foods is shown by a comparison of the growth produced in vitamin A-deficient rats.

"Vita-Yam" candy gave better growth than the cookies for both the raw and cooked product. The raw candy was better than the cooked, but the baked cookies were superior to the raw ones.

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## Some Effects of Viet

ANNIE MAE MELTON, Mary Hardin-Baylor College, Belton

The experiments reported in this paper were undertaken to interest biology students in the specific effects of vitamins in the daily diet. For this, a new product known commercially as Viet was used. It is known from preceding experiments that Viet consists of ten vitamins, of high mineral content as well as of high vitamin content, and a rich source of the grass juice factor.

In the Journal of the American Medical Association, Vol. 112, September 25, 1939, this new product was described. The trade name at that time was Cerophyl. Later, when the product had its missing vitamin D added, its name was changed to Viet. This product is on the Food Council's list of accepted foods. It includes a powdered dried mixture of young leaves of cereal plants such as wheat, oats, and barley, selected and blended to maintain the minimum vitamin potency.

As stated by the manufacturers, the green leaves of most plants are rich food sources of carotene, ascorbic acid, riboflavin and minerals. Green leaves of grasses also contain Vitamin K, a fat-soluble substance. The absence of this substance in the diet of chickens causes the blood to become slow in clotting. Because Vitamin K is widely distributed in food and can be synthesized by bacteria, it is not apt to be deficient in the human body except when bile, which appears to be necessary for its proper distribution, is lacking. Cabbage, kale, and spinach are rich sources of Vitamin K.

The analysis submitted by the manufacturers is as follows:

Moisture 8%, total solids 92%; ash 12%, fat 5%, protein 25%, reducing sugars 11.3%, carbohydrates other than crude fiber 35%, oxalic acid, calcium, phosphorous, magnesium, potassium, sodium, iron, manganese, copper, and cobalt in quantities less than 1% each.

The calorie value is 2.85 per gram.

Specifically, Viet has been shown by chemists George O. Kohler, W. R. Graham, and C. F. Schnabel of Kansas City, Mo., to increase resistance against colds. These scientists reported that they ate this grass product all winter, caught no colds, and enjoyed excellent health.

It was desired to ascertain the effects of Viet upon individual zoology students of Mary Hardin-Baylor College and to determine whether a balanced diet, with Viet employed as the source of additional vitamins and mineral content, or the same diet without Viet gave different results. The experiment appeared particularly interesting because of the shortage in many canned and fresh vegetables during the fall and winter months.

In October, 1942, one class of twelve girls was used as experimental group 1. Another group of twelve girls was used as controls. All the girls in the experimental and control groups ate in the same dining hall and under the same dormitory regulations.

At the beginning of the experiment each girl tabulated a report on the following points:

Number having colds, sore throat, constipation, headaches, indigestion, fatigue, nervousness, poor condition of gums, night blindness, undue sensitiveness to glare, poor appetite, insomnia, acne on the face, and acne on the back. Each week individual reports were made to check possible improvements. This continued through the month of January.

## Discussion of Results

Although statistical analysis was not made of the results, it is evident that the two groups of girls who took part in the experiment showed definite improvement over the control group.

## Experiment Number 1

The first experiment, testing the effects of Viet in addition to a balanced diet versus a balanced diet without Viet, gave favorable results. Previous investigations showed that the physical status of each group was approximately the same.

The chart showed for experimental group 1 a slightly smaller number having colds from October through January. Two of the three who were susceptible to sore throats showed improvement after taking Viet. Six girls of the experimental group reported improvement or entire relief from constipation whereas only two of the eight in the control had gained relief during this time.

The girls in the experimental group showed improvement over the control group in overcoming fatigue, nervousness, night blindness, insomnia, acne, and poor appetite. One student who had suffered previously from a slight kidney ailment reported entire relief after having taken Viet these months.

The hemoglobin count for the experimental group increased in all except one girl. Her count was 90 at the beginning of the experiment. The count of the control group remained approximately the same during these months.

Experiment Number 2

The second experiment was carried on as in number 1 with different girls during the months of February through May. The charts showed results similar to those of the first experimental and control groups.

There was an increase in the hemoglobin count of each girl in the experimental group. The counts of those in the control group remained approximately the same with one exception.

Conclusion

This was not a quantitative experiment but was carried on as a class project as was stated above. We should allow for some individual differences in the four groups and for accuracy in reporting. But in general the significant fact is that there was a general improvement in every case in those taking the Viet and in both the fall and spring periods.

## Fungus Slide Cultures: New Methods

MARIE BETZNER MORROW AND SISTER M. GERMAINE RACHANER, Department of Botany and Bacteriology, The University of Texas, Austin

So as to study the habit of the organism microscopically, permanent preparations showing the complete structure of the plant may be made with most filamentous molds by growing them directly on glass slides or cover slips. Slide cultures are used by workers who desire to study the organism in its entirety with vegetative and fruiting structures in their natural relationships and in place.

The slide culture is preferred to the usual method of transferring a portion of the growing mold from a plate or slant with needles or forceps and teasing it out in a drop of mounting medium on a glass slide before covering with a cover slip. Such a preparation as the latter may show all the parts, but disarranged. The method reported in this paper has been developed in this laboratory and used sufficiently to demonstrate its practicability.

The materials required are simple and include sterile glycerine water (one percent), sterile water, two sterile Petri dishes with two sterile slides in one for each culture slide, straight inoculating needle, loop inoculating needle, Bunsen burner or alcohol lamp, Waksman's agar in a tube or flask, and a plate or tube culture of the fungus to be studied.

Melt the Waksman's agar in a water bath. Place two loops of the medium on one of the sterile glass slides. The agar may be spread in a ribbon-like streak or to form a more or less circular area several millimeters in diameter. Place this slide, agar side up, crosswise on the other slide in one of the Petri dishes, in the bottom of which a few drops of sterile water have been placed so as to form a moist chamber. Keep the preparation at room temperature, and keep water in the bottom of the Petri dish, but avoid getting water on top of the culture slide.

Immediately, or after several hours, inoculate the agar streak with a pure culture of the mold prepared as follows: Using the other sterile Petri dish, place a series of drops of sterile glycerine water over the bottom of the dish; four to six may be used without danger of the drops running together. With a sterile, straight needle introduce a portion of the culture material into drop number one; spores are preferred if the culture is sporulating. Disperse the mold material well in the drop, then with a sterile loop needle transfer a bit of this suspension into the next drop until a series of dilutions has been set up. Examine the last drops microscopically to determine the presence of spores or mycelial fragments. From the last dilution in which spores or mycelial fragments are well separated, inoculate the agar streak, using a sterile loop needle. Return the slide to the Petri dish moist chamber. See that sterile water is kept in the bottom of the dish to prevent drying of the culture. Incubate at room temperature.

Some growth should be noticeable after 24 hours, but development of the fruiting structures will depend on the species and somewhat on the incubation temperature, some requiring up to 72 hours. Perithecia, pycnidia, and other reproductive "bodies" will require longer periods for development. A week is required for the development of perithecia in *Chaetomium*, but this is rather an exception.

As the culture develops, it may be examined under low power to determine gross morphological features. When examined immediately, the slide may be removed from the moist chamber without danger of contamination, if returned promptly, and if the air about the work table has been washed down previously with some suitable spray. When the culture has developed to the desired stage, the slide may be made permanent by mounting the culture in a suitable mounting medium following fixing and possibly staining. Linder's lacto-phenol mounting medium with aniline blue is recommended since it serves as a combined fixing agent, stain, and mounting fluid. In mounting the culture, a drop of the medium may be placed on the culture and a small drop on the cover slip before putting it in place. This seems to help in avoiding the accumulation of air bubbles in the mounted material. The cover slip is supported on a dissecting needle and lowered from one side very carefully for the same reason.

The culture slide is now more or less permanent. For some time when not in use it should be kept in such a position that the culture is on top of the slide and the slide parallel to the bottom of the box, tray, or other support. The culture may now be examined under higher powers or even oil, although it is better to wait with oil until the cover slip has been made more secure with a ring of Damar or other sealing material applied some time later after the fixing process is complete. Ringing the cover slip is not necessary but does make the slide more permanent and durable.

The features that seem most to contribute to the success of the use of the slide culture as developed in this laboratory include the method of dispersing the mold material to be inoculated in glycerine water, the method of spreading the streak, the method of slide arrangement in a moist chamber, and the use of Linder's solution as a combined fixing-staining-mounting medium.

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5. Culture Conditions and Growth Characteristics in Relation to Photosynthesis in the Green Alga Chlorella. By Jack Myers, The University of Texas.

6. The Songs of East Texas Song Birds. Mrs. Emily Barry Walker and Oscar Adams, East Texas State College, Commerce, Texas.

7. Muskrats of East Texas. Daniel W. Lay; Game, Fish and Oyster Commission.

# SECTION III: SOCIAL SCIENCES

## A Decade of Advance in the Improvement of Educational Opportunities for Negro Children

GORDON WORLEY, Texas State Department of Education, Austin.

During the scholastic year of 1942-1943, the State Superintendent of Public Instruction, the President of The University of Texas, and the President of the Agricultural and Mechanical College of Texas jointly sponsored a comprehensive study of educational opportunities provided for Texas Negroes. The steering committee requested me to make a study of the reports of superintendents who operate dual school systems and to secure salient facts and conditions pertaining to public educational opportunities provided for Negro children and youth at the elementary and high school levels. From that study, certain data are taken as a basis for this paper.

The study covered one hundred Texas counties which contained 232,760 of the State's 240,041 Negro scholastics. The few remaining scholastics were so widely scattered over the remainder of the State that it was not thought feasible to include other counties and children in the study.

The census figures show a gradual decline in the Negro scholastic population in the hundred counties during the decade. According to the 1932-1933 census enumeration of Negro scholastics in the hundred counties, there were 249,450 Negro children of public school age. By 1936 the number of scholastics had declined to 236,590 and by 1942 the number had fallen to 232,760. This decline is general for the various population groups. Part of the decline doubtless is due to closer checking of the census rolls for the removal of duplications and over-age youth included on the rolls.

Although the number of Negro scholastics declined 16,690 during the decade, the number of teachers and principals employed increased from 5436 to 6419 which is an actual increase of 918 teachers, more than 18%.

The total annual salaries of the teachers and principals during the decade increased from $3,044,645 in 1933 to $4,877,827 in 1942. This was an actual increase of $1,833,182 or nearly 61%.

The average teacher's annual salary in these hundred counties in 1933 was $560 and it climbed to $760 by 1942. However, the different counties behaved very differently in the payment of the salaries of their Negro teachers. The highest average salary for any county in 1942 was $1463 and the lowest was $358. One district's average salary was only $260.

The following table gives a fuller picture of the behavior of the counties in the manner of average salaries paid.

*Salary Range and Frequency by Groups*

| Salary Range | $300 to $399 | $400 to $499 | $500 to $599 | $600 to $699 | $700 to $799 | $800 to $899 | $900 to $999 | $1,000 to $1,099 | Over $1,100 |
|---|---|---|---|---|---|---|---|---|---|
| No. Counties in Each Group | 1 | 9 | 21 | 22 | 23 | 14 | 3 | 5 | 2 |

The average salary of white teachers in the hundred counties was

$1244 and the lowest average for any county was $769, while the highest was $1830.

*Teacher Preparation*

As to the preparation of teachers, the data show that 62% of all Negro teachers and principals employed in the hundred counties during 1942 held college degrees as compared with 26% at the beginning of the decade.

*Range in Percentage of Teachers With Degrees*

| Range of Percentage | 1% to 10% | 11% to 20% | 21% to 30% | 31% to 40% | 41% to 50% | 51% to 60% | 61% to 70% | 71% to 80% | 81% to 90% | 91% to 100% |
|---|---|---|---|---|---|---|---|---|---|---|
| No. Counties in Each Group | 1 | 5 | 2 | 13 | 17 | 19 | 16 | 11 | 7 | 9 |

For the white teachers of the hundred counties it may be said that 82% held degrees, while the highest percentage of degree teachers for any county was 98% and the lowest 43%.

*Teacker-Pupil Ratio*

The average Negro teacher in the hundred counties enrolled 33 pupils, but the range of average enrollment per teacher in the hundred countis varied from 16 as the lowest average for any county to 57 as the highest. The table below gives the range and frequency of average enrollment.

*Range and Frequency of Average Student Enrollment Per Teacher*

| Range in Enrollment | 15-20 | 21-25 | 26-30 | 31-35 | 36-40 | Over 40 |
|---|---|---|---|---|---|---|
| No. Counties in Each Group | 1 | 7 | 31 | 40 | 16 | 5 |

The average teacher load per white teacher in the hundred counties was 29 pupils, while the lowest was 21 and the highest was 37.

*Instructional Cost*

The average instructional cost per Negro pupil enrolled in the hundred counties in 1942 was $23 and the range varied by counties from $11 at the bottom to $42 at the top.

The table below gives the frequency of average per pupil instructional cost by counties.

*Per Capita Cost of Instruction*

| Range Groups | $11-$15 | $16-$20 | $21-$25 | $26-$30 | $31-$35 | $36-$40 | Over $40 |
|---|---|---|---|---|---|---|---|
| No. Counties in Each Group | 13 | 29 | 31 | 19 | 7 | 0 | 1 |

The average per pupil cost of instruction per white pupil enrolled in the hundred counties was $42 and the lowest average for any county was $29 while the highest was $62.

*Per Capita Investment in School Property*

The average investment in school property per Negro pupil enrolled in the hundred counties in 1942 was $75, while the lowest average for any county was $14 and the highest was $252. The table below gives a picture of the range and frequency of average groups.

*Average Per Capita Investment in School Property*

| | $10 to $19 | $20 to $29 | $30 to $39 | $40 to $49 | $50 to $59 | $60 to $69 | $70 to $79 | $80 to $89 | $90 to $99 | $100 to $124 | $125 to $149 | $150 to $199 | Over $200 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| No. Counties in Each Group | 1 | 12 | 17 | 22 | 14 | 6 | 7 | 3 | 2 | 3 | 5 | 6 | 1 |

The average per pupil investment in school property by counties per white pupil enrolled in the hundred counties was $246, and the lowest average for any county was $64 while the highest was $458.

From these data it will be seen that the difference in the average school property investment per Negro pupil by counties in the hundred counties was $238. This difference is seventeen times the amount invested per pupil in the county with the lowest average. For the white children the difference between the average for the highest and lowest counties in school property investment per pupil in these counties was $395. This difference is more than six times the average investment per pupil in the county with the lowest average for white children.

## *High Schools*

During the decade the high school situation improved rapidly in several respects. The number of accredited high schools has increased from forty-four to one hundred fifty-one. Fourteen of these have been admitted to membership in the Southern Association. The high school enrollment has increased from 19,934 to 34,964. But there are still several counties without accredited high schools, although the number of Negro scholastics in some of the counties runs from 2,000 to 3,500.

## *Attendance*

Ninety-two percent of all Negro scholastics in the hundred counties and 95% of all white were enrolled in school. The average daily attendance for each group was 75% of the enrollment, but the average attendance percentage for the Negro children in the various counties varied as shown in the table below.

*Percentage of Attendance*

| Range Group | Under 60% | 60% to 64% | 65% to 69% | 70% to 74% | 75% to 79% | 80% to 84% | 85% to 89% |
|---|---|---|---|---|---|---|---|
| No. Counties in Each Group | 2 | 2 | 19 | 33 | 29 | 14 | 1 |

## *Personal Comments*

1. The authorities of some school districts and counties were practically impartial in the provision of opportunities for the education of the children of the two racial groups, while others discriminated against the Negro children under their administration shamefully.

2. The reason for rank discrimination against the Negro children is often more the result of attitude than of financial poverty. It is not usually

the poorest counties and districts which practise the grossest discrimination.

3. Before we may reasonably expect generally fair provisions for the education of Negro children in the South, teacher training institutions will have to give more emphasis to the preparation of superintendents for the administration of dual educational systems. I suspect a little more attention on the part of our theological schools to the question of preparing prospective ministers for a more intelligent and positive role in the matter of building sentiment for fairer dealing with our minority racial problem would be tremendously helpful to superintendents in the improvement of educational opportunities for the Negro children under their administration.

## The Negro in Defense Work in Texas

CARLOS E. CASTANEDA, Assistant to the Chairman, President's Committee on Fair Employment Practice, Dallas.

On May 27, 1943, the President of the United States issued Executive Order 9346 to reaffirm the principles set down two years before in regard to the fuller utilization of our manpower in the total war effort. "The successful prosecution of the war," the President declared, "demands the maximum employment of all available workers regardless of race, creed, color, or national origin." In the months that followed, the demand for a fuller utilization of our total manpower steadily increased. Unjustified scruples and traditional prejudice can no longer be permitted to retard production and the prosecution of the war by allowing large numbers of available workers to remain idle or employed in non-essential industry. Such a policy would be suicidal, un-American and unpatriotic.

Among the minority groups in Texas the largest by far is the Negro. Here was a potential pool of able men and women whom the various war industries refused to employ or reluctantly admitted as common or unskilled laborers regardless of their qualifications, previous experience, or ability to learn new skills. The vocational war training agencies showed the same reluctance in fitting the Negro for industrial jobs where his best aptitudes could be utilized. In some instances training was given to Negroes, but when the graduates of these schools applied for a position they were generally employed as common laborers regardless of their qualifications, thus not only failing to utilize them at their best skill, but making a total waste of the time consumed in training and of the cost to the governmental agencies that trained them.

Even before the new Executive Order was issued the compelling force of stark reality had begun to overcome the blind obstinacy of employers. The last few months of 1943 multiplied beyond all expectations the demands on industries essential to the war effort for an ever mounting production in order to bring about victory at as early a date as possible. These circumstances, coupled to the determined opinion of the President that, "it is the policy of the United States to encourage full participation in the war effort by all persons . . . regardless of race, creed, color, or national origin, in the firm belief that the democratic way of life within the nation can be defended successfully only with the help and support of all groups within its border" have seen a gradual but significant integration of the

Negro in the various war industries in the South and more particularly in Texas.

By the end of the summer more than a million Negroes were employed in war plants in the whole United States. In Texas the percentage of Negroes being used in common, semi-skilled, and skilled positions in war industries steadily increased from a five percent ratio to as high as eight and ten percent on the average, varying greatly in the individual industries. The aircraft industry completely reversed its original position. In 1941 one of the executives of the largest aircraft organization emphatically declared it would not employ any Negroes. By the fall of 1943 all aircraft manufacturers were employing Negroes and in some instances the ratio of the total number of non-whites to whites was 35 percent.

The aircraft industry was not the only one to realize the importance of integrating the Negro in Texas. The shipyards have come to use larger and larger numbers. The extent of utilization of Negroes in this industry in Texas may be shown by a rise from 6.4 percent in November, 1942, to almost nine percent by the fall of 1943. Similarly the guns, firearms, ammunition, and blast furnaces manufacturers came to make wider use of Negro labor, gradually integrating him into the semi-skilled and skilled jobs.

The industries that have made an effort to integrate the Negro have kept special statistics on his suitability, his regularity, his ability to gain new skills, and his performance on the production line. In every case the facts show that he is a willing worker, that the rate of absenteeism is two or three percent higher than that of other employees, that he readily learns new skills, and that when placed on the production line he compares favorably with the others.

Texas war industries are still in the experimental stage in the full utilization of the Negro. The constantly growing demand for increased production and the equally constant diminishing supply of labor as the result of the call made on our manpower for the more effective prosecution of the war make the full utilization of this minority group imperative. Racial prejudice should not be permitted to retard the total war effort. To retard production by refusing to employ qualified workers or to utilize them at their best skill in view of a constantly diminishing labor supply is little short of criminal. It is a negation of the basic principle of equal opportunities that underlies democracy.

Texas industrialists realize these facts and have begun to make a conscious and determined effort to integrate every available worker regardless of race, creed, color, or national origin. We are all engaged in a gigantic war such as the world has never seen. Its purpose is to make effective what Lincoln said at Gettysburg that "Liberty and freedom may not perish from this world."

## Origins and Nature of the Study of Negro Education in Texas

B. F. PITTENGER, The University of Texas, Austin.

On July 30th, 1942, a group of some seventy white and colored professional leaders of Texas met at the capitol in Austin at the call of the State

Superintendent of Public Instruction and the Presidents of the University and the Agricultural and Mechanical College of Texas. This conference was called to discuss ways and means for improving the status of Negro education in this state. Concluding the afternoon's discussion, the group organized itself into a continuing group to be called the Commission on Negro Education in Texas, recognized the State Superintendent and the institutional presidents named above as a Sponsoring Committee, and authorized the committee to appoint a bi-racial Steering Committee for the Commission, to study the situation and make recommendations to the Commission at a later date to be set by the Sponsoring Committee.

The Steering Committee which was designated in response to the action consisted of W. R. Banks, T. D. Brooks, Thomas W. Currie, R. T. Hamilton, J. J. Rhoads, Mrs. Joe A. Wessendorf, L. A. Woods, Gordon Worley, and B. F. Pittenger (chairman). Because of illness, Dr. Hamilton was unable to accept membership, which was then tendered to Dr. H. R. Lee, of Houston.

The Steering Committee met for the first time on August 24, 1943, in the office of the State Superintendent. It broke its problem into two parts for immediate attention, one having to do with the higher education of Negroes, and the other with Negro education at the elementary and secondary levels. With respect to the first, it directed its attention to the needs of Prairie View College and requested Principal Banks to prepare a statement of the needs of this institution for later consideration by the Committee. With respect to the second, it was decided to make a series of short surveys in a dozen Texas counties which have large Negro enrollments in the lower schools, and in which there were one or more higher educational institutions, either white or colored, which could be called upon to sponsor and direct the project. A request was addressed through the Sponsoring Committee to the General Education Board for a grant of $2500 to finance and publish these and other studies. Among the latter was a summarization of the county and independent school district superintendents' annual reports as filed with the State Superintendent. The counties chosen for the survey studies, and institutions agreeing to participate, were:

Bexar County: Trinity University

Dallas County: Southern Methodist University

Denton County: North Texas State Teachers College and Texas College for Women

Harris County: University of Houston

Harrison County: Bishop College and Wiley College

Hunt County: East Texas State Teachers College

McLennan County: Baylor University

Nacogdoches County: Stephen F. Austin State Teachers College

Smith County: Texas College

Travis County: Samuel Huston College and Tillotson College

Walker County: Sam Houston State Teachers College

Walker County: Prairie View College

Directors and working committees were designated by the cooperating institutions, and Professor Hob Gray of The University of Texas generously undertook the general directorship.

The various institutional directors and the general directors met with the chairman of the Steering Committee in Austin on October 29, 1942. At this meeting the plans for the local surveys were worked out, and it was determined to ask representative white and colored citizens in each county to serve as an advisory committee to the institutional working committee in that county. The general director and Mr. Worley of the State Department visited every county involved, during the first week in November, to get these advisory committees established and each survey under way.

These county surveys were completed largely during the month of November, and reports were in the hands of the general director early in December. The general director's summary and recommendations, together with the results of the study of the superintendents' reports in the files of the State Department, and the recommendations from Principal Banks concerning Prairie View College, were presented to the Steering Committee on December 10, at which meeting a report was prepared for presentation to the Commission. The Commission was called to meet in Austin on December 16, 1942, and adopted the following recommendations:

1. That the Commission be requested to continue itself at least during the next biennium so that a body of interested people may be available to continue to work for improvement of opportunities for the education of Texas Negro people.

2. That the present Bi-racial Steering Committee be continued and that the sponsors be authorized to designate another to assist them in a continuation of the study of the educational needs at all levels and especially at the college level and in the work of trying to achieve the goals that will be set up by the Commission. The Steering Committee should report back to the sponsors and Commission before June 30, 1943.

3. That teacher training colleges and universities be invited and urged to include in their courses in administration and supervision necessary content material to prepare superintendents and supervisors more fully to realize and to handle the problems peculiar to the administration and supervision of the dual education system.

4. That the Commission authorize the sponsors to set up a legislative committee to work with the sponsors in the preparation of a bill for a salary schedule beginning, without regard to race, with a minimum of say $600 annual salary and providing for increases based on preparation and successful experience, and providing that state aid be conditioned upon impartial and fair adherence to the law.

5. That provision be made for the addition of two Negroes to the supervisory staff of the State Department of Education.

6. That the Commission urge the State Superintendent of Education and the State Board of Education to formulate a plan by which such service in supervision and leadership in Negro Education as is rendered by the Jeanes Teachers be made generally available to all counties with considerable Negro population and request from the Legislature the necessary legislation and appropriation.

7. That the State Superintendent of Education and the State Board for Vocational Education be urged to provide a plan of area supervision in homemaking education for Negroes comparable to that now obtaining in vocational agriculture.

8. That the sponsoring committee be authorized to publicize factual information in any way it sees fit for the advancement of the undertaking.

9. That scholarship aid for out-of-state study by qualified Negro graduate and professional student be continued as during the last two bienniums, except as may be deemed wise to change because of Federal government plans and regulations for graduate and professional education.

10. That the importance of providing for the erection of a new library building at Prairie View State College as early as possible be emphasized in order that the State may be able to secure substantial aid for equipment and books from the General Education Board, Rosenwald Fund, and Carnegie Fund before these funds are liquidated. The library building and books are also essential to the development of graduate work at Prairie View State College.

11. That the Committee endorse and recommend the passage of appropriations for Prairie View College as requested by Principal Banks in their report to the Commission with the addition of $11,325.00 for library and other graduate instructional services.

(The recommendations contained in items 9, 10, and 11 were adopted at the legislative session immediately following this report.)

In response to Item 2 of the foregoing, the Sponsoring Committee set up a new Survey Committee on Negro Higher Education in Texas, with the following membership:

Dr. T. S. Montgomery, Sam Houston State Teachers College
Mr. O. J. Baker, Prairie View College
Dr. T. D. Brooks, A. & M. College
Dean A. P. Brogan, University of Texas
Dr. V. E. Daniel, Wiley College
Dean Chas. Deslandes, Sam Houston State Teachers College
Mrs. Willie Mae Douglas, Texas College for Women
Dr. B. B. Harris, North Texas State Teachers College
Professor John Lewis, Tillotson College
Dr. E. R. Perry, Prairie View College
Professor C. O. Rogers, Bishop College
Professor Henry Ross, A. & M. College
Miss Ruby Simpson, Texas State College for Women

This Committee carried out its labors during the spring of 1943, and its report and recommendations are now in preparation. When ready, they will be presented to the Steering Committee for consideration and will become the basis for a further report to the Commission. It is also expected that the Steering Committee will make such recommendations as seem desirable concerning improvements in Negro Education in the lower schools. The work of the conference and of the Steering Committee is planned to be continuous in the future.

## Rebuilding the American Family After the War

R. B. MELTON, Professor of Sociology, Sam Houston State Teachers College, Huntsville, Texas.

Within recent months the American public has been deluged with a plethora of plans for "rehabilitating," "re-building," "reorganizing," and "recasting" various parts of our way of life. The emphasis in these projects for creating Utopia seems to have leaned heavily toward economic matters. Without disparaging this emphasis, one feels inclined to be a little upset over the fact that few people have called attention to the need of strengthening the most fundamental human group we have, which is the family.

As nearly everyone knows, the American family has undergone tremendous change in recent years. Many of its most important functions have been taken away by other apparatus devised by our society. Nevertheless, the American family still performs at least four of the most important functions any group can serve in any culture. These four functions are: (1) Personality development of the child; (2) providing emotional stability and response to both children and adults who are members of the family; (3) developing a moral code within the family and moral discipline in the character of the individual; (4) reproduction of the species. The performance of these functions means that our American family, no matter how great the changes in it have been, is still our most important human group.

Now let us turn our attention to the question why our American family will need re-building. That question can be answered by an examination of two propositions. The first of these is that there has been tremendous disorganization in the American family in recent decades and there is abundant promise of more to come. The second proposition to be advanced here is that the American family is being destroyed by certain outside and inside influences.

Let us examine some of the proofs of increasing disorganization in the American family. The most striking proof we have is the terrific divorce rate, which we ought to know about in Texas, since we have one of the highest rates in the nation! The figures indicate, as nearly as one can be sure of an accurate interpretation of them, that about one out of every five marriages ends in divorce. Recent studies indicate that the figure may be higher than this. Certainly the trend is toward a higher rate, which is expected to follow the end of the war.

There are no reliable figures on desertion rates, for obvious reasons, but it is quite certain that there is a significant amount of desertion in our nation, and when this form of family break-up, plus "separations," is taken into consideration, we move clearly toward a condition where perhaps one out of every four marriages will be broken up by factors other than death of one of the partners. There is no need to comment on the significance of these figures and the light they throw on the instability of the American family.

There is no scientific benefit to be gained by piling mountains upon each other, but some additional evidence of family disorganization exists that should be noted in this connection. Reference is made to the high illegitimacy rate to be found in our country, that from seventy-five to one hundred thousand illegitimate births occur each year. This indicates that about one in every twenty-five to twenty-seven births is illegitimate. Such a rate of occurrence of events, which our society condemns, indicates exceptionally loose family control and organization.

Finally, some facts regarding a problem with which everyone is more or less familiar may be given here. Reference is to juvenile delinquency. From one-fourth to one-half million children per year are coming into conflict with the law now. No exact figures are available, though we know that the rate has risen in war-time and that normally it amounts to at least two hundred thousand youngsters each year. The most authoritative study made in Texas of the effects of the war revealed a fifty-seven percent increase in delinquency among adolescent girls over pre-war conditions. This problem is so well known and the facts so well established that we need not comment further on it.

The facts given regarding divorce, desertion, illegitimacy, and delinquency might be added to, but there is no need. They indicate beyond any shadow of a doubt that the American family is in a highly disorganized condition. Knowing that the trend in recent decades has been toward acceleration of family disorganization, we may be sure that the American family will be critically in need of re-building after the war.

Now, let us take up the more serious proposition made earlier that the American family is in effect being destroyed. If this proposition can be established, then there can be no doubt of the need of family reconstruction measures.

There is so much evidence supporting the thesis that very serious destructive influences are at work on the American family that only a few of the more important points can be mentioned here. The most significant bit of evidence is our falling birth rate. This fall has been steady and definite for decades and has produced practically a stable population in this country at the present time. Unless the trend is reversed, we shall eventually have smaller, fewer and weaker families, because we shall have fewer children to grow up and marry, and an increase in the number of old people who are not able to make and hold families together.

This falling birth rate is due to the increase in the use of reliable contraceptive techniques and to certain other factors, chief of which seem to be (1) the high cost of children, and (2) certain mores regulating social status in our community. A few figures on the cost of children are enlightening. The Metropolitan Life Insurance Company recently estimated the cost of rearing a child to the age of eighteen in a family with an income of $2500 per year, as $7,700. These figures were based on pre-war price levels, and the present price increase would raise the cost of rearing a child to $10,000. Remember that this is in the middle class. It is certain that this high cost of children decreases the number produced.

In our society, certain beliefs prevail regarding social prestige. In some social levels, children prevent normal social life and are actually a social embarrassment. These social groups find it just as emotionally satisfying and much more socially satisfactory to maintain a high-class home for dogs, as to rear babies. Throughout the classes most seriously indoctrinated with our leisure class standards of living, the influence of this ban on babies has made itself strikingly felt.

Naturally, the cities are the main centers of the leisure class way of life, and it is in the cities that we find the most illuminating figures on human reproduction. The data we have support the conclusion that cities, on the average, fail to reproduce themselves by thirty-three and one-third percent. The only part of our population that has a reproduction rate above unity is the rural population and, as practically everyone knows, the rural population is beating a broad and rapid trail to town. The ultimate result, unless the trends are reversed, will mean a declining population for our nation, which is tantamount to destruction of many families.

We need only refer to two other causes of family destruction: War and Economic Depression. The initial result of war is to stimulate marriage. The long-term result of war is to break up families and cause fewer families to be formed over a period of time. The last depression caused postponement for many years of at least a million marriages. Postponed marriages mean for many people failure to marry and less successful marriage when marriage finally occurs. The evidence in hand gives abundant support to our two propositions that the family is being terrifically disorganized as time goes on and that there are forces at work destroying the American family.

Let us turn to the question posed by the title of this discussion: "What must be done to re-build the American family after the war?" The first point that seems in order here is that leisure class mores, which have elevated dogs to a higher status than babies, must go. Without the destruction of the social values inherent in our leisure class philosophy of family life, there can be no reconstruction of the American family. This leisure class, thrill-directed, super-saturated, emotionalistic culture is one of the great primary causes for the collapse in recent years of our respect for such a vital human group as the family. This same culture is responsible for war workers, toiling in our armament factories, being refused the right to occupy vacant premises which might shelter young American citizens who are so unfortunate as to be infants. Respect for children will never come back as long as our money making culture exists, simply because one gains more prestige by making money than by rearing useful citizens.

Finally, our leisure class culture must go before respect for women who are willing to bear children can be restored. There is no need to refer to the unfortunate remarks and jibes that fall to the lot of women who become pregnant. It may be old-fashioned to argue that women who reproduce the species should be entitled to reasonable respect. They are not so respected now.

Is it necessary to add that as long as these ideals prevail there can be no fundamentally sound reconstruction of the American family?

We shall not be able to rebuild our families on a sound basis unless we also deal with another set of influences. These are economic and cultural. In my opinion, we must eliminate economic depression and economic insecurity generally from the world in which people live before they will again undertake the serious business of reproduction. We must bring the cost of children down somehow or there will continue to be fewer children produced. We must recast urban life so that it will leave room for families and nourish family life. Only by such far-reaching measures as these can we hope to restore to sound health our weakened and weakening American family.

## The Four Horsemen, the Four Freedoms, and Science

R. G. UPTON, Professor of Biology, Stephen F. Austin State Teachers College.

The four horsemen of the apocalypse were seen in a vision by John and are recorded in the sixth chapter of *Revelations*.

The first horseman was dressed in white, riding a white horse. To John, he represented conquest. In the story by Ibanez, he represented Pestilence and carried all kinds of disease germs to turn loose on the population of the world.

The second rode a flame-red horse and was called War.

The third horseman was bald, old, and skinny and rode a black horse. He was Famine.

The fourth horse was the color of ashes with a rider of parchment-like skin, whose knees were sharp as spurs. He carried the long sickle and was called Death.

The apostle John seemed to think these four horsemen were to be turned loose only once. Ibanez seemed to think they were first turned loose at the beginning of the First World War.

In truth, the four horsemen of the apocalypse have been present in every generation and in every decade. Civilization, through the development of the medical sciences, has reduced Pestilence a little more each year. The millions of white-clothed doctors, nurses, and assistants are fighting the white horseman, Plague, at every turn in the road with increasing success.

In civilized countries, Famine is almost conquered and would be completely so if our machinery for the distribution of wealth were as perfect in operation as is that of production.

Civilized, capitalistic nations derive great self-satisfaction from their philanthropy each time they give a little food and medical aid from their abundance to the plague and famine victims of the over-populated localities of Asia and other unfortunate peoples. These "stop-gap" philanthropies should be replaced by a stabilized, permanent civilization.

The third horseman, War, has been made many times more horrible by the aid of scientific inventions, and the worst is still withheld within the fields of the future. We have done the least to stop this horseman. Civilization seems to be forwarding in place of hindering war.

The fourth horseman, Death, does not belong in the same group as the other three. Death is necessary for all animal life, man included. The fight of science is not against death, but against premature death. War, Pestilence, and Famine cause death of both the young and of older people before their allotted time.

The pain of death is alleviated by medical science. The sorrow of death is assuaged by our belief in the continuation of the personality, the immortality of the spirit.

Science will continue to decrease the rate of premature death, although at present machinery, including all modes of transportation, is taking a terrific toll daily, due to its careless use.

War is the unconquered enemy of mankind. It was caused in primitive peoples mostly by overpopulation and hence lack of food. In modern times, this has been used as an excuse for war, whether it was true or not.

Kaiser Wilhelm stirred up his people to fight for "a place in the sun." The "master race" philosophy now seems to be going out like "the place in the sun" idea.

In both these instances, personal and racial vanities were the real causes. Such causes of war can be held in check only by a competent police force on an international scale.

What are the scientific aspects of the four freedoms as discussed by President Roosevelt before the Congress of the United States of America in January of 1941 before we were in World War II?

Freedom of the press is good only as long as it is a truthful press. An untruthful press would better be suppressed.

Freedom of religion is good only when religion is democratic and not antisocial. All religions, including those of Asia, could be scientifically measured in terms of their benefits to humanity. Any religion is good in so far as it helps the common man, all the people. If a religion makes a static society with most of the population in want and misery, it is in need of improvement.

Freedom of speech also needs the safeguard of telling the truth. It needs some safeguards against untruth.

Freedom from want is the most questionable of the four. It is attainable in well-developed countries but even dangerous in the lower, oppressed levels of mankind. Statistics show that a few years of better living conditions in India result in an increase of fifty million in population. People multiply under primitive conditions much like the lower animals. The result of a few years of good crops will cause a greater famine when food production fails because of the greater number of empty stomachs to be filled. The principles stated by Malthus and later by Charles Darwin are still true.

Overpopulation, past, present, and future, is the greatest cause of war. Stability of population is the only hope for world peace for any great length of time.

Under natural conditions, overpopulation is reduced by the four horsemen: Famine, Pestilence, War, and Premature Death. War is avoided if the other three are sufficiently destructive of human life, in which case the neighboring tribes or nations would be spared the scourge of war, and to them their neighbors' calamity would seem beneficial.

If freedom from want is to become universal, or even common, future wars can be prevented only by the addition of a fifth freedom, the freedom from excessive child-bearing under adverse conditions or freedom from unwanted child-bearing.

Limitation of the size of the family is already in practice in most enlightened countries. This knowledge must be passed on to the less fortunate peoples if disease, famine, and oppression are not to be their common lot.

Some will say it cannot be done because family control is contrary to the religious beliefs of most of the world's population. However, religious beliefs change with the passage of time and the direction of change is subject to control.

Moreover, there is one easy way to overcome or sidestep the obstacle of religious belief and tradition. The poorest and most unenlightened woman will seek advice from a woman doctor or nurse, especially one of her own race. The answer to the problem of over-production is medical schools for native women and nurse training for native women. Let the women gynecologists treat and advise their native sisters concerning control of human reproduction. The women in underprivileged nations do not desire frequent pregnancies any more than do those of the western world. If they find contraceptive information available from their own tribal women, their birth rate will be reduced regardless of all man-made theories concerning proper conduct for women.

With a controlled birth rate, the less fortunate people will not have to raise babies by the million only to see them die in infancy from disease and starvation. Neither will they have to reduce their population by war. The women themselves will act in their own behalf if contraceptive knowledge is available to them. Otherwise, all our efforts to secure freedom from want will only accentuate the vicious circle of more food, more population, more famine, and want and war.

The fifth freedom should be added and made available to all underprivileged peoples.

**Other papers listed on the programs of meetings**

1. The Health of Negro School Children. By Dr. Connie Yearwood Odom, Negro Medical Consultant in Maternal and Child Health, Texas State Department of Health.

2. Psychiatry in Action, Dr. David Wade, Superintendent, Rusk State Hospital, Rusk, Texas.

3. The Scientific Approach to the Study of History, Miss Mary Love, Associate Professor of History, Stephen F. Austin State Teachers College, Nacogdoches, Texas.

4. Purport of Mental Hygiene in Social Situations, Miss Maud B. Davis, Dean of Women and Professor of Pysychology, Trinity University, San Antonio.

5. Some Economics—Present and Postwar, Mr. Vernon Hughes, Professor of Economics, East Texas State Teachers College, Commerce, Texas.

# SECTION IV: GEOLOGICAL SCIENCES

## ABSTRACTS

**Chemical Outlets for Farm Products**—VICTOR H. SCHOFFELMAYER, Science Editor of The Dallas Morning News, Dallas. In the past ten years American agriculture has passed through one of its greatest crises, the result of overproduction on the one hand, and underconsumption and maldistribution on the other.

This crisis brought government crop and acreage control measures designed to limit agricultural production to market demand. In short, a program of artificially produced shortages of crops and livestock was enforced, and these have brought about profound shifts in crop production.

These crop shifts have seriously affected Texas, especially the annual crops of cotton, wheat and peanuts.

Texas, which before the control years, starting with 1933, annually raised an average of 4,000,000 bales of cotton, in recent seasons barely produced 3,000,000 bales. About 10,000,000 acres were taken out of cotton production in this state, or a decline from a peak of 18,000,000 acres to less than 8,000,000 last season.

In reducing the output of cotton fiber by artificial control, our farmers automatically reduced the quantity of essential protein stockfeed in the form of cottonseed cake and meal. Texas no longer was able to supply its own livestock feed needs with cottonseed feedstuffs, nor the Corn Belt States, whose farmer-feeders turned to northern-grown soybeans so that in the same ten years the acreage of commercial soybeans in the Midwest increased from 100,000 acres to 12,000,000 acres and the crop from 50,000 bushels to 210,000,000 bushels.

Today the Corn Belt and the Northwest depend largely upon soybean cake and meal instead of Texas cottonseed cake and meal.

This example is cited merely to show what happens to a crop in one region when another region makes up its mind to produce and use a substitute. We see what serious consequences may follow unwise restrictions upon agriculture, and how regional competition may upset the best intentioned schemes when they are basically questionable.

In the meantime war has swept this nation into one of the most critical economic situations in our history. We are faced with food shortages in supplying our home needs and those of the fighting forces at the front, as well as the populations of nations freed from oppression. Those crop surpluses which brought about the government controls today would certainly be welcomed, not only by us but by hundreds of millions of other hungry people. We, therefore, are belatedly expanding our agricultural machine to raise the largest crops in history.

All this type of program, however, deals with crops from the standpoint of human and animal food. Now let us look at these food crops—wheat, corn, grain sorghums, cotton, milk and many others—as to what they really are—raw chemical materials. To the chemist and physicist food crops are only building blocks of industry.

New Chemurgic Outlets

The industrial use of surplus and waste food and other farm and forest products is known by the now widely accepted name—chemurgy.

Chemurgy has for its objective the greatest possible production of farm and forest products and their widest possible use by industry.

Chemurgy, therefore, is the direct opposite of a program of scarcity, because it fosters maximum production of every raw material which can serve industry.

Although our farmers have for centuries looked upon wheat, corn, sorghums, potatoes only as food, to the chemist these are only such chemical raw materials as protein, cellulose, lignin, starch, sugar, resins, gums and waxes. Since all these materials are needed by industries, and many of them have been imported from foreign lands in millions of tons, it would seem a wise provision of our agricultural program to encourage our farmers to grow at least a substantial portion of these products and thus increase their earning power.

The farmer would be called on not only to feed and clothe the world, as he has done for thousands of years, but he would sell his surplus products—his wheat, corn, oats, hay, cane, wood, potatoes or whatnot—as so much chemical raw material.

To paper and plastics mills he would sell his pulpwood, to cigaret paper mills his flax and rice straw, to industrial alcohol plants his low-grade corn, wheat, rice, barley, sweet potatoes, Irish potatoes or grain sorghums.

To starch plants again he would sell his potatoes, whether white or red, to oil mills his flaxseed, soybeans, castor beans, safflower, sunflowers and other seeds adapted to his area.

These industrial plants would give farmers a new outlet for products which in the past constituted a surplus, depressed the market and brought the farmer to the brink of ruin.

That in a nutshell is the aim of chemurgy.

Regional and local adjustments to crop practices, of course, must be adopted. Entirely new crops probably will be grown along with long established crops. Crops will be rotated more efficiently and soil management and replenishment will go hand in hand as farming begins to pay the farmer a profit.

Established rural industries, such as lumbering, would undergo significant changes. For the first time in their history they would suddenly discover a market for their formerly wasted sawdust and lumber-mill trimmings, which in the past were burned year in and out at a frightful loss of chemical materials, not only to the mills but to the nation as a whole.

We are now entering upon perhaps the most important phases of our Machine Age economy—that of the Era of Industrial Chemistry.

We need only to think of synthetic rubber made from waste gases of petroleum or from ethyl alcohol, or of plastics made from cellulose, lignin, starch or sugar, proteins from soybeans or cottonseed.

We are beginning to realize that such a common, traditional material as wood—lumber, boards, sawdust—is playing a big role in the manufacture of fighter planes during the war and possibly passenger and freight air carriers after the war.

We have discovered that such simple chemical materials as cellulose, starch and sugar, protein and lignin, which ordinarily are soft of structure and perishable, can be pressed into durable, hard materials which in turn can be fashioned into wallboard, furniture, automobile and airplane bodies, railroad cars and practically any other needed products.

Chemistry is rapidly transforming ordinary vegetables and other forms of plant life into highly prized industrial materials.

Throughout the past century of lumbering in our country only about 25 percent of a tree, as it stood in the forest, ever reached the consumer in the form of finished goods. In other words, 75 percent of a tree was wasted—burned at the mill in the form of trimmings, or as sawdust left to rot, or as odds and ends. But when whole trees are chewed up by powerful machines into fibers, and these fibers are recombined into new materials such as the sun never shone on, materials which do not splinter, shrink or crack, or emit rosin in the hot sun, or warp and absorb moisture, materials almost as hard as iron or steel but lighter than aluminum, then we begin to see the role of chemurgy.

Now then, for a final word why chemurgy must take its rightful place in American and world industry. As our raw materials—iron, copper, nickel, aluminum and others—become more or less exhausted by the heavy demands of war and postwar industry, our manufacturers must turn to substitute materials—wood, crops, milk, vegetable proteins, starches, sugars or resins. Why? Because these can be grown from year to year and need never become exhausted if we take care of our soil.

We, therefore, will have at our command ever renewable raw materials which for most purposes can be substituted for steel, glass, stone, wood, or cement. Pressure and heat will do what is necessary—the result is plastics.

Plastics alone will probably become the great new field of American industry—automobile bodies, airplanes, railroad cars, walls of houses, paving blocks or furniture pressed or stamped in huge plants or poured into molds to emerge as durable and probably cheaper products than the world has ever known.

As long as the sun shines and the rains fall these chemical raw materials can be grown to supply industry's needs. We must remember that 98 percent of our plant structure comes from sunshine, air and water. That is the foundation of chemurgy and its challenge to agriculture and industry in a rapidly changing world.

**Waters from the Frio Formation in the Texas Gulf Coast**—F. W. JESSEN AND F. W. ROLSHAUSEN, Humble Oil & Refining Company, Houston. Oil field brines have been studied for many years in an attempt to solve some of the geologic and production problems encountered in the production of oil and gas.

It is the purpose of this paper to present data on brines occurring in the Frio formation of the Texas Gulf Coast and to show how their composition varies, (1) with depth below the surface, (2) with depth below the top of the formation, and (3) along the approximate strike.

The brines vary in chloride content from 3,180 to 73,000 ppm, though the average salinity of the salt waters is shown to vary with total depth, the concentration being 35,000-40,000 ppm at 4,500-5,500 feet and above 50,000 ppm chloride at 5,500-6,500 feet.

From the analyses available, it appears that the highest concentration of salts occurs in the upper 300 feet of the formation, while lower salinity is found with increasing depth below this point.

The salt waters from wells in Starr County show lower concentrations of dissolved salts than those from any other group of wells farther north along the strike.

In all, 116 analyses from 63 fields and 14 wildcats, from depths ranging from 1,300 feet to 11,400 feet below the surface and from two feet to 3,240 feet below the top of the Frio, are recorded.

**Disposal of Oil Field Waste Water in Streams**—J. G. BURR, Game, Fish and Oyster Commission. Disposal of oil field brine by dilution in streams, preferably at flood stage, was the prevailing method over the State until about a year ago when injection wells in the East Texas field began to take a large share of the brine. A beginning was made in 1938.

Last October 8, 179,494 barrels of salt water were put back into the ground through 56 injection wells, was shown by figures of Engineer W. S. Morris, General Manager of the East Texas Salt Water Disposal Company of Kilgore.

The purpose is not only to protect streams from contamination but to arrest the decrease of bottom-hole pressure and thus extend the life of the field.

Based on a salt water production of 305,930 barrels daily in May, 177,607 injected back into the ground (see Morris report), there were left 128,323 barrels to be released from storage into the streams. This would require the combined average of 1641 second feet flow for the Sabine and Neches Rivers to dilute properly the chlorides which are said to average 38,000 parts per million. Such an average stream flow will prove adequate in normal years with proper storage control, but in a dry year such as 1925 perhaps as much as one-half of the brine would have to be held over, unless the injection program is greatly accelerated which will, no doubt, be done.

The proper maintenance of pressure, says Mr. Morris, will increase the recovery between 350 million and 625 million barrels of oil, and he concludes that the salt water injection program will be the most outstanding conservation program ever attempted in the oil industry. (Published in the January issue of "Texas Game and Fish," Austin, Texas.

**Rights of a Fisherman Along the Cut-Banks of a Public Stream**—J. B. BURR, Game, Fish and Oyster Commission, Austin. The bed of a river is that portion of the terrain between its fast land banks. The cut-bank is so named when applied to a public stream because the river boundary line cuts through the middle of the bank giving the upper half to the riparian owner and the lower half to the State. The bed, of course, belongs to the State.

The cut-bank extends upward from the river bed to the adjacent upland. The upland borders the bank of the river and is at times overtopped by the flood. The Supreme Court ruling states, "The boundary line is a gradient of the flowing water of the river. It is located midway between the lower level of the flowing water that just reaches the cut-bank and the higher level of it that just does not over-top the cut-bank."

Thus, if the top of the cut-bank has an elevation of 20 feet, and the lower edge of the bank is two feet above the flowing water, the cut-bank has an extent of 18 feet; one-half of this is nine feet which, added to the two feet belonging to the bed, would mean that an 11-foot rise would cover all that belonged to the State, or that the boundary of the river has an elevation of 11 feet.

(Published in the December issue of "Texas Game and Fish" at Austin, Texas.)

**The Great Soil Groups of the World and Their Agricultural Systems**—ELMER H. JOHNSON, The University of Texas, Austin. With reference to the world's agriculture in relation to the Great Soil Groups the following conclusions stand out quite clearly.

1. It has taken World War II to bring about anew the fundamental nature of agricultural production, that is, the outstanding importance of the great agricultural staples particularly. Agriculture from the broader point of view is much more than either a local or regional problem; it is even more than a national problem—it is an international problem of the first magnitude.

2. Historically considered, the world's agricultural problem has always been primarily a food problem; more particularly, it is a grains problem, as livestock food products are largely dependent upon the use of grain as feedstuffs.

3. Viewed in historical perspective, the world's food problem has always been a critical one.

The pessimism of Malthus was allayed by developments in the 19th century which affected the Western World mostly; a phase of Malthusianism, however, was revived by Sir William Crookes at the close of the 19th century in consideration of the sharply limited supplies of natural nitrates.

4. Although it passed unnoticed by the economists of the time, and even later for that matter, the shift of the large production in grains, fibers and livestock to the vast areas of the grassland plains in the interiors of the continents during the latter third of the 19th century constituted the greatest agricultural revolution in all historical time. This shift was intensified and even extended considerably by the greater use of large-power agricultural machinery which came with the period of World War I.

In the two decades following World War I the Western World was plagued by over-production of the staple crop products. This increased production was primarily the consequence of the great regional surpluses supplied by the agriculture that had grown up on the Great Soil Groups of the interior continental plains, the agricultural conquest of which came after 1870. The problem of these surpluses was intensified by the increased output of certain specialized production in the tropics, particularly of cane sugar and vegetable oils. During the period of this "over-production," however, the food supply at large for half the world's population in the Orient was close to the barest of subsistence levels, large numbers of people in Europe had insufficient food, and even in the United States a large part of our own population could have consumed much more of foodstuffs then they did.

5. Now again the problem of foodstuffs has risen to be a critical one in a world that does not lack serious problems; already the specter of starvation and famine is dramatizing the seriousness of the world's food situation.

6. The question of what can be done about the world's food situation in the postwar years resolves itself into a consideration of what the larger food producing regions of the world can do; localized areas are apt to be important only locally. The problem is one that concerns primarily the regions of large production. In brief, these are the Orient, western Europe and eastern United States, and the vast areas of interior continental plains of the middle latitudes.

a) The Orient is at large a vast deficit region as regards food production and that in spite of the fact that its agriculture is the most intensive in the world; nor can its food output be greatly increased over what it was before the war. There are surplus food producing regions in the Orient but all such available surpluses and more, too, will be in demand within the Orient itself.

b) Western Europe and eastern United States are large deficit staple food producing regions. West-central Europe and East-central North America are the two world regions whose agriculture is of the mixed farming type—a type that sometimes is regarded as nearly self-sufficing. But these are regions of large urban populations engaged in industry and commerce and they are the regions that supplied to a large extent the great markets for the surplus agricultural products that began to be so important after 1870. But even the agriculture of these regions is not self-sufficient since, for instance, with the increased competition they were subjected to by the agricultural conquest of the new lands in the latter part of the 19th century, these regions of West-central Europe and East-central North America became large producers of quality livestock products. This practice, however, was made possible by the imports of concentrated feedstuffs such as grains, together with oil-seed products—oil cake and oil meal.

c) As to the tropics at large, there is no question as to their capacity ultimately to produce large regional surpluses of food products. But for some time to come their surplus food output will be limited mostly to sugar and vegetable oils and certain specialties, of which cacao is an example. Other than these foods, the tropics will be able to contribute but little to the solving of the world's food problem in the postwar period. Agricultural organization in the tropics at large has as yet not been effected.

d) By elimination, this leaves but one series of the Great Soil Groups of the world available for increasing to any considerable degree the world's food production in the near future. These are the continental interior plains, the conquest of which set in motion the agricultural revolution of the latter part of the 19th century.

The largest sector of these grassland plains is the Steppes of Russia, the home of the famed Chernosem, or Black Earth soils; these plains extend eastward into Siberia, westward into Roumania, and another fairly large area comprises the Plains of Hungary.

In North America these interior plains, though smaller in extent than those of Eurasia, are nevertheless large, and they present considerably more agricultural variety than the Steppes of the Old World. They include the Midwest Prairies (the Corn Belt), the Southern Prairies (mostly the Black and Grand Prairies of Texas) and the Western Plains which lie between the Prairies and the Rocky Mountains and extend from the area of Edmonton, Alberta, to the Rio Grande and the Gulf of Mexico.

On the basis of moisture conditions these Western Plains are subdivided into eastern and western portions—into the sub-humid, that is the Black Earth or Chernosem zone, and the Dry Plains. On the basis of temperature conditions, they are subdivided into northern, middle, and southern belts, which of course cut across the moisture zones thereby producing a checker-board pattern of subdivisions, and this is the basis of the regional variety displayed in these plains of North America. This southern sector includes the High Plains and the Red Bed Plains of West Texas, the Edwards Plateau, and the Coastal Plains of South Texas.

Attention, however, should be directed toward the potentials for food production possessed by the extensive area of the Lower Mississippi Alluvial Lowlands. This is a region in which highly fertile soils occur in a humid region with a warm and long growing season.

In the southern hemisphere, Argentina and Australia also have interior grassland plains. The Pampas of Argentina, much smaller than the North American plains, comprise a relatively small prairies region, the Argentinian Corn Belt; a larger sub-humid zone, the Wheat and Alfalfa Belt; and the Dry Plains sectors largely devoted to grazing enterprises.

In Australia, the sub-humid plains are smaller in area than in Argentina, a fact that is reflected normally by Australia's smaller wheat production; Australia's Dry Plains, however, are relatively large, as reflected in cattle production and even more so in the large production of sheep and wool.

Smaller, more or less isolated areas of dark-colored grassland soils occur elsewhere in the world, and they may add something in the way of surplus food production. There are, for instance, areas of dark-colored soils in both North and South Africa.

7. Finally, it must be recognized that the postwar food problem is intimately tied in with facts and policies of national economics and of international trade.

. There is much to consider in attempting a pre-view of the postwar world, which will certainly be a different world from that of 1870, or 1900, or 1920, or even of 1930.

It is certain, too, that the basic patterns of international trade in the postwar world will be different, perhaps quite different indeed, from what has obtained in the past.

It is not out of place to state the question, and it is one of immense importance: what will be the position of the exportable surpluses of foodstuffs in the actualities of world trade of tomorrow?

**Some Characteristics of Subsurface Formations in Peninsular Florida and Suggested Correlations with Other Gulf Coastal Areas**—E. R. APPLIN, The University of Texas, Austin. A discussion of the sub-surface formations of Florida ranging from the Ocala into the Lower Cretaceous. The paper includes a generalized description of the lithology, extent, members, list of diagnostic forams, and remarks on the probable relationships of these formations with those of the Gulf Coast area to the west.

**A Restoration of the Triassic Amphibian Buettneria**—H. J. SAWIN, The University of Texas, Austin. A restoration of the skeleton of *Buettneria howardensis* is described and discussed in relation to the other known American metaposaurids and the rhachitomous amphibian *Trimerorhachis*.

**Air Corps Geography**—G. W. SCHLESSELMAN, A. & M. College of Texas, College Station. The objectives of the Air Corps geography course are: (1) to lay the foundations for the technical use of maps and charts in aerial navigation, (2) to prepare for work in meteorology by offering instruction in physiography and climatology, and (3) to acquaint the student with the geographical factors which influence the policies of modern states.

**Mineral Locality Map of Texas Showing Occurrence of Useful Minerals, Rocks, and Other Geologic Substances**—E. H. SELLARDS, The University of Texas, Austin. This map will be on the scale of 1:1,000,000, one inch equals 16 miles approximately. It is intended to show localities of mineral production in Texas. In addition, the map will show some localities of mineral occurrence. It has been found impossible, however, to map distribution of minerals, particularly those occurring in bedded deposits, since there is so much overlap in occurrence. The map will be printed in colors: base in black; oil fields in green, solid color; gas fields in green, stippled; other mineral localities in red. Oil and gas, or both, occur in about 162 counties of the State, and there is no county lacking mineral production of some kind.

**The Geography of Panola County, Texas**—AVIS KINARD, Beckville Schools, Beckville, Texas. Panola County is located slightly north of the center of the East Texas pine timber belt. It is on the Louisiana border and is crossed from northwest to southeast by Sabine River. American pioneer settlements were made in this area before the war for Texas independence. The county was organized in 1846 with Pulaski as its county seat, but the government center was soon transferred to Carthage on account of its more central location.

Panola County is a rolling coastal plains area drained by the Sabine and some tributary bayous. Level land is interspersed among the hills and valleys, being most abundant in the south and east. In the southwest there are elevations above 500 feet. Top soils are mainly light colored sand and sandy loam but clay is exposed on some eroded slopes. The best soil is in alluvial areas, but overflows prevent its general cultivation. Summers are long and hot, and it is usually dry during August and September. Winters are short and mild, but there are brief periods of cold weather.

In general, the more sloping land and the valleys are forested while fields and pastures abound on relatively level upland. The timber is mostly second growth shortleaf pine, but oaks, gums, hickory, elm, and other hardwoods are dominant in valleys.

In 1850 Panola County had 3,871 inhabitants. The population increased until 1930 when 24,073 lived there, but by 1940 the number had declined to 22,513. About 42% of the people are Negroes. The poorest Whites and Negroes live in shacks. Farm homes are distributed along paved highways and roads, six of which radiate from Carthage where 3,178 people lived in 1940. Beckville then had 453 inhabitants. Gary and DeBerry are other postoffice towns.

The 4,389 farms occupy two-thirds of the county and have an average size of 72 acres. About 35% of them are operated by owners and most of the others have Negro tenants. Cotton has long been the chief crop, but its acreage has decreased 20% since 1934 due to prevailing low prices and to government restrictions. The staple is baled and marketed; some of the seed is sold locally, some is kept for use as feed and for planting, and some is exchanegd for cottonseed meal at gins. Corn occupies about as much land as cotton but the crop is used on the farm. The fodder and most of the grain is fed to livestock, but corn is also used as roasting ears, for canning, and for making corn meal and hominy. A small acreage is planted to hay, and patches of sugar cane are raised for making syrup. Tomatoes and sweet potatoes are commercial crops, and almost every farmer has a home garden.

Cattle are the chief kind of livestock. Milk and butter are produced for local use and some farmers ship to outside markets. Two dairy farms sell milk and cream in Carthage. Beef cattle, especially Herefords, have increased in number since the fever tick was eradicated. Hogs are raised for local use, and most farmers have chickens. Horses and mules are used as work stock although some farmers have power machinery.

Small sawmills are operating in all parts of the county and there is a rather large one at Carthage. The war-time price of lumber is so high that all are operating at capacity, and trees as small as six inches in diameter are being cut, but some timber land owners limit the cutting to more mature trees. Timber is also used in making firewood, fence posts, split boards, picket fences, poles, and cross ties. Boxes and crates for shipping tomatoes and window sashes and doors are manufactured at Carthage. There are also grist mills for grinding corn into meal and hammer mills which prepare livestock feed.

Carthage has a hospital, five doctors, and two dentists, while DeBerry and Gary have one doctor each. Three telephone companies serve the county and a telegraph line extends along the railroad. The towns have electricity and rural lines radiate from them. Carthage is served by a gas company.

Panola County has 27 common school districts and three independent ones. In 1940 there were 38 common schools with 1,512 white pupils and

36 with 2,099 colored pupils. Schools for Whites have a higher percentage of teachers who are college graduates and longer school terms than those for colored children. There is a county school library. The Carthage Independent School District has 25 teachers and there are 19 at Beckville which has a large consolidated district. All teachers in these schools are college graduates and a few have the Masters degree.

The development of Panola County has been based upon agriculture and lumbering. These industries will endure because the long summers and abundant rainfall of this area encourage the growth of crops and trees. Livestock raising promises to increase. It is in diversified farming and livestock raising that Panola County may be expected to hold its own.

**Origin of the Travertine Deposits of the Llano Region**—F. B. PLUMMER, Geologist, Bureau of Economic Geology, The University of Texas, Austin. Large deposits of travertine occur in the Llano region in central Texas. The most common occurrences are in the bottoms of valleys one-fourth to one mile below springs. Travertine also occurs on ancient terraces of the San Saba river spread over a square mile or more of area and 10 to 20 feet thick. The deposits are pure calcium carbonate and are formed by aeration of spring water, which has been saturated with calcium bicarbonate. Aeration is most rapid and deposition largest where there are rapids, waterfalls, or cascades in the streams, but the travertine also forms where water is spread out into thin shallow sheets or tiny streamlets over flat areas. Algae and other plants play very little part in the precipitation of the calcium carbonate but apparently help to strain the minute particles of calcium carbonate out of the water and help to retain it near points of precipitation. It is thought this travertine will prove to be useful for limeing of acid soils for improving grass crops and for manufacture of a cheap foam for extinguishing fires.

**The Lumbering Industry at Diboll, Texas**—WILBER F. PATE, Superintendent, Diboll Public Schools, Diboll, Texas. The largest sawmill of its kind in the Southwest is said to be at Diboll, Texas. This mill is now operating day and night producing defense orders and is making more than 2,000,000 board feet of lumber each month. It is owned and operated by the Southern Pine Lumber Company which has sales offices at Texarkana and lumber yards in almost every large northern and eastern city.

When the mill was established at Diboll, that sandy land section was a virgin forest area. Because of the shade, there was no underbrush in this forest, but an occasional oak or hickory stood among the pines on uplands, while a variety of hardwoods with a few pines and cypress trees occupied stream bottoms. This virgin forest has been cut away, and second growth pine now occupies about 85% of the wooded area, the remainder being grown up with black jack, sand jack, briars, bushes, vines and weeds.

In the early eighties some eastern capitalists formed the Southern Pine Lumber Company, bought timber land along the Neches River, and established a sawmill at Diboll. The first mill produced about 1,900,000 board feet of lumber per year, but after a few years of operation the plant capacity was doubled by the construction of another mill. After this one burned, the present large pine sawmill was constructed in 1910, and the old mill was converted into a hardwood sawmill in 1925. From time to time, modern machinery has been added to increase the plant's efficiency so that its present capacity is 29,600,000 board feet of lumber a year. In 1927 a box factory was built to utilize slabs from the mills that otherwise would have been wasted, and a broom and mop handle plant was added in 1937 to conserve more of this waste material.

The town of Diboll, a creation of the Southern Pine Lumber Company, has grown with the development of this great industry, until now it has about 3,500 inhabitants. Most of the workers are laborers in the mills and factories, but two doctors, two druggists, one nurse, twenty White and seven Negro teachers, and four preachers are employed there. The company store employs ten clerks, three deliverymen, and a janitor. Other employees include bookkeepers, billing clerks, stenographers, and timekeepers.

Wasteful early methods of logging and manufacturing lumber have been replaced by modern methods which promote conservation and the scientific growing of timber. For a time logs were hauled to the mill on eight-wheeled wagons drawn by oxen. As the logging front receded, a company railroad was constructed, but most of the logs are now brought by truck. They are lifted from the millpond into the sawmill by an endless chain. There they are cut into lumber of various dimensions, which, after being dried in the kilns or stacked in the dry yards for some months and finished in the planer, is ready for market. On account of wartime restrictions on the operation of trucks, almost all shipments now move by rail, the lumber being loaded into box cars at the planer mill.

The lumberman's life is hard, rough, and toilsome, but men seem to like it. Once on the payroll at a sawmill they are likely to spend their lives in that industry. The young timber in East Texas is now being cut so rapidly that large sawmills will perhaps be unable to continue operating long after the war. Hence many men who have never worked anywhere except at sawmills will probably find it necessary to enter other occupations.

**The High Plains of Texas**—VICTOR SCHOFFELMAYER, Agricultural-Science Editor of The Dallas Morning News, Dallas. This vast and almost level highland is located in northwestern Texas. Its surface slopes gently southeastward from an elevation of 4,400 feet in the northwest to about 3,000 feet where it merges with Edwards Plateau. For ages the haunt of the bison and antelope, this grassland region became a ranching section as it was settled by Americans and is now a mechanized farming region where drought resistant types of cotton, wheat, and grain sorghum are grown and where many cattle are raised.

With only 15 to 25 inches of rainfall annually, farming was considered impossible until about 1910 when the growing of cotton and grain sorghum began. Ranching is still followed on the rougher lands such as the Breaks of the Canadian River and the Palo Duro Canyon area, but much of the level land has been brought under cultivation where rainfall is sufficient.

During the period from 1934-36 a great drought resulted in crop failures, starving cattle, and such terrible dust storms that the name "dust bowl" became attached to this region. However, recent years of more abundant rainfall together with new farming techniques designed to conserve soil moisture have enabled the dust bowl to become green again. Rain water is now caught by terraces and contour furrows which farmers make to hold the moisture on their fields until it sinks into the soil. This reduces the runoff and stores water in the land so that it can be utilized by crops.

The introduction of drought resistant crops and the development of varieties especially adapted to the High Plains region helped to make its agricultural development possible. The grain sorghums and Sudan grass, brought from Africa, became dependable feed crops on the Plains, while Russian wheats made successful cash crops there. Scientific plant breeding at agricultural experiment stations has increased the adaptation of these crops to High Plains conditions and contributed drought resistant strains of cotton and corn which are grown there.

The Panhandle or North Plains section produces millions of bushels of wheat in years of normal rainfall. This crop is planted in autumn, can be grazed during the winter, and is harvested by combine in July. Farms are large and power machinery is used, but the eight or ten section wheat farm failed to survive the depression of the early 1930's when the grain sold for less than 25 cents a bushel.

Cotton is the great cash crop of the South Plains section. In the good crop year of 1937 about 1,000,000 bales—one-fifth of the Texas crop—were grown there, much of it being picked by machine methods. Lubbock, the principal center in this section, has become a city of 45,000 inhabitants.

No attempt is made to deny the disaster which swept the High Plains when drought destroyed crops and livestock, buried farm houses and barns under drifts of silt and sand, and drove many of the inhabitants to migrate; but tribute is given to heroic, resourceful people in country and town who remained there and helped reclaim the region. Their courage and staunch persistence have saved a great agricultural section and proved that the Plains region is habitable.

**Handle Manufacturing at Diboll, Texas**—O. G. SPEER, Edison Junior High School, Houston, Texas. Woodworking has long been the chief manufacturing industry in the East Texas timber belt. Both Indians and pioneer Americans used wood in their construction work. Early settlers laboriously made lumber with ripsaws by "pit sawing," but large sawmills operate there now which cut millions of board feet of lumber each year.

At Diboll, in the heart of this wood producing area, the Temple-White Manufacturing Company established, in 1939, a broom and mop handle factory which makes 14,000,000 handles a year. This plant produces broom and mop handles of every size and description. About 90% of them are of pine and the remainder are hardwood.

The long, square pieces of wood used in making handles are secured from sawmills operating at Diboll and other towns in that section. These mills select appropriate slabs and strips from their waste material and rip them into "squares" for the handle factory. The squares range in size from ¾ to 1⅜ inches square and vary in length from 24 inches to 12 feet. Pine squares are tied into bundles, treated in the dry kiln for 24 hours, and sent by railway or truck to the factory at Diboll. Hardwood squares are bundled as they leave the ripping machine and brought to the handle factory where they are stacked in sheds or in the yard to dry.

The factory building measures 600 by 100 feet and is a well ventilated, steam heated structure, equipped with an automatic water sprinkling system for fire prevention. About 100 people are employed there. The principal officials have had college training in woodworking and experience in northern factories. Some supervisors came from other handle factories. Most of the men who operate machines have worked in sawmills. Farmers and women drawn from the Diboll area supply common labor.

Orders for handles give detailed specifications as to size, shape, and length. They indicate whether the handles are to be bored, threaded, or left plain, whether they are to be waxed or painted, and if painted how many coats and what color. In the supply shed, men load push carts with squares of the size and length desired and deliver them at the lathes or the hawkers. The lathes round the broom handles and can be set to make them of various sizes and lengths. The hawkers cut out different kinds of mop handles. From these turning machines the handles fall into cars which are pushed to chuck and boring machines. As they are fed through these machines, one end is rounded off or chucked, and a hole is bored in the other end where the broom straw or mop strings are to be fastened. Then they are passed through a sanding machine. Wood shavings and dust are pulled from all these machines through suction pipes and used as fuel at the power plant. The handles are graded, culls being set aside for reprocessing into smaller sizes.

If the handles are to be painted they are taken to "dip tanks" which are sunk into the factory floor. These are two-inch cylindrical basins 12 feet in depth. Each is filled with lacquer of the desired color and has a sheet of rubber containing a small hole tied across its top. Women paint the handles by pressing them through the hole in the rubber sheet and down into the lacquer. As the handle is pulled from the dip tank the rubber strips off all surplus paint, and the worker places the handle on a rack to dry. Some handles receive as many as seven coats of paint. After painting, the handles are passed through a buffing machine which gives a smooth finish and applies a coat of paraffin. If specifications call for it, handles are then threaded so they may be screwed into mops or brushes. Then they are tied into bundles of 50 to 100, wrapped in paper, and are ready for shipment.

Texas and Louisiana manufacturers buy all their handles from the Diboll plant, but the largest markets are in eastern and northern states. Some Diboll handles are shipped to foreign countries.

**Nacogdoches County and Its Rural Community Life**—LAVERNE WHITEHEAD, Port Neches Schools, Port Neches, Texas. Nacogdoches County lies in East-central Texas, a rolling coastal plain area where forests of pine, oak, gum, and other timber abound. The land is generally sloping but there are essentially level uplands and strips of almost flat alluvium. Much of the hill and valley land is wooded and much of it is used as pasture for cattle, hogs, and work stock. Many clear, cool, springs flow from the hills, supplying water for farm animals and tending to keep streams flowing during droughts which occur in late summer and autumn.

Fine sandy loam, some of it red in color, is abundant in Nacogdoches County. When properly supplied with organic matter, fertilized and well cultivated, these soils are successful producers of cotton, corn, watermelons, peanuts, peaches, plums, and other crops. Although most of its soil is sandy, Nacogdoches County is renowned for its "redland" which has long been considered the best agricultural land in this section. Redland is found chiefly in the central and northern parts of the county and is preferred for growing cotton, corn, peaches, and tomatoes. Sandy land that has a heavy subsoil is often planted to cotton and corn but is better adapted to growing peanuts, watermelons, and sweet potatoes. Deep sandy land is considered unfit for cultivation, but pine timber thrives upon it. However, in some areas the pines have been destroyed and there is a growth of scrubby oaks, wild grape vines, weeds, grass, and other vegetation. Pines tend to occupy sandy uncultivated uplands, while hardwoods thrive on alluvium and on redland. East Texas trees contribute much to the beauty of the section, especially in autumn when the multicolored leaves of hardwoods present a gay contrast to the stately evergreen pines. Native grasses are crab, carpet, needle, and sage, but Bermuda is the favorite pasture grass. These geographical conditions constitute the basis for rural life in Nacogdoches County.

There are three types of rural white communities in this county, namely rural towns, farm settlements, and farm neighborhoods. The first class includes Garrison (770), Chireno (650), Appleby (500), and Cushing (453). In these towns the business buildings are grouped about a public square or on both sides of a highway where lateral roads intersect it. Many of the homes are equipped with electricity and running water. Yards are sodded with Bermuda grass and have shrubs, flowers, and shade trees.

Trawick, Swift, Alazan, Woden, and Sacal are representative farm settlements. Many of their inhabitants are farmers but several of their homes are grouped and each center has a few retail grocery, gasoline, and feed stores, a blacksmith shop, and perhaps a general merchandise store. The cotton gin is often near the school, and children come riding to school on cotton wagons.

In the farm neighborhoods, many of which have names, the people are farmers and their homes are scattered along a highway or road. The rural school and church are the chief organizing centers, and there is often much blood relationship among the people.

Negroes and Mexicans have their own rural communities. Sand Hill, Winter's Hill, Center, and Fellowship are Negro farm settlements; while Bonaldo, Moral, and Fern Lake are leading Mexican communities, each of which has a Roman Catholic church.

The great problem of rural life in Nacogdoches County is that of maintaining farm prosperity. Foreign markets for cotton have dwindled and died, and farmers cannot pay taxes and secure essential supplies and services unless they have an adequate money income. Much has been accomplished by "live at home" farming, and the income from cotton is supplemented by that from the sale of forest products, watermelons, sweet potatoes, and cattle. Homestead exemption from state taxation has aided farmers, but their incomes remain so low that children are urged to seek other employment.

Another farm problem is that of obtaining needed labor. Many tenant farmers have secured other employment. High wages and short hours in defense industries are attracting laborers, while young men and boys are being absorbed by the military services. Hence the farm labor problem becomes more and more critical.

## PAPERS

# Chemistry of Luling Oil Field Water

F. B. PLUMMER and P. F. TAPP, The University of Texas, Austin.

*Previous work on oil-field waters*—Most investigations of oil field waters have dealt with the analyses of the water from oil wells with the interpretation of the analyses, and with methods of distinguishing one oil field water from another. Thus Palmer (20,21), Rogers (29,30), Mills (19), Washburn (36), Maljarott (18), Sandford (32), Richardson (28), Clarke (7), Schoch (33), Plummer and Sargent (24), and many others have presented chemical analyses of brines and have discussed the interpretation and usefulness of water analyses. Rogers (30), Maljarott (18), and Bastin (1,2) have discussed the presence of bacteria in oil field waters and ascribed the decrease in sulphates and the presence of $H_2S$ in some oil field waters to the action of sulphate-reducing bacteria. Rice and Hatch (27), Davis (8), and other chemists have discussed the chemistry of boiler waters and described the chemistry of the formation of calcium and magnesium compounds in pipes and boilers, reactions which in some cases are comparable to those in oil field water. Jessen and Battle (12) have pointed out the application of the use of sodium hexametaphosphate to stabilize brine and to retard the precipitation of insoluble carbonates. Plummer, Merkt, Power, Sawin, and Tapp (23) have described briefly a mode of formation of insoluble precipitates in Luling oil field water and have attempted to measure quantitatively the plugging action of the insoluble precipitates on cores of oil reservoir rocks. These authors ascribed the presence of insoluble carbonates to aeration of the water and to the action of blue-green algae and the presence of sulphur and iron sulphides to the action of sulphur bacteria which produce $H_2S$; this precipitates iron sulphide from the waters. They showed that precipitates produced by iron bacteria, sulphur bacteria, and algae definitely clogged oil sands and that the ferrous iron sulphide was the most difficult precipitate to remove by chemical means.

*Scope of present investigations.*—In the present investigations an attempt has been made to study more thoroughly and quantitatively the chemical and biochemical changes in salt water and to evaluate, if possible, to what extent the changes were due to physical conditions, such as changes in pressure, temperature, natural and artificial aeration, or directly to life processes of microorganisms. With this purpose in view, temperature changes in the salt water, rate of flow of the water, changes in the pH of the water, in the concentration of the $HCO_3$ radical, in the concentration of the $H_2S$ in solution, and in the concentration of soluble iron compounds with time and with distance traveled from the well have been determined.

*Chemical composition of the water.*—Luling oil field water, sampled at the wellhead, according to Hill, Bauserman, and Carpenter (11), contains on the average the following chemical constituents in milligrams per liter:

Composition of Luling Water*

| | | | |
|---|---|---|---|
| Calcium | 918.00 | Sulphate | 824.00 |
| Magnesium | 375.00 | Chloride | 6582.00 |
| Sodium | 3347.00 | Total solids | 12810.00 |
| Iron | trace | $H_2S$ | 346.00** |
| Bicarbonate | 1048.00 | | |

| | |
|---|---|
| Specific gr. | 1.008 |
| pH | 6.790 |

The analysis is shown graphically in Figure 1.

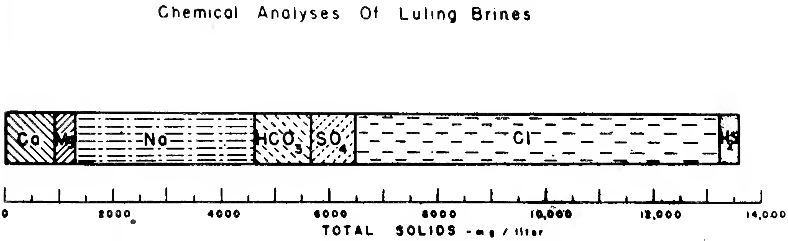


Fig. 1. Graphic illustration of chemical composition of salt water from Luling oil field.

*Method of handling Luling water and effect on composition*—The water coming from the oil wells on a certain lease and mixed with oil in ratio of about three percent oil to 97 percent salt water flows into the flow tanks where the oil is separated at the top by gravity and the water drained off below through a bleeder into an open ditch where it flows into a skimming pit. From the skimming pit the water runs into ditches and then into a small stream containing water from other skimming pits and travels through a somewhat winding, sandy clay channel to San Marcos River, a distance of 1800 feet from the flow tanks. The arrangement of the tanks, flow lines, pits, and ditches is shown on the map, Figure 2.

As soon as the water from the oil-sand reaches the surface, changes in its composition begin to take place. These changes increase as the water stands in the steel tanks and continue at an increasing rate as it becomes more and more aerated in the flow lines, ditches, pits, and sumps. Finally, it is contaminated by other chemicals which are produced by the biological processes of millions of minute organisms that thrive in the ditches and along the course of the stream. These changes will be considered for each chemical constituent which plays a part.

*Soluble iron compounds.*—There is little iron in the original water as it comes from the well. However, as the water flows into the flow tanks and becomes mixed with oxygen from the air, it tends to cause the steel

*The average of more than 20 analyses made in the laboratory of the U. S. Bureau of Mines and published by Hill.

**Determined by the authors.

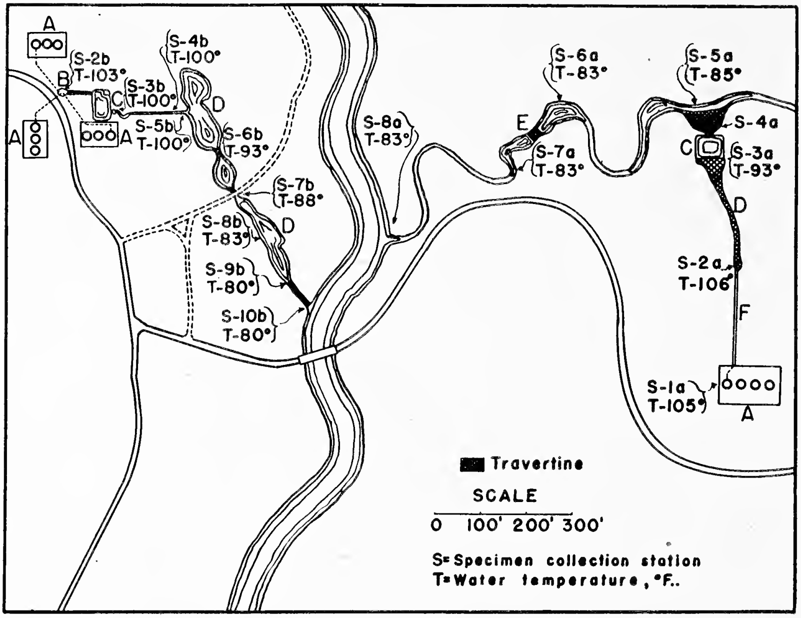


FIGURE 2

Map of the area near the San Marcos River in the Luling oil field showing stations where collections of microorganisms were obtained and the temperatures (Fahrenheit) of the water (October, 1943).

in the tanks to rust and soluble ferrous hydroxide and ferrous bicarbonate are formed:

$$Fe(OH)_2 + H_2CO_3 \rightarrow Fe(HCO_3)_2 + 2H_2O$$

This soluble ferrous hydroxide and ferrous bicarbonate probably, for the most part, react immediately with hydrogen sulfide:

$$Fe(OH)_2 + H_2S \rightarrow FeS + 2H_2O$$

Perhaps a little of the ferrous hydroxide is oxidized by further agitation with air to form insoluble ferric hydroxide which remains in the water along with the iron sulfide, so that the water which flows from the tanks is slightly discolored by these precipitates. The iron compounds, upon standing in the tanks and pits, tend to flocculate and to settle out, so that the water in the ditches and streams becomes clear again. The changes in the iron content of the water from place to place along the disposal system have been measured and are shown in the diagram, Figure 3.

*Hydrogen sulfide.*—The Luling water as it comes from the well contains about 350 parts per million of hydrogen sulfide. This compound, when it reaches the surface and is exposed to the atmosphere, begins to escape into the air, and this loss to the air continues as it flows through the shallow ditches and over the waterfalls. Some hydrogen sulfide is consumed in reacting with soluble iron compounds to form ferrous sulfide as explained above, and some is thought to be used up by sulphur bacteria that take up hydrogen sulfide and precipitate sulphur. Trillions of sulphur bacteria swarm in the Luling water. The result is that the hydrogen sulfide under normal conditions diminishes rapidly at first as the water flows through the tanks and skimming pits, then more slowly as the water reaches the ditches, and never quite disappears from the water before it reaches the river. The concentration of the gas at different localities along the water-disposal system is shown in Figure 3.

At Luling, during the warm summer months, purple bacteria grow in enormous numbers in the shallow oil field waters of the drainage lines.

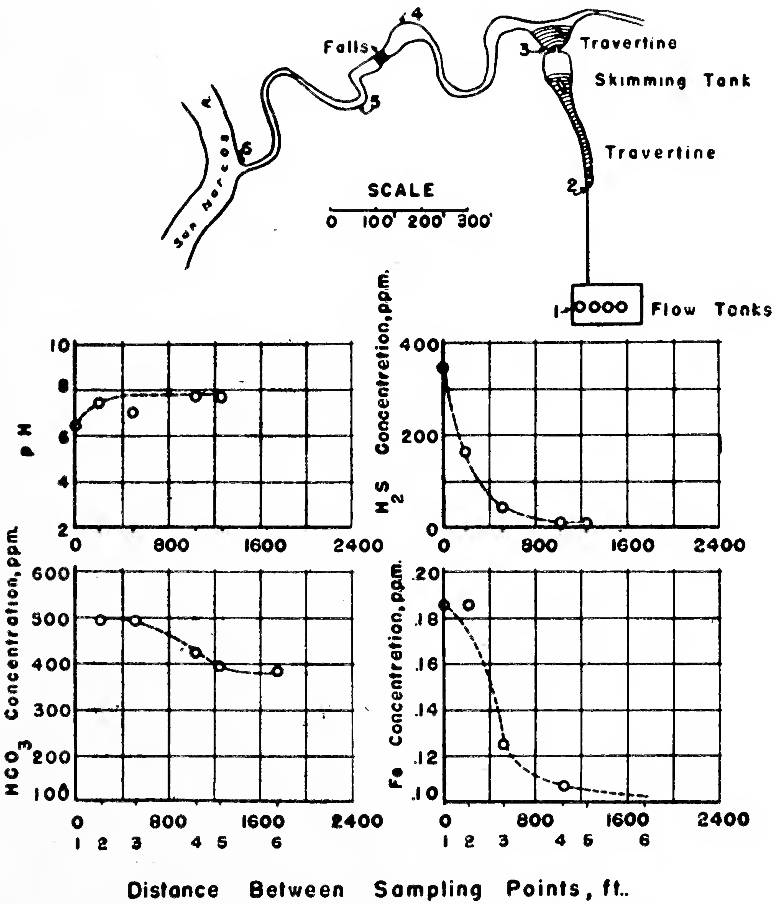


Fig. 3. Graphs showing changes in pH and in the concentration of $CaSO_4$, Fe, $H_2S$, and $HCO_3$ at different points along the disposal system between the oil wells and the river.

These bacteria are short, thick, slightly curved, sausage-shaped forms belonging to the genus *Vibrio* and apparently live in close association with, and may be dependent upon, the blue-green algae. They are probably facultative, living with or without oxygen, breaking down $H_2S$, assimilating the sulphur and freeing the $H_2$. Their growth is favored by bright sunlight, and they develop a light-purple pigment from which they derive their name. They occur all over the surface of the soil over which the shallow water is flowing and thrive in enormous numbers to form a layer one inch thick or thicker. The net result of the life processes of the bacteria appears to be the consumption of the hydrogen sulfide and the formation of sulphur both inside and outside of their tiny cells. The developing mass of bacteria also forms a purple or black sludge which resembles black muck. This sludge is added to the chemical precipitates that form on the bottom of the pits and ditches and consists of calcium carbonate, iron sulfide, iron hydroxide, and bacterial debris which eventually forms a solid rock crust or rock-like layer.

*Calcium sulphate.*—The concentration of sulphate ions in the oil field water changes from 800 to 1500 parts per million. The sulphate probably exists largely in the form of calcium sulphate. This salt appears to remain in solution at all ordinary temperatures, since the solubility of $CaSO_4{\cdot}2H_2O$ amounts to 2.3 grams per liter of pure water at 68° F. If the salt water becomes concentrated by evaporation at any time, supersaturation of $CaSO_4{\cdot}2H_2O$ may occur and crystals may form. Since such concentrations are unlikely, the sulphate ions appear to form stable solutions in the brine for the most part. The only reactions involving the sulphates, which might take place in the water, are reactions due to sulphate-reducing bacteria *(Microspira* or *Vibrio),* or to some other as-yet-unknown reduction process involving the presence of nascent hydrogen, by which the sulphates are reduced to sulphides. This reaction appears to take place where both the purple bacteria and the blue-green algae are abundant and may possibly be expressed by the following formulae:

$$CaSO_4 + 8H \rightarrow CaS + 4H_2O$$

$$CaS + H_2CO_3 \rightarrow CaCO_3 + H_2S$$

These formulae are purely hypothetical, and it is very doubtful if free hydrogen is formed or, if formed, that it would reduce stable calcium sulphate. If bacteria reduce sulphates, the reduction is probably to be explained by much more complex biochemical reactions, not yet understood. However, there is some evidence that the concentration of calcium sulphate increases between the wells and the disposal pits and then decreases slightly as the water flows through the pits and takes up moisture from the soil. The changes in the disposal ditches are shown in the following table and in Figure 3; they are slight and may or may not be due to bacteria.

*Concentration of calcium sulphate at different places in the water-disposal system at Luling*:

| Locality | $CaSO_4$, Mgr. per L. |
|---|---|
| Well head | 1049[b] |
| Flow tank | 1518[c] |

| | |
|---|---|
| Aeration pit | 1500[c] |
| Skimming pit | 1480[c] |
| Disposal ditch at travertine falls | 1501[d] |
| End of disposal ditch, San Marcos River | 1480[d] |

a Analyzed by I. W. Walling.
b From a single well.
c Combination of all wells from a lease.
d Combination of water from several gathering systems.

*Reactions of sodium salts.*—The Luling waters contain over 3300 parts per million of sodium, which is larger than the concentration of any other metal ion. This is thought to be combined, for the most part, with chlorine to form sodium chloride, the chief ingredient of most oil field waters. As would be expected, sodium chloride is stable in the water and the sodium chloride concentration changes but little throughout the flow of the water from the well to the river. Slight decreases, if any, in the several analyses are due probably to slight dilutions in the water by moisture and very small seepages of ground water. These dilutions are offset however, by concentration due to evaporation which even on hot days is a small factor.

*Reactions of calcium bicarbonate.*—The water as it occurs in the oil sand contains up to 1000 milligrams per liter of the bicarbonate radical, probably existing largely as soluble calcium bicarbonate. This bicarbonate remains in solution within the well and during the passage of the water through the tubing into the flow tanks. The hot solution, however, after rising from

Fig. 4A. Fountain used in aerating salt water, Luling oil field the bottom of the well, where the pressure is 977.7 pounds per square inch, to atmospheric pressure at the surface, mixes with oxygen from the air and begins to release $CO_2$ and to precipitate calcium carbonate, which settles out in the form of minute white crystals according to the following equation:

$$Ca(HCO_3)_2 \rightarrow CaCO_3 + H_2O + CO_2$$

Unlike the ferric hydroxide precipitate which flocculates, the calcium carbonate crystals attach themselves to the bottom and sides of the tank unless rapid agitation keeps them in suspension. They mix with iron rust on the tanks and tend to form an incrustation. The rate of formation and precipitation of the carbonate depends upon the amount of carbon dioxide held in solution, which is dependent upon the temperature, pressure, composition of the water, amount of aeration, and also on a time factor. Under normal conditions, the water is supersaturated with $CO_2$ as it leaves the well, and the calcium carbonate does not precipitate much in the tanks but drops out more rapidly as the water is discharged from the bleeder and flows into the open skimming tanks. Many of the water flow lines from

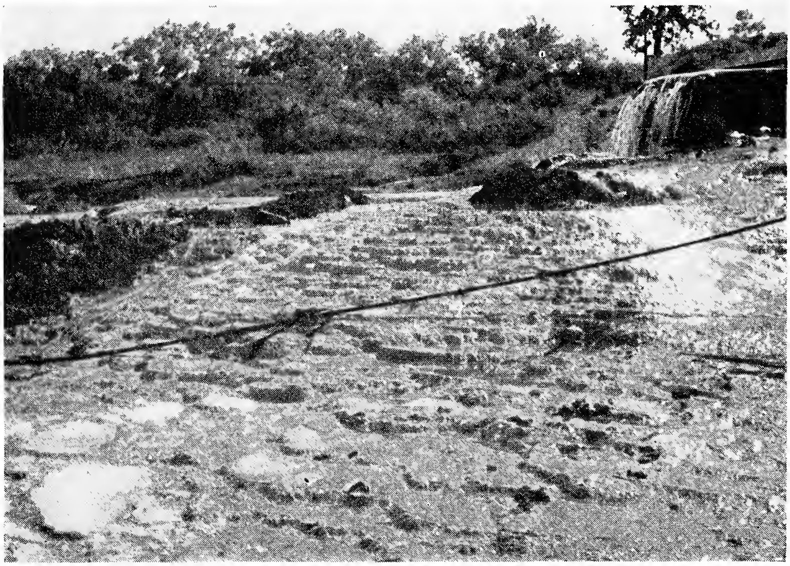

Fig. 4B. Travertine forming in water flowing from oil tanks, Luling oil field

the tanks at Luling are equipped with fountain-type aerators, and calcium carbonate drops out more rapidly as a result of the aeration and accumulates in quantities around and below the fountain (Figs. 4A and 4B). The concentration of the bicarbonate radical at different points along the disposal system is shown in the diagram, Figure 3.

*Theories regarding calcium carbonate precipitation.*—The exact process by which the calcium carbonate is precipitated from the water has been the subject of much speculation and some experimental work. Early workers, as for example Kitchell (14), Cohn (6), Lyell (15), Davis (8), and others attributed the precipitation to algae, charae and other aquatic plants. Blatchley and Ashley (3) regarded the contribution of calcium carbonate from inflowing water from springs to be fully as important as plants in explaining the calcium carbonate precipitates in the lakes of Indiana. Johnston and Williamson (13) noted that the quantity of calcium carbonate held in solution in the form of bicarbonate depended upon the amount of carbon dioxide in the water and that the latter in turn was dependent upon the carbon dixoide in the atmosphere above the water and upon the temperature. They stated that if air varies from 3.3 to 3.0 parts per 10,000 in its content of $CO_2$, the solubility of $CaCO_3$ in water in contact with the air is decreased from 65 to 63 parts per million and two parts per million are precipitated. The precipitation of an equal quantity takes place with a rise in temperature of 2° C. These authors indicate that the effect of oxygen from plants or air would be to act as an agent to remove $CO_2$. McClendon (16) observed that limestone deposition in the interior of Bahia, Brazil, was due to loss of carbon dioxide. He stated that the calcium carbonate was dissolved from the older limestones of the region by underground water, came to the surface through springs in the form of calcium bicarbonate, and was deposited where the spring waters lose carbon dioxide, mainly at points where the waters are agitated by ripples, falls, and other disturbances. Twenhofel (35) summarized the process by stating that calcium carbonate is deposited in waters flowing from springs and is precipitated by release of pressure, rise of temperature, and by agitation.

It was thought worthwhile to try to ascertain just how much of the precipitation at Luling was due to plants, to changes in temperatures, to changes in pressure, and to agitation or at least to find out which process was a dominant factor. Accordingly, a number of experiments was set up in the laboratory using Luling water for the study.

*Effect of aeration on precipitation of calcium carbonate from Luling water.*—When Luling water flows over falls or is agitated violently in a bottle, some calcium carbonate is precipitated and the water becomes cloudy. In order to study this reaction quantitatively, one gallon of Luling water was placed in a bottle. The bottle was set in a constant temperature bath, a temperature of 80° F. maintained and air forced through the bottle at the rate of 22 liters per hour (Figure 5). A 100-cc. sample of the water

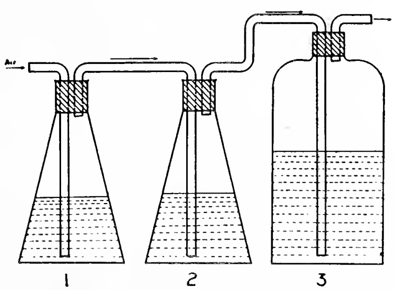


Fig. 5. Diagram of apparatus used in aeration of Luling oil-field water. Flask 1 contains calcium hydroxide; 2, distilled water; 3, oil-field water.

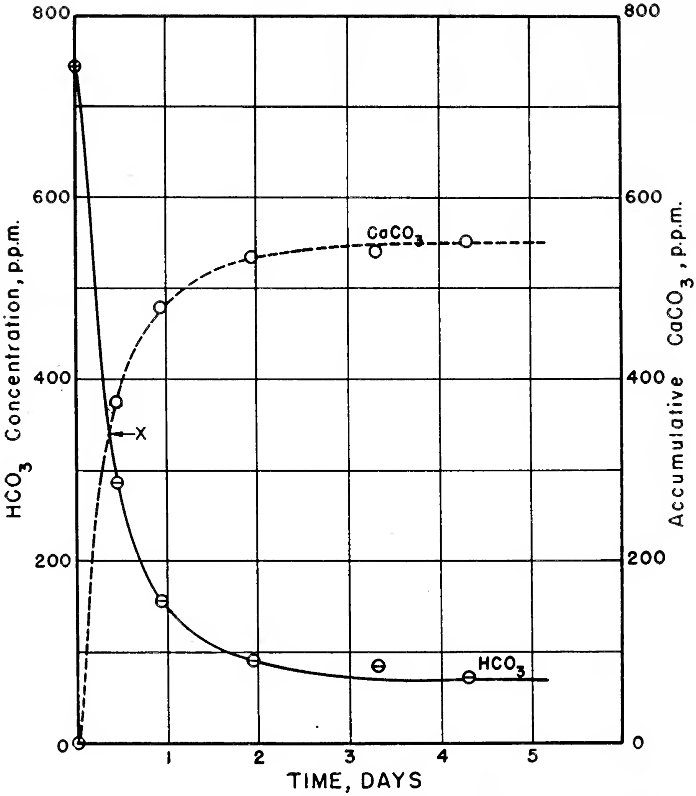


Fig. 6. Graph illustrating changes in concentration of $HCO_3$ and $CaCO_3$ resulting from aeration of salt water from Luling.

was withdrawn every 12 hours and titrated against 0.1 normal $H_2SO_4$; the decrease in concentration of $HCO_3$ and the increase in concentration of $CaCO_3$ were calculated. The results are shown in the diagram, Figure 6. The point x at the intersection of the curves indicates the concentration at which calcium carbonate first became conspicuous by its cloudy white precipitate. This was at the end of the first half day. The position where the curve begins to slope less steeply indicates that the $CO_2$ is escaping less rapidly from the water and rapid precipitation of the calcium carbonate is over. Most of the precipitation takes place in the first two days and the water becomes stabilized and precipitation practically ceases at the end of four or five days as shown by curves A and D of Figure 7.

*Effect of temperature.*—Four bottles of Luling water were collected and aerated by bubbling air through the water as described above. Bottle A was aerated at 60° F., bottle B at 70° F., bottle C at 80° F., and bottle D at about 90° F. (room temperature). The results are shown in the graphs, Figure 7. The results indicate that the complete precipitation of calcium

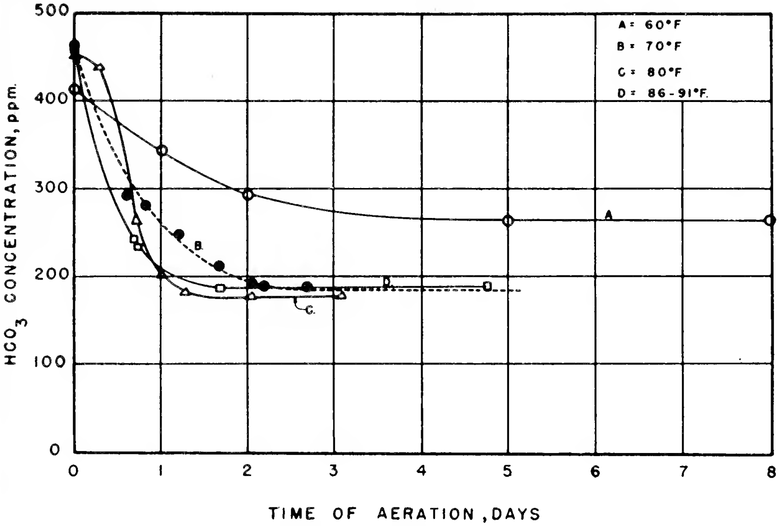


Fig. 7. Graph showing effect of temperature on precipitation of $CaCO_3$ when aerated at the rate of 22 liters of air per hour; A, aerated at 60° F.; B, at 70° F.; C, 86-91°F. (summer temperature).

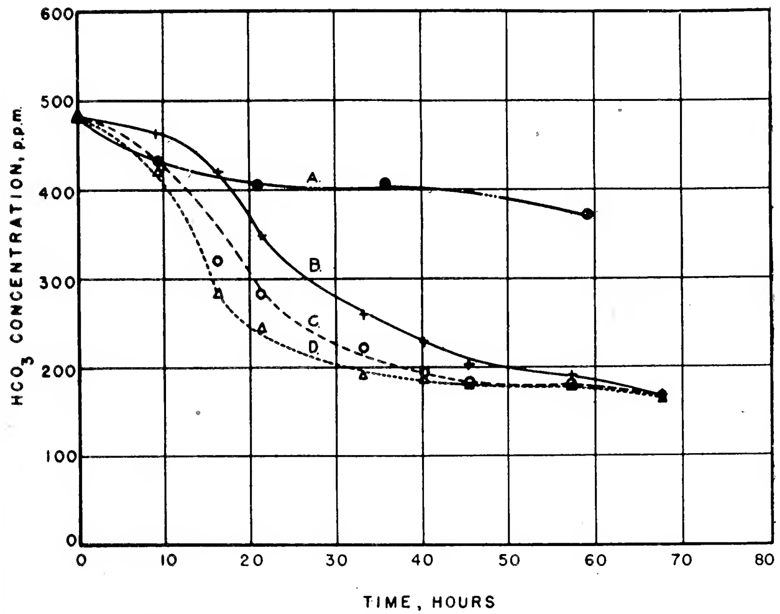


Fig. 8. Graph showing effect of different rates of aeration on precipitation of $CaCO_3$. A, water left standing at 80° with aeration; B, water aerated at rate of 11.22 liters per hour; C, water aerated at 22.34 liters per hour; D, water aerated at 42.20 liters per hour.

carbonate from Luling water increases markedly with increases in temperature, but that the total amount precipitated is about the same.

*Effect of temperature on precipitation of* $CaCO_3$

| Sample number | Temperature, degrees F. | Time required, hours | Percentage reduction in time compared to A |
|---|---|---|---|
| A | 60 | 96 | — |
| B | 70 | 48 | 50 |
| C | 80 | 40 | 58 |
| D | 90 | 30 | 69 |

*Effect of rate of aeration.*—Three bottles of Luling water were collected and aerated by bubbling air through the bottles as described above. The rate of flow of the air through the bottles was varied as follows:

Bottle B was aerated at the rate of 11.22 liters per hour.
Bottle C was aerated at the rate of 22.34 liters per hour.
Bottle D was aerated at the rate of 42.20 liters per hour.

The results are shown in the curves, Figure 8, and in the table below.

*Results of aeration at different rates*

| Sample Number | Rate of aeration, L. per hr. | Temperature, degrees F. | Time required for complete precipitation of $CaCO_3$ | Percentage reduction in time compared to B |
|---|---|---|---|---|
| B | 11.22 | 80 | 67 hours | — |
| C | 22.34 | 80 | 45 hours | 33 |
| D | 42.20 | 80 | 40 hours | 40 |

The increase in the rate of aeration decreased the time required for complete precipitation up to a certain rate of flow; then further increase in aeration rate has less effect.

These results seemed to confirm the suggestion of Johnston and Williamson (13) that the air tended to sweep the $CO_2$ out of the water and thus increased the precipitation of $CaCO_3$. In order to test this idea, it was thought worthwhile to try an inert gas like N or $CH_4$ in place of the air or oxygen. If the process is simply a flushing action, any inert gas ought to work the same as oxygen.

*Effect of* $CH_4$ *gas on rate of precipitation of* $CaCO_3$—One gallon bottle of Luling water was placed in the constant-temperature bath set at 80° F., and marsh gas ($CH_4$) was passed through the bottle at the rate of 0.75 cubic feet per hour. The bicarbonate solution was titrated with 0.1 normal $H_2SO_4$ as before and the loss in $H_2CO_3$ carefully recorded. The result of agitation of the bicarbonate with marsh gas is shown in curve A, Figure 9. No more precipitation of calcium carbonate took place in 48 hours than appeared in a blank unaerated solution tested similarly during the same period, curve B, Figure 9. Next, oxygen from a cylinder of liquid oxygen

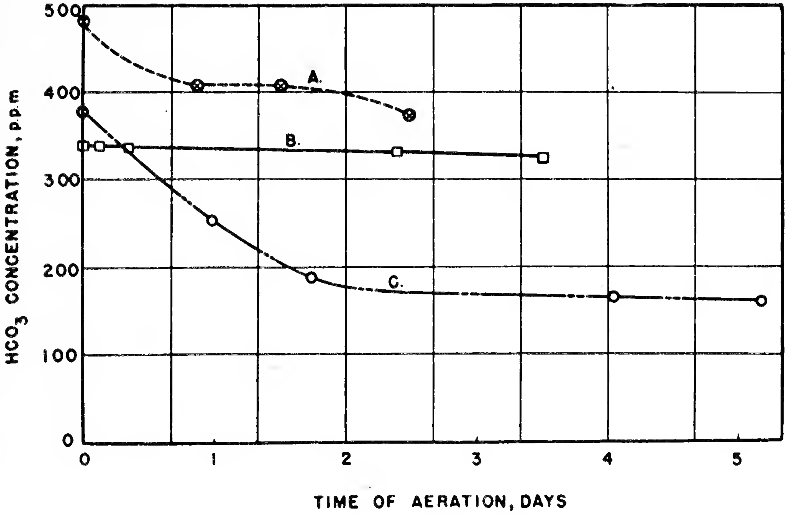


Fig. 9. Graph showing differences in effect of air, oxygen, and $CH_4$ gas on removal of $HCO_3$ from spring water; A, changes in $HCO_3$ content in unaerated spring water; B, water from the same spring treated with $CH_4$ gas: C, water from the same spring treated with oxygen.

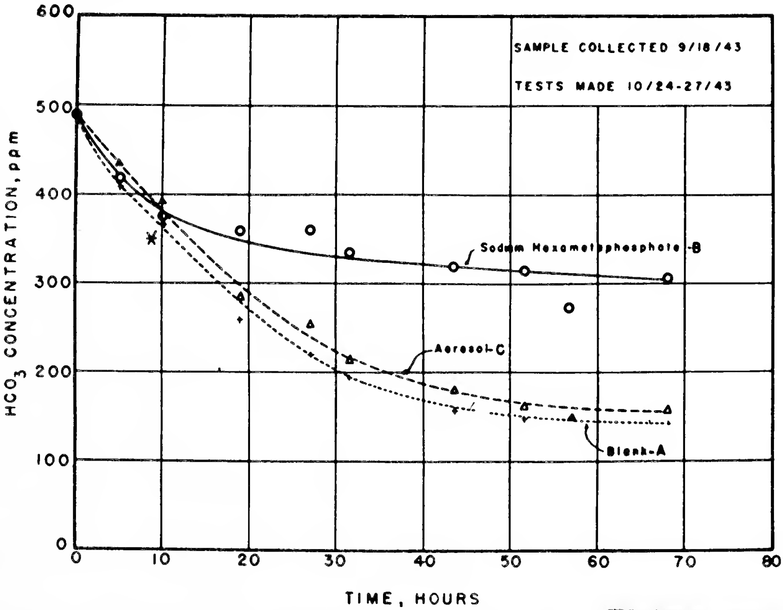


Fig. 10. Graph showing effect of hexametaphosphate and aerosol on rate of removal of $HCO_3$ from spring water aerated with air; A, spring water containing no hexametaphosphate; B, spring water containing 2 mgr. per liter of hexametaphosphate; C, spring water from same spring containing 10 mgr. per liter of aerosol.

was run through a fresh sample of the same water for a period of 48 hours and the bicarbonate titrated every hour as before. The result is shown in Curve C, Figure 9. Strong precipitation of $CaCO_3$ took place with reduction of the bicarbonate to about the same extent as when air is passed through the solution. Hence, it is evident that the agitation of the bicarbonate with marsh gas does not flush out carbon dioxide or bring about precipitation of calcium carbonate, and it seems evident that oxygen from air plays an important part in the chemical reaction.

*Effect of hexametaphosphate and aerosol.*—Some information on the chemistry of this reaction is gained by the action of hexametaphosphate. Hall (10) applied hexametaphosphate to boiler water to prevent precipitation of calcium carbonate in boilers; Jessen and Battle (12) experimented with its use as a stabilizer of oil field brines and found that when two to five parts per million were added to oil field water, calcium carbonate would not precipitate from supersaturated solution during a period of seven to fourteen days, thus allowing time for the water to be circulated through the gathering system and disposed of in the ground. The effect of the hexametaphosphate on the precipitation of $CaCO_3$, due to the loss of $CO_2$ from spring water containing 450 parts per million of bicarbonate solution aerated at 80° F., is shown in the diagram, Figure 10. Curve A shows the effect of air on untreated spring water; curve B, the same solution to which has been added 2 mgr. per liter of hexametaphosphate; curve C is the same solution to which has been added 5 mgr. per liter of aerosol. It will be noted at once that the effect of very small quantities of hexametaphosphate is to inhibit the reaction and prevent the loss of $HCO_3$ and hence to prevent the precipitation of $CaCO_3$. Aerosol, on the other hand, is a surface-active chemical, which has the faculty of reducing the surface tension of water and therefore might conceivably affect the escape of $CO_2$ molecules by adsorption or surface-active phenomena. The effect of the aerosol, however, was slight as indicated by curve C, Figure 10. The explanation of the stabilization of the bicarbonate by hexametaphosphate has been discussed by Hall (10) and by Reitemeier and Buehrer (25). Hall assumed that in the stabilized solutions the calcium was in the form of a complex ion, the exact composition of which was unknown. Reitemeier and Buehrer (25) concluded that the inhibition process, at least as applied to ammoniacal solutions of calcium bicarbonate, is a surface adsorption phenomenon. They think that the action involves either a stable electrostatic attraction between the calcium metaphosphate ions or is due to a marked decrease in the activity of calcium ions on account of the presence of the metaphosphate. Whatever the explanation, there appears to be a definite retardation of the precipitation of the $CaCO_3$ by the metaphosphate and a slight retardation by aerosol.

*Effect of blue-green algae on calcium carbonate precipitation.*—Almost as soon as the salt water is exposed to sunlight in the ditches, algae swarm in the shallow water and attach themselves to stones, twigs, sides of tanks, and bottoms of ditches. The small blue-green algae, *Oscillitoria brevis* Gom.* (23) and the larger form *Phormidium tenue* (Menegh.), grow in

*Identification of the algae was made by Dr. Francis Drouet, Curator of Cryptogamic Herbarium, Field Museum of Natural History, Chicago, Illinois.

Luling brines in enormous quantities, and in some of the ditches they form a continuous blue-green mass a few inches beneath the surface of the water, completely obscuring the bottoms of the streams. In those portions of the channels where the flow is rapid and small falls or cascades occur, and around fountains, in fact, wherever aeration is rapid, solid calcium carbonate accumulates in large quantities to form a travertine deposit (Figure 4B). In many places a cloudy trail of calcium carbonate particles in suspension can be seen floating down the ditches below the cascades, and in most places it covers the surfaces of the blue-green algae. Algae in sunlight, as other chlorophyll-bearing plants, take up $CO_2$ from the water and release oxygen; they are thought to aid in the precipitation of $CaCO_3$ as follows:

$$\text{Algae} + \text{sunlight} = O_2$$
$$O_2 + Ca(HCO_3)_2 \rightarrow CaCO_3 + CO_2 + H_2O + O_2$$

In other words, the algae use up $CO_2$ and contribute oxygen to the aeration of the water during bright days. They live only in bicarbonate waters and thrive best in the spots in the stream where there is most aeration, generally in cascades and rapids. In the streams arising from springs, for example, no travertine forms until the water flows some distance, usually at least 1300 feet, and is strongly agitated by cascades or rapids. Blue-green algae become abundant only at and below the points of aeration. They appear to need $CO_2$ for their life processes and to grow best in shallow, aerated water where $CO_2$ is formed.

The algal threads appear to have a gelatinous, slightly sticky surface coating which holds minute calcium carbonate particles and aids in holding the carbonate at the points where it is precipitated. Algae contribute to travertine accretion and in most places are accessory aids, but they are not necessary to its formation. In order to study quantitatively the effect of algae on $HCO_3$ formation and on $CaCO_3$ precipitation, each of two battery jars was filled with three liters of salt water from a Luling oil well, covered by a plate glass, and set up in an east window of the laboratory

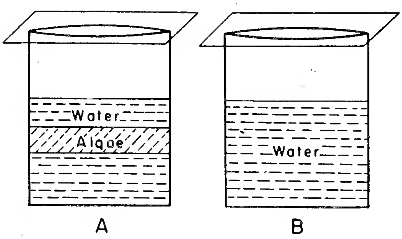


Fig. 11. Diagram showing glass jars used in demonstrating the effect of blue-green algae on $HCO_3$ content of Luling water; A, glass jar of Luling water containing algae; B, glass jar of Luling water without algae.

(Figure 11). Then 100 cc. of salt water were withdrawn from each and titrated against 0.1 normal $H_2SO_4$. Next a culture of about 100 grams of blue-green algae, collected at Luling, was introduced into jar A. Jar B was left standing as a blank. From each jar, daily, 100 cc. of the salt water were removed and titrated with 0.1 normal $H_2SO_4$. The temperature of the room, day and night, averaged about 90° F. with a fluctuation of not over 5° F. The results of the titrations are shown in Figure 12. Curve A repre-

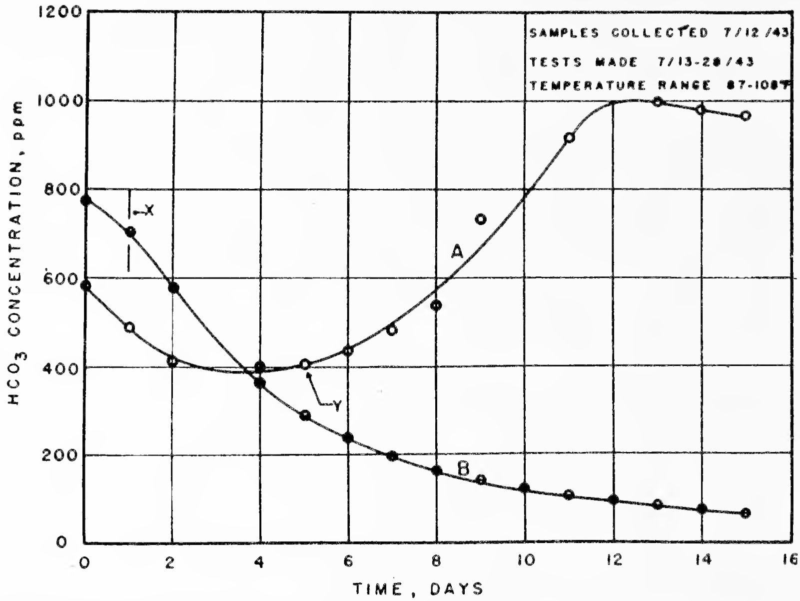


Fig. 12. Graph showing effect of blue-green algae on $HCO_3$ content of Luling water; A, changes in concentration of $HCO_3$ in spring water containing blue-green algae; B, changes in concentration of Luling water containing no algae. X and Y indicate points where first noticeable precipitation of calcium carbonate appeared

sents the water in the jar containing the algae; curve B, the jar containing only the salt water. A comparison of the $HCO_3$ concentrations in the two jars is quite striking. Brine B became stabilized in about fifteen days. Brine A containing the algae appeared to be stabilished in three days and then for the next ten days the $HCO_3$ increased and finally at the end of twelve days tended to decrease again. The algae, in their life processes, including the synthesis of chlorophyll and cellular material in the sunlight, give off oxygen and take up $CO_2$. During the night they give off $CO_2$. The period of bright sunlight on the east window is about three hours and apparently the amount of $CO_2$ given off at night is in excess of the amount used up in the daytime, so that $CO_2$ is constantly added until a concentration of 1,000 mgr. per liter is reached.

These results indicate clearly that the presence of algae in salt water hinders, at least under laboratory conditions, the precipitation of calcium carbonate from Luling water and is detrimental to common aeration methods of removing $CO_2$ from the water. These observations and others indicate that the algae are only partly responsible, at most, for the formation of the travertine and that natural aeration and temperature and pressure changes play a major part in the precipitation. Their chief function appears to be to help hold or fix the calcium carbonate in the place where it is precipitated and thus to aid in building up a travertine accumulation.

*Conclusions regarding the explanation of calcium carbonate precipitation.*—The exact process by which additions of oxygen from the air aid in the precipitation of $CaCO_3$ from $Ca(HCO_3)_2$ solutions has been the subject of considerable discussion. One conception is that a solution of $Ca(HCO_3)_2$ ionizes to Ca and $(HCO_3)_2$. The $HCO_3$ ion then dissociates to form H and $CO_3$. Oxygen passed into the solution ionizes also to O. Then one ion of oxygen combines with two of hydrogen, displacing the equilibrium to release more $CO_3$ which unites with Ca and precipitates as $CaCO_3$. Others believe that no oxidation occurs, that the reaction simply involves dissocation of unstable $HCO_3$ and recombination of ions to form new molecules as follows:

$$Ca(HCO_3)_2 + H_2O \rightarrow CaCo_3 + 2H_2O + CO_2$$

They believe that the water coming from the wells is supersaturated with $CO_2$ and that lowering the pressure and greatly increasing the surface area of the water as it flows over shallow slabs releases the $CO_2$, reducing the concentration and displacing the equilibrium in the direction of $CaCO_3$ precipitation. The fact that the reaction can be inhibited with hexametaphosphate suggests, according to Reitemeier and Buehrer (25), that an electrostatic attraction between the calcium and metaphosphate ions may be developed so that $CaCO_3$ is not precipitated. If this is the case with metaphosphate, perhaps the Ca ions, before aeration, develop electrostatic attraction with some complex ions in the water and this complex element is broken up by the oxygen. For example, there is much hydrogen sulphide in the water and perhaps the calcium becomes attached to HS ions either as $Ca(HS)_2$ or perhaps as Ca $\begin{cases} \rightarrow HS \\ \rightarrow HCO_3 \end{cases}$

Perhaps the oxygen tends to oxidize the HS to form $H_2SO_3$ or $H_2SO_4$, and the calcium then combines with $CO_3$ ions, as follows:

$$CaHO_3.HS + 2O_2 \rightarrow CaCO_3 + H_2SO_4$$

If $H_2SO_4$ were formed it would immediately react with the $CaCO_3$ to form $CaSO_4$ so that the pH would not change much, but the concentration of $SO_4$ ions ought to increase. We have been able to measure an appreciable increase as a result of aeration in our laboratory, but our methods are not sufficiently refined to be conclusive. It is possible also that the process is due to an adsorption phenomenon, as Reitemeier and Buehrer suggest, in which case no chemical changes will be indicated. Whatever the explanation, there appears to be a definite reaction of some sort with oxygen which releases $CO_2$ and permits the calcium carbonate to precipitate.

*Application of a knowledge of the chemistry of oil field water to water disposal problems.*—It is becoming more common to dispose of waste water from oil fields by pumping it back into the oil sand below the oil-producing zone. In order to accomplish this successfully, all insoluble matter must be removed from the water before returning it to the ground. The harmful ingredients in the Luling water are calcium carbonate, iron hydroxide, iron sulfide, and bacterial matter. Filtering of the water to remove the insoluble compounds is not quite sufficient, since precipitates may form after the water is filtered. It is important to determine if the various chemicals are stabilized, so that no more ferric hydroxide and calcium carbonate will form and to ascertain that all hydrogen sulfide is removed. This condition can be accomplished by sufficient aeration, or by heating to increase chemical action, or by addition of chemicals to increase oxidation. Air is the cheapest agent to accomplish all of these requirements, and by allowing time enough and using properly designed aerators, complete aeration can be cheaply accomplished. Hydrogen sulfide can be reduced by aeration to one part per million, and the final removal can be accomplished by chemical methods. A knowledge of the chemistry of oil field waters, therefore, is requisite to the proper disposal of waste waters in the ground.

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## Greater American Deserts

W. ARMSTRONG PRICE, Consulting Geologist, Corpus Christi.

Extensive fields of stabilized longitudinal dunes occur widely in the North American steppe in the Navajo Plateaus of Arizona, the Llano Estacado of Texas and New Mexico, and the Depositional Plains of the South Texas Coastal Plain, Figure 1. These fields are interpreted as indicating deserts formed during the early Recent, with their maximum limits including the areas of the present deserts (arid) and the steppe (semi-arid regions) to the east. A dune-field karst of ridges and intervening swales is found to be etched into the "caliche" limestone cap rock of the Llano Estacado in its western scabland zone.

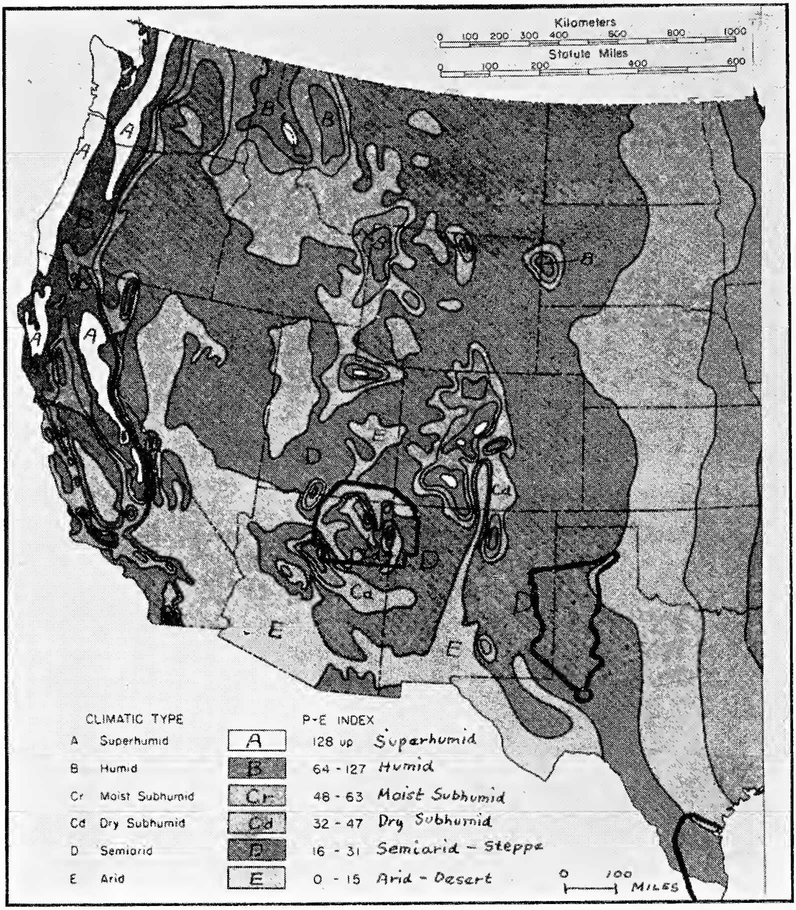


Fig. 1. Climatic zones of Western United States, after Thornthwaite (1941). Dune-field regions in semi-arid zone Arizona, Texas-New Mexico, and South Texas outlined.

The information on which the foregoing conclusions are based is derived from Hack's (1941, 1942) detailed studies of the Navajo Country and from the writer's field work and study of aerial photographs on the Llano Estacado and on the South Texas Coastal Plain.

Longitudinal dunes are parallel ridges trending with the dune-forming wind, Figure 2. They are perhaps the most characteristic type of desert dunes, considering world-wide abundance[1] and size of areas covered. It has not been conclusively proved that fields of longitudinal dunes can not be formed under semi-arid (steppe) conditions, but the evidence in hand is that they are of desert origin. Individual longitudinal dunes of this type are active to day in the Navajo Country but chiefly on the more arid mar-

[1]In Australia, Turkestan, India and the Sahara (Hack 1941, p. 243).

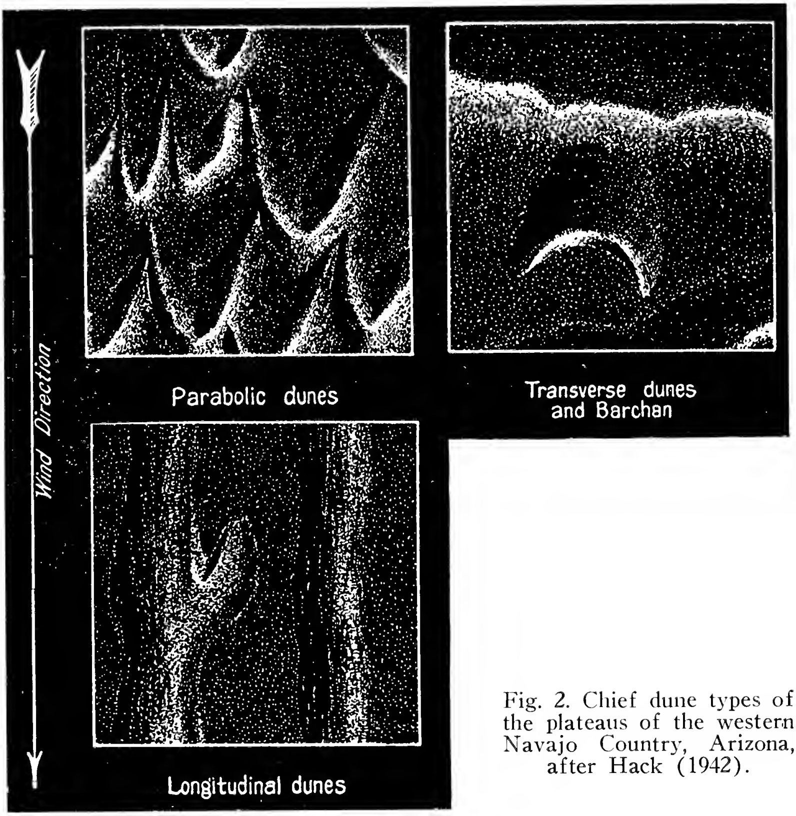


Fig. 2. Chief dune types of the plateaus of the western Navajo Country, Arizona, after Hack (1942).

gins of the steppe plateaus. Evidence in hand seems to favor true desert origin for the great fields of longitudinal dunes named, as it required a very large total volume of sand to produce them, and as sand, although still available in the three regions named, is not able there today to escape being fixed by vegetation in quantities large enough to form dune fields of regional size. Hack thought that the longitudinal dunes of the Navajo Country, Figure 3[2], were formed under conditions of distinctly higher aridity than those to which the stabilized dunes of that area are today subjected. Study of his data suggests that they were formed under as much as 30 percent greater aridity than that of the main area of the Navajo plateaus today.

In the Navajo Country and in South Texas, the dune fields rest on strata containing the elephant and horse fauna, the Jeddito and Beaumont formations, respectively. The Beaumont is late Pleistocene. Its plain was entrenched by the last lowering of sea level and accordant stream valleys.

[2]In Figure 3, straight lines show longitudinal dunes; sharp crescents show parabolic dunes; heavy, open crescents, transverse dunes and barchans (now active). Fine stipple, pinon-juniper forest; heavy stipple, yellow pine forest. Scale staff in upper left-hand corner is 30 miles long.

The soils of the dune ridges[3] of South Texas and the plains on which they lie (Lissie and Beaumont) show the same degrees of maturity, that is, of weathering (Hawker et al. 1929). In these two regions, the directions of the ancient and modern dune-forming winds have been the same. These

[3]McAllen topographic sheet, State Reclamation Dept., Texas.

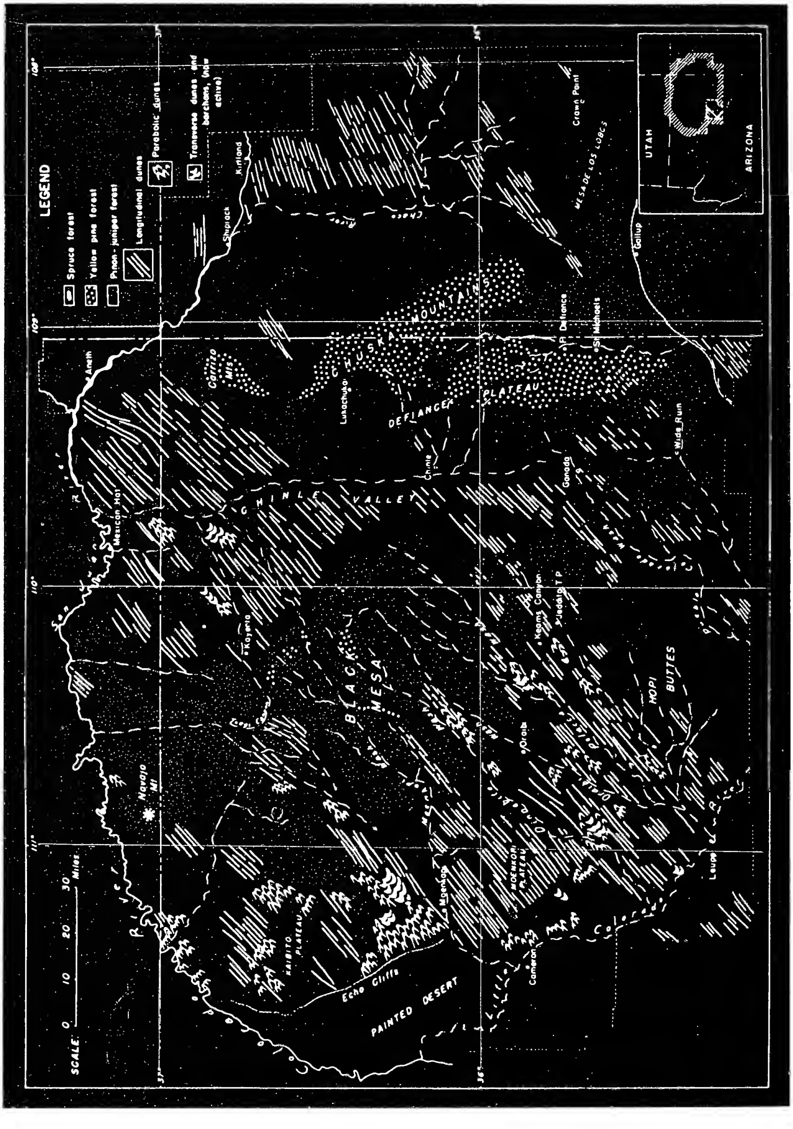

Fig. 3. The Navajo Country, northeastern Arizona and adjacent borders of Utah and New Mexico, from Hack (1941).

are southwest winds in Arizona and southeast, onshore, winds in South Texas (Price 1933, fig. 9).

In the Colorado Plateau, Hack assigns his Jeddito formation of the Navajo Country to the earliest Recent. The dune-making period of the fields of longitudinal dunes is early post-Jeddito, therefore early Recent.

On the Llano Estacado (High Plains south of Canadian River), the dune fields were developed in a sand mantle which lies on the "caliche" limestone cap rock of the Ogallala Pliocene. Beneath the cap rock a thick friable sand is exposed on escarpments. In places the mantle has been removed by deflation, a part of the material lodging on eastward portions of the plateau. Dunes on the mantle where it is thick are stabilized

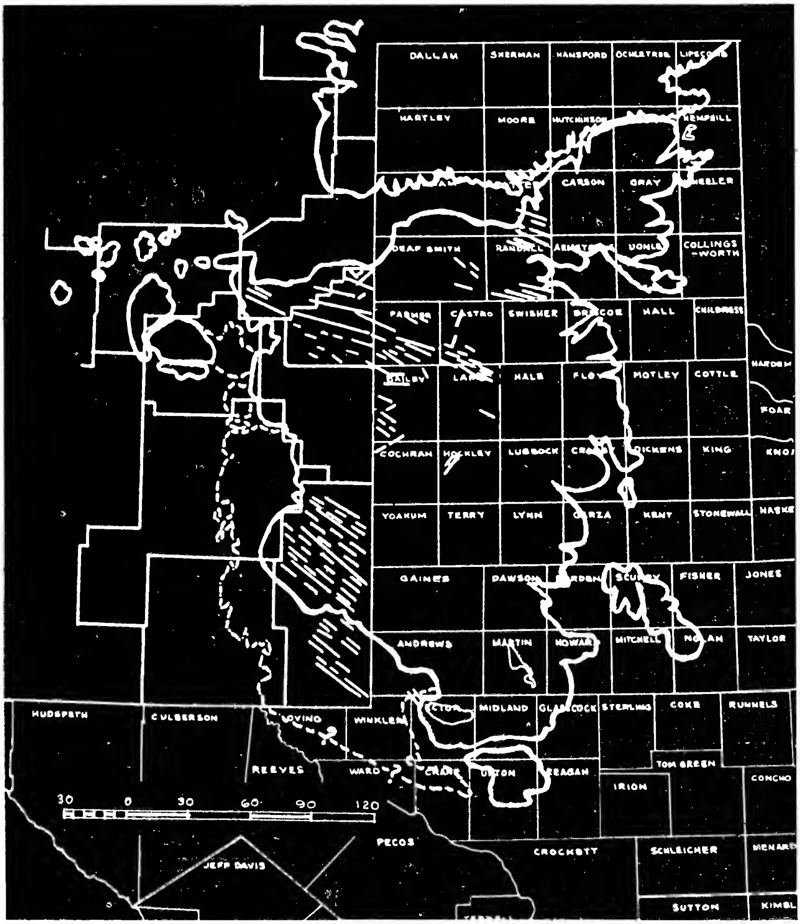


Fig. 4. Llano Estacado Plateau showing topographic grain of ancient fields of longitudinal dunes.

and, so far as observed, generally have indefinite form, but where they show definite elongations most of them seem to be on northeast-southwest axes, in agreement with the modern, northeastward, direction of sand movement. A younger and an older series of dunes, or dune-sand formations, have been described in a small area of this or a similar adjacent mantle by Huffington and Albritton (1941) on the eastern side of the Pecos "Valley," or slump trough, as the Judkins and Monahans formations.

Melton (1940) has described dunes of the western Llano Estacado having the trends of the hot-season winds (Melton 1940, fig. 29) and more ancient dunes formed by winds which blew from the northwest and westnorthwest (Melton 1940, fig. 30). The older dunes of Melton agree in directions of original sand movement with, and may be a part of, ancient dune fields of the plateau delineated by the writer, Figure 4.[4] These ancient dune fields are represented today by a ridge-and-swale karst etched in the soft cap rock limestone. Only vestiges of the original associated sand mantle remain and these are chiefly in the swales. Dark soil development in the swales makes them appear as striking, long, parallel, black lines when seen from several thousand feet above ground. Identity of pattern of the ridge-and-swale karst with that of fields of longitudinal dunes is seen by comparing the soil map of the Lovington area, New Mexico (Harper and Smith 1935), with topographic maps of the sand plain of the South Texas coast.[5]

In nine counties of the northwestern Llano Estacado,[6] there is a still more advanced development of karst topography, showing capture of drainage by the dune-field swales, similar to an example from Australia described by Madigan (1936, fig. 12), and entrenchment and alignment of solution basins (maximum size: 3 miles long by 50 feet deep) along the more ancient dune-field swales, Figure 5.[7]

A small karst basin in the southern edge of the Southern High Plains in Roberts County, Texas, across Canadian River from the Llano Estacado, yielded from its eolian and lacustrine filling a flint artifact (Folsom spearhead) in close association with an elephant vertebra (Sellards 1938). The age of this particular basin with reference to the basins entrenched in the inter-dune swales is not known. Its growth ceased with its filling, but, according to the writer's interpretation, possibly because of the encroachment of the scarp of Canadian River valley and initiation of surface drainage

[4]Figure 4 is a map of the Llano Estacado Plateau, showing outliers, and the edge of the Southern High Plains to the north. Broken line shows adjacent, down-dropped portion bordering Pecos trough ("valley"). Northwest-southeast straight lines show topographic grain of limestone karst of Ogallala cap rock formed by etched ridges and swales of a vanishing field of longitudinal dune ridges. Centering around Parmer County in the northern Llano, the grain contains a basin karst with alignments and long axes along the antecedent inter-dune swales, vestiges of which remain. With the basin karst are entrenched arroyos following the ancient swales. From aerial photomosaics and ground mapping.

[5]Saltillo Ranch quadrangle, Kenedy County, U. S. G. S.

[6]Bailey, Castro, Deaf Smith, Lamb, Parmer, Potter, Randall, in Texas; Curry and Quay, New Mexico.

[7]The figure shows the west-northwest, east-southeast topographic grain in Parmer County, Texas, formed by the solution-basin karst of the vanishing field of longitudinal dunes, all etched in scabland of the Ogallala caprock of soft, "caliche" limestone. Southeastward-flowing drainage lines (arroyos of the semi-arid zone) are entrenched slightly in inter-dune-ridge swales; alignments and long axes of karst basins record positions of the ancient swales, remnants of which are shown. The mapping is from aerial photo-mosaics.

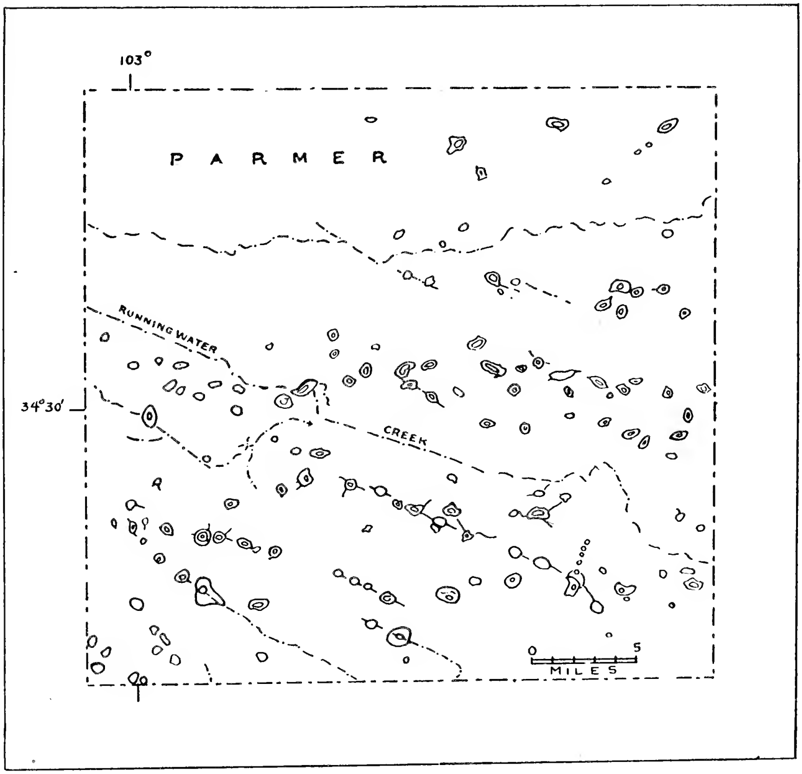


Fig. 5. West-northwest, east-southeast topographic grain, Parmer County, Texas, on Llano Estacado cap rock.

(Sellards 1938, fig. 2). Karst basins of this plateau seem not to have grown to significant size within a mile of present transecting valley scarps.[8]

It is concluded that there were ancient deserts in North America, during early Recent time, which were more expanded toward the east than those of today and reached higher altitudes than the present deserts; that the longitudinal dune fields of North America here studied were formed under desert conditions; also that no such dune fields are forming today in these regions under less than arid (desert) conditions.

The directions of the dune-forming winds of the ancient longitudinal dune fields of the Llano Estacado indicate that they came from the direction of the Western Mountains, including the Rockies. These must have been hot winds of the dry seasons. A different wind regime from that of today and of the later periods of light dune formation in the Llano Estacado was necessary to produce the ancient dune fields.

The younger stabilized dunes of the same regions seem not to include

[8]See soil sheets of Potter and Randall Counties, Texas (Templin et al, 1934, 1935).

fields of longitudinal dunes, although a few such individual dunes are known there (Fig. 4). They may have been formed under winds having the same direction as those of today, but, being few, they may have been contemporaneous with the northwest-southeast ridges and formed by aberrant storm winds.

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## Geopolitics of the United States of America*

WILLIAM T. CHAMBERS, Stephen F. Austin State Teachers College, Nacogdoches.

The oceans occupy 139,440,000 square miles—almost 72% of the surface of this planet—while the land area which rises above the sea measures only 57,510,000 square miles—somewhat less than 29% of the total. The oceans are connected by broad expanses of water so that there is really only one ocean, whereas the continents are relatively discontinuous, the Old World being separated from the New, while Australia is a land apart, and both Africa and South America are almost severed from the larger land masses north of them. Almost half of the ocean area is in the Pacific and most of the remainder is in the Atlantic, the Indian and Arctic oceans being relatively small. Likewise, more than half of the land of the earth is in one vast mass which includes Europe, Asia, and Africa and may appropriately be called the Old World Island, while most of the remainder is in

* This is in no sense an official or government publication. It is based entirely upon geographical conditions and history and attempts to portray the influence of geography upon the political and military position of the United States in the modern world.

the Americas. Although the Old World is only about twice as large as the New, it has more than seven times as many inhabitants. These major facts of world geography have vast significance to people who wish to understand the political and military position of the United States in the modern world.

Less than 29% of the earth's surface is land and much of that area has little or no value to man. There are vast expanses of desert and steppe where almost unending drought restricts productivity and prevents the growth of large compact populations, although much development is possible where the land can be irrigated or dry farmed. Even more desolate are the cold lands of earth, those perpetually buried in ice and snow such as Antarctica and the interior of Greenland, or the sparsely peopled plains which border the Arctic Ocean where snow melts away for only a few weeks each summer. Hot, forested plains near the equator have thus far proved but little better. There the luxuriant growth of natural vegetation, coupled with abounding insect and bacterial life, has tended to prevent man's control of the land and retarded his attempts at development. Also, highlands tend to be inhospitable because they have relatively rugged surface features, thin stony soils and rare, cold air.

*Power Centers of the Earth*

The world contains three major areas of really good land—areas which are neither too dry, too cold, too hot and damp, too high, nor too rugged and stony for the intensive development of human society on a large scale. One of these good land regions is in North America. It includes the eastern half of the United States and some adjacent territory in Canada. A second area is in the western part of the Old World Island. It occupies the western, central, and central-eastern parts of Europe and also includes some land in central-western Siberia, in Turkey, and on the northwestern shore of Africa. The third large block of good land lies in the southeastern and central-eastern portions of Asia. It includes China Proper, Japan, Chosen, Manchukuo, and that section of the Soviet Union near to and south of the Amur River.

These large bodies of good land are the power centers of the earth. In various parts of the world, men have organized governments to provide for the common defense, to promote the general welfare, and to advance their respective group interests and civilizations. But only in these three areas— all of them humid lowland regions in the middle latitudes—have such organizations succeeded in developing really great political and military power. From the geographical point of view, this is due to the fact that these regions excel in natural wealth and have large populations of more energetic, ambitious, and skillful people than can be found elsewhere. Hence every great power of the world is centered is one or another of these three areas, while several lesser states have positions there, also.

Thus the United States of America—colossus of the New World—possesses the lion's share of the American power area, although Canada holds its northern margin. The important countries known as Britain, Germany, France, and Italy are in the European power area, while the

Soviet Union—rising colossus of the Old World—possesses the entire eastern half of that region. The Soviets or Russians also hold the northern fringe of the Asiatic power area, but the great bulk of that region is occupied by Chinese people. Yet, because of internal weakness in China, the Japanese, who inhabit only the northeastern island fringe of the Asiatic power area, now dominate vast expanses of land and sea in that part of the world. Only the strongest states in these power areas can play leading roles in power politics and in the dreadful wars which break out between nations for regional and for world leadership.

*Essential Unity of the American Power Region*

The American power area is essentially united. The great bulk of its land, resources, and population are in the United States. The Canadian section is only a northern fringe or borderland, small and therefore relatively weak, and so distributed along the margin of the United States that it is distinctly subordinate in power potential to its mighty southern neighbor. Although Canada is a British Empire land, her chief industrial, commercial, and cultural ties are with the United States. Hence there is a firm foundation for cooperation between these two countries.

The United States and Canada control the New World north of the Rio Grande, and their industrial, commercial, political, and military leadership is so imposing that complete independence of action on the part of Latin American countries is impossible. Divided into many weak states and relatively remote from other great powers, Latin America has been swept into the geopolitical orbit of the great northern republic. For more than a century Uncle Sam has protected his neighbors to the south from Old World aggression under the Monroe Doctrine. His great navy dominates the oceans which envelop the southern continent, and his air force could assume mastery of all American skies. No Latin American country or group of countries can seriously challenge the supremacy of the United States. Hence all of them, more or less willingly, follow her lead. They maintain membership in the Pan American Union, delight in our good neighbor policy, and direct part of their energy and resources toward the achievement of world objectives fixed by the United States.

*Supporting Disunity in the European Power Region*

While the American power area is essentially united, the European and Asiatic ones are divided between rival nations; and, for geopolitical reasons, British and American leaders seem resolved to maintain this situation as long as they possibly can. When France, under the leadership of Napoleon, was striving to unify Europe, Great Britain was her implacable enemy; and more recently German efforts to achieve that objective have twice thrown the world into turmoil. The weaker nations, desiring to continue their independent careers, resist the aspirations of the mighty aggressor, and in this they are strongly supported by Great Britain and the United States.

While other factors had their influence, from a geopolitical point of view it seems that Great Britain and later the United States entered World War I to frustrate a German attempt to unite much of central and western

Europe under her leadership (1). The Anglo-Saxon nations assisted Belgium, France, and other countries in that war to save them from conquest and subjection to German control. British and American interest in continued European disunity is evidenced also by the fact that after victory was won eight new countries were organized upon that continent while several of the weak states were strengthened. This was done largely at the expense of major European powers, the Austro-Hungarian Empire being dismembered, while both Germany and Russia lost important territories.

Europe, as reorganized at the close of World War I, had a stormy career but it did not reach the brink of World War II until Adolf Hitler rose to power in Germany, organized the Rome-Berlin Axis, and began to pursue his policy of treaty revision by force. Confronted by this great and steadily mounting peril, France and Great Britain drew together for mutual protection, and public opinion in the United States began rallying to their support. The hostility of these nations to Germany was intensified as that country began to unite central Europe by annexing Austria, forcing the session of Sudetenland, seizing Bohemia and Moravia, and establishing a protectorate over Slovakia (2). The spirit of war was running high, but the outbreak of hostilities was delayed because it seemed that this alarming expansion of Germany could be halted by power politics and that its might could be offset by firm cohesion between Britain, France, and Poland. However, when the Germans invaded the latter country, the policy of appeasement died, and Great Britain and France issued declarations of war with at least the moral support of the United States. The unification of central Europe could not be allowed to proceed further. If Greater Germany secured control of a large, productive, and populous country like Poland and was allowed to organize it thoroughly, she would, from her central location, soon become able to dominate much of Europe.

With every success of German arms the United States veered more completely into the ranks of her opposition. The fall of Austria was accepted with regret, the absorption of Czechoslovakia was mourned, the conquest of Poland was counted a disaster, but it was not until 1940, when the Nazis occupied Norway, sent armies crashing through Netherlands, Belgium, and France and forced the British to Dunkerque that the dreadful seriousness of the situation was realized. The United States had been assisting China in her unequal war with Japan. She now began giving active assistance to Great Britain and soon disclosed willingness to assist any country that dared resist the Axis states. This policy of resistance to aggression in the Old World gradually involved the United States in the war as a belligerent, so that for the second time in less than twenty-five years the threat of German success in unifying the European power area resulted in American participation in war against the Reich(3).

Great Britain and the United States cooperate to maintain disunity on the European mainland because they dare not allow that region to become united. If the 400,000,000 energetic, capable, and ambitious people who inhabit that area should become united under able leadership, the safety of the 46,000,000 inhabitants of Great Britain and their world-girdling empire would vanish. With the vast resources and overwhelming manpower of the continent under its control, that government could outstrip Great

Britain and the Anglo-Saxon element of her empire in power on the sea, in the air, and on the land. It could then reduce Britain to the position of a province and take possession of at least part of her empire. Although the United States is much larger, stronger, and farther from Europe than Britain, she could hardly hope to offset the organized might of 400,000,000 Europeans who could perhaps secure assistance from eastern Asia. Canada would doubtless remain loyal, but under these conditions the Latin allies to the south would probably seek alignment with this mighty European state to obtain what her leaders might call protection from North American aggression and to secure access to Old World markets for the products of their farms, ranches, forests, and mines. Thus Anglo-America could be reduced to a relatively weak and isolated position in the world, and its continued existence as an independent pair of nations would be jeopardized (4).

*Resistance to Unification in the Orient*

An equally serious threat to Anglo-Saxon security could arise in the East-Asian power region. Some 460,000,000 Chinese occupy all except the northern and northeastern margins of that area. This is the largest homogeneous population in the world. Although the Chinese are now ineffectively organized and very poor, their highly distinctive culture gives them cohesion, and they cherish ancient traditions of political unity, power, and prosperity. For many centuries Chinese civilization dominated the Orient, and it is only natural for that people to seek leadership in their region again. If this great but generally peaceful nation should become organized for aggression as the Japanese have, it would present a very serious problem. China, united with Japan and Chosen under a strong and aggressive government could make a powerful bid for "a place in the sun" (5). Such a government, having control of more than 500,000,000 of the most industrious people in the world and commanding the resources of southeastern Asia, could perhaps win a world armament race and secure for its crowded population an enlarged share of the land and other resources of the earth. From their base in southeastern Asia the Oriental peoples might organize much or even all of the Old World Island (6). Then, commanding 54% of the land of earth and seven-eighths of its population, they could seize control of the oceans and extend their rule to the remote parts of the world.

The United States and Great Britain are now fighting the Japanese to prevent a militaristic organization of Oriental peoples from developing under their leadership. In 1895, Japan broke Chinese power in Korea, or Chosen as it is now named, and at the close of the Russo-Japanese War in 1905 she established a protectorate over that country. Five years later Chosen was formally annexed to the Japanese Empire, thus unifying those two countries. World War I gave Japan an opportunity to strengthen her naval grip on the western Pacific by acquiring the Marshall and Caroline Islands. In 1932 she invaded the northeastern part of turbulent China and established the "puppet state" of Manchukuo there. Persistent diplomatic efforts by the United States to relax the Japanese hold upon that country were unavailing, and when the tide of conquest was turned against China in

1937 it seemed certain that war with the United States would ensue. From a geopolitical point of view that great republic could not allow militaristic Japan to gain control of China and so unite 550,000,000 Orientals for a possible crusade against American, British, and Dutch interests in the Pacific (7).

*The Outbreak of War in the Pacific*

Yet the beginning of hostilities was long delayed. Japan pursued her course cautiously, not declaring war against China, throwing but a fraction of her strength into the contest, seeking to avoid major clashes with Americans in the Orient and apologizing promptly whenever a provocative incident occurred. The American people were reluctant to begin armed intervention in an Asiatic war; moreover, after the fall of Czechoslovakia, the mounting crisis in Europe diverted attention to that continent. However, American sympathies were aligned solidly with China, loans were extended to the Chungking government, some American pilots went to assist in the war, increasing restrictions were applied to Japanese trade (8), and the President publicly declared that Japan as well as Germany and Italy would have to be defeated. The resulting crisis came to a focus when Japan, after the fall of France, secured military bases in French Indo-China and occupied that country. When representatives of Japan arrived at Washington to explore the possibility of avoiding war, the United States demanded that she "get out of China and Indo-China." To this the Nipponese responded by bombing Pearl Harbor, Manila, and Singapore. Japan, far advanced toward her goal of unifying the Asiatic power region, would not give up her conquests there; and the United States, already engaged in a "shooting war" in the Atlantic, found that her foreign policy of resisting aggression in Europe and Asia had led to involvement in a two-ocean war. Existing geopolitical situations in the three great power areas of the earth made this development almost inevitable—an example of the inexorable way in which geographical conditions help to shape the destiny of man.

*The Power Position of the United States*

Holding her position as the chief nation of the New World, the United States is now serving as the leading member of the Anglo-Saxon family of nations. She has a population three times that of Great Britain and, because of her continental extent, her vast natural wealth, and the technological skill of her people, she has a productive power far greater than that of the mother country. Canada and Australia, the largest and most important overseas dominions, are comparable to the United States in area; but their populations and power potentials are far less than those of this country. Although the inhabitants of the British Empire are much more numerous than those of the United States, advanced English speaking people form only a fraction of the total, and their residence in widely separated parts of the world so exposes them to attack that their survival now appears to depend upon the political and military support of the United States. Under these conditions, relatively weak members of the

Anglo-Saxon galaxy of nations inevitably play secondary roles, because only the strongest and most capable member of a group can assume the heavy responsibilities of general leadership.

If and when we shall win this global war the United States will probably emerge as arbitrator of the world. Her ships will dominate the oceans which comprise almost three-fourths of the surface of earth, and, since the oceans are all connected, these ships could be gathered in any ocean and employed to envelop any shore. Also, the United States will possess the greatest air armada of earth, and by the use of her ships she could seize bases from which to dominate the sky almost anywhere. Since no nation would then risk war with the United States, she could, in a general way at least, control every settlement that is made—whether in Europe, Asia, or Africa.

*Objectives at the Peace Conference*

Assuming that this vast power will be employed at the peace conference to promote her own interests and to increase her security, it seems from the geopolitical point of view that the United States will seek the following objectives: 1. to extend the Monroe Doctrine or, rather, a policy similar to it throughout the world. 2. To reestablish various national states in Europe. 3. to establish another system of national states in the Orient. 4. To preserve Germany, Italy, and Japan as potentially strong nations.

*A Monroe Doctrine of the World*

Since the Monroe Doctrine has proved so satisfactory in the Americas, its extension to the Old World is quite natural. With the Axis states humbled, our allies tired of war, and the United States fully armed, our government could declare that henceforth its foreign policy would be designed to protect relatively weak states from aggression by the strong in all parts of the world. To cover this pledge the United States would need only to maintain the greatest navy and air force in the world together with a skeleton army capable of rapid expansion, and it is probable that she will do these things in any case. Although cooperation with Britain is likely to continue, it will be unnecessary—perhaps even undesirable—for the United States to ally herself with any other state or group of states. Thus she could demonstrate her willingness to be friendly with every nation and at the same time maintain complete freedom of action (9). If an alliance were formed in the Old World it would of course provoke a counter alliance. True to her pledge, it would then be the right and duty of the United States to support the weaker and therefore the more peaceful group of powers against the stronger and more militant one. If a change came in the relative strength and aggressiveness of these groups, she would shift her support from one side to the other (10).

Thus a world balance of power favorable to the United States and to the less aggressive nations in the Old World could be maintained. This would tend to prevent, or at least to postpone, great wars as long as it was humanly possible, but when a major contest did break out the United States would have to fight on the side of the weaker group of Old World powers. However, the united strength of the Americas, together with that of their allies, would tend to ensure the defeat of the aggressor nations. It would be the prime objective of our diplomatic service to keep the balance of power in the Old World sufficiently even so that the strength of the United States would be decisive. Admittedly there is some danger of failure in this, and failure would perhaps be fatal; but since the strength of Britain employed thus has long sufficed to keep Europe divided, it seems that the United States, supported by other New World countries, could contrive to keep the nations of Eurasia divided and therefore unable to employ their united strength against the Americas.

While Eurasia remains divided between rival powers, each of them must focus its energies upon the creation of an army for the defense of its land frontiers. The resulting competition for supremacy on land will limit their ability to develop sea power, so that the United States, specializing in naval defense and with no dangerous land frontiers to guard, can maintain supremacy on the sea. Control of the oceans and of the air over them will tend to ensure the safety of the Americas and the insular parts of the British Empire. Also, it will give the United States access to overseas supplies of industrial raw materials and to world markets and thus help her people to retain and perhaps to increase their prosperity.

The foregoing discussion deals with the probability that the United States will extend her Monroe Doctrine to all the lands of earth, but events of recent decades indicate that a policy of this sort, although not formally announced, is in operation already. German invasion of Belgium, France, Russia, and the Balkans culminated in an American war against that people in 1917. More recently, aggression in Asia, Africa, and Europe by Japan, Italy, and Germany led to our present war against those powers. The record shows that the foreign policy of the United States resists aggression in the Old World as well as in the New, and this is the practical equivalent of an operating Monroe Doctrine of the world.

*Reestablishment of National States in Europe*

Victorious United States and Great Britain will seek to reestablish the various national states of central and western Europe. France will be reconstituted and possibly strengthened at the expense of Germany in order to balance power more evenly in that vital region. Presumably the reestablishment of Norway, Denmark, the Low Countries, Austria, Hungary, Yugoslavia, Greece, and Bulgaria will also be favored. Doubtless some boundaries will be shifted in one direction or another according to the situation at that time, but in general their precise locations do not vitally concern the United States. However, since this country is interested in the future stability and peace of the continent, it seems that she would insist upon the reduction of minority problems in central Europe by placing boundaries there more precisely along lines of linguistic transition (11).

A victorious Russia will probably aspire to gain control of Finland, Estonia, Latvia, and Lithuania, and at least some parts of Rumania and Poland. The first four countries, excepting only the Memel district of Lithuania, were included in the Russian Empire before World War I along with the Bessarabian section of Rumania and a large share of Poland. The Soviet Union would like to recover these lost territories, together with any others that might be obtained farther westward. From the Russian viewpoint, she needs these lands in order to improve her contacts with the sea and thus facilitate her trade (12). But she is already so powerful and so centrally located in Eurasia that a very large westward extension of her territory would, for geopolitical reasons, be viewed with alarm by Great Britain and the United States. In the long run Eurasia or the bulk of it united under the leadership of Russia would be as dangerous to the Anglo-Saxon nations as central and western Europe under German control (13). Hence, if and when it becomes necessary, we shall fight to resist the former eventuality as we are now fighting to resist the latter (14).

*National States in the Orient*

In eastern Asia as well as in Europe the geopolitical interests of the United States and Great Britain demand the establishment of a system of independent states. The Chinese and Japanese are the principal Oriental peoples, but the Russians, expanding eastward, have obtained a strong position in that section. It is vital to the future peace and stability of the Orient that there be an effective balance of power between these three major peoples, and its establishment will be a chief concern of the United States at the peace conference. Thailand will probably retain its independence, and both Chosen (Korea) and the Philippine Islands have been promised freedom by the United Nations.

Manchuria (Manchukuo) is another Oriental country which may emerge as a separate nation. Although long a dependency or outer territory of China, it was not administered as a part of that country. The United States has steadfastly refused to recognize the present Japanese sponsored government there, but its acceptance as a genuinely independent country would be a very different matter. The government of Manchukuo is unlikely to seek political subordination to China at the close of this war, its conquest by that country would probably prove a difficult undertaking, and there is little reason to suppose that the United States, Great Britain, or Russia would force it to accept Chinese control.

*Germany, Italy, and Japan Will Survive*

Finally, it seems that the security of the United States and Great Britain can be strengthened by preserving Germany, Italy, and Japan as potentially strong national states. It would be exceedingly difficult if not impossible for nations which champion democracy to destroy the 195,000,000 inhabitants of those militant countries or to subject them permanently to alien control. All the Axis states may be forced to unconditional surrender, but they should be saved because there will be a real need for them in the postwar world. From a geopolitical point of view, neither Great Britain nor the United States would be safe if there were only one great power in Eurasia (15). A medley of small rival states cannot, or at any rate will not, cooperate to resist a mighty aggressor. Hence there can be no effective balance of power either in Europe or in the Orient unless there are at least two strong countries in each region, around either of which small states can rally when danger threatens. The major Axis nations should be saved in order that they may serve as such nuclei in their respective portions of the Old World. Germany is perhaps the only country on the European mainland that can offset the power of Russia there (16), and Japan would have a similar position with respect to a strong China in the Orient (17).

### *A Negotiated Peace*

In the preceding discussion of our peace conference attitude toward European and Asiatic states it has been assumed that the United Nations will win this war, and that the United States, the leading victorious country, will then be in position to insist upon the establishment of a new balance of power both in Europe and in Asia. Most Americans anticipate unqualified success in the war, but victory is not yet won, and it is possible that the conflict will close with a negotiated, rather than an imposed, peace.

In that event the geopolitical position of the United States would be weaker than that outlined above. However, she would remain the dominant power in the Western Hemisphere, and she might decide to make definite commitments in both Europe and Asia. The survival of Germany and Japan would then be due to their own strength rather than a result of Anglo-American preoccupation with the balancing of power in the Old World. Presumably Germany would then dominate much of Europe west of Russia, while an enlarged Japanese Empire would rule part of the western Pacific and hold some portions of the Asiatic mainland. Under these conditions Russia and China would be essentially cut off from the open ocean, and the Anglo-American nations would face a naval race with the Axis powers. However, Germany and Japan, confronted by Russia and China upon the Eurasian mainland, would be forced to divide their military appropriations between land and sea armaments; whereas Russia and China would necessarily specialize in land power, while the Anglo-American nations would continue to concentrate upon the development of sea power. From the American viewpoint this situation would be far from hopeless, but anticipation of it would impel the United States and Britain to make the Soviet Union and China as large and strong as possible at the peace conference so that they could more nearly balance the power of their mighty Axis neighbors. Then in the postwar world Russia and China would tend to rely partly upon the United States and Great Britain for defense against the Axis nations, and we in turn would be partly dependent upon them.

### *The United States as Mistress of the Oceans*

Geographical conditions indicate that, in the historic era now beginning, the United States of America will be the world's greatest sea power. She is the only powerful country that has a broad frontage upon both the Atlantic and the Pacific—the two largest and most important oceans; and the canal at Panama greatly augments her naval strength by enabling its rapid concentration in either ocean. The New World is severed from the Old by broad oceans except at the north where generally narrow and frozen seas and almost uninhabited lands intervene. Therefore, it seems that the Americas can be defended by coordinated naval and air power, and the United States now possesses the largest and most rapidly growing navy and naval air force in the world. Possessing upon her own soil a large share of the coal and of the known petroleum resources of earth, having access to the vast and varied mineral wealth of both North and South America, and with a population of 130,000,000 of the best fed, most energetic, and technologically most advanced people of the earth, the United States is the world's greatest base for the development of sea power as long as the Old World peoples remain divided. Americans now see that their security is contingent upon the possession of a "two-ocean navy" with its auxiliary air force, and their abilities and resources are such that they can have it. There is little reason to think that they will again be satisfied with less than the greatest navy and naval air force in the world.

Possessing an armament adequate for the defense of the Western Hemisphere and yet sufficiently mobile that it can operate along the shores of the Old World and strike far inland by air, there is abundant reason to believe that the United States can shift the balance of power among the countries of Eurasia whenever it becomes necessary to do so. Hence, while maintaining her leadership in the Americas, she can in a measure control the solution of international disputes in the Old World and thus enforce a reasonably just peace everywhere. This is indeed an exalted position, but Americans must remember that world leadership of the sort here contemplated is possible only while disunity prevails among the national states of Europe and Asia. If and when the more than 1,500,000,000 people who dwell in the Old World Island succeed in forming a more or less perfect union, they will emerge as masters of this world. By failing to keep her political and military pressure upon them within reasonable bounds, the United States could cause their union in self defense and thus prepare the world stage for her own downfall.

## CONCLUSION

From the geographical point of view it is competition between nations for the control of living space that causes them to follow the grim cycle of power politics, war, and the exploitation of conquered peoples. This cycle is perhaps as old as history, and the record seems to indicate that nations tend to follow it to ultimate disaster. Surely the United States and the world will find an alernative, a more satisfactory and safer course to follow than that presented by geopolitics. Continuous international friction and recurrent war reveal man as perhaps his own most uncompromising and deadly enemy; yet this paradoxical situation will continue until the peoples of the world finally merge their fortunes in a world state which possesses enough power in its own right that no one or a few of its member states can enforce their will and so organized that people everywhere can secure essential justice and an opportunity for self advancement without recourse to war. The formation of another League of Nations or of a modern Holy

Alliance designed to enable certain nations to control and exploit the defeated, the weak, and the backward peoples of the world will fail to solve the problem that besets us.

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## Geology, Climate and Soils of Texas

CHARLES LAURENCE BAKER, A. & M. College of Texas, College Station.

The best soils of the world have four different origins. First are the residual soils derived from weathering of the great basaltic lava fields, such as the Hawaiian Islands, Java, the Deccan of India and eastern South America, and of the great batholiths of British Columbia and the Sierra Nevada. Second are the scrapings of Pleistocene glaciers from pre-Cambrian shield areas of crystalline rocks such as are found in the upper Mississippi-Missouri basins, in the North German plain and western Russia. Third is the wind-deposited loess, derived from relatively unleached rocks of the arid regions, found in the upper Mississippi basin, southern Russia, the Danube basin, the eastern Argentine and the Yellow River basin of northern China. Fourth are the stream and lake deposits, derived from one or more of the other three, such as those of the Nile in Egypt and the Sudan, derived from the basaltic plateau of Abyssinia, or of Lake Agassiz, derived from the second and third classes noted above. All four classes have a common characteristic in that they consist of relatively fresh or unleached minerals mainly from igneous rocks or produced by emanations from igneous magmas. Either because of lack of rainfall or of excessive heat, or because their primary source rocks are either young or were only lately exposed to weathering, the mineral plant foods have not been dissolved out of them.

When the writer first saw Texas in 1909, he was at once impressed by the poor crop yields and the general poorness and run-down condition of farms as compared with those of other areas. Observations in succeeding years have confirmed and strengthened first impressions. In order to explain the conditions observed, comparisons have been made with other regions. As examples may be cited the facts that the Iowa glacial and loess soil is 5.7 times as productive as that of Texas and that dominantly agricultural Java, with soil derived from fresh basaltic rock and very favorable rainfall and temperature throughout the year, supports 30 times as many people per square mile as does Texas. Also, Iowa, a dominantly agricultural state with little mineral income, has nearly twice as many people per square mile as Texas, half of whose present income is derived from mineral products. Half the area of Texas lost population during the decade 1930-40.

Therefore, comparatively speaking, Texas soil productivity ranks fairly low in this world. Inasmuch as the main factors in soil formation and productivity are geology and climate, we proceed to study the effects of these factors both absolutely and comparatively with respect to Texas and other regions. The good soils of Texas are found principally in such dry sections with fresh mineral plant foods as the High Plains of the Panhandle, Llano Estacado and Seymour depositional plains, the areas of geologically young igneous rocks of the Trans-Pecos mountains and, in areas of greater rainfall in the low plains of Texas, only in the black land prairies with parent Upper Cretaceous and Oakville Miocene geologic formations. Most of the remainder of the good land of the state is found in stream flood plains and terraces whose sediments have been derived from the areas already mentioned.

Since the black land prairies, the important good soil belt of the lower plains, have the same climate as their surroundings, there must be something in their geology to account for their fertility. All the parent rocks contain a large percentage of volcanic dust or ash which has become hydrated to bentonite. Bentonite is relatively impermeable to air, other gases and water, and therefore when in abundance produces hardpans. However, when intimately mixed with calcium carbonate, soil water causes clay to flocculate; the calcium carbonate also aids in the utilization of phosphoric acid and potash and converts vegetable matter into humus. Where bentonite is abundant and lime is lacking, as in practically all the Cenozoic deposits of the Coastal Plain except the Oakville, the soils are unproductive. The Upper Cretaceous and Oakville formations are relatively non-resistant and produce low, smoothly-contoured surfaces originally covered with grass or shrubs; during late geologic Cenozoic times they trapped wind-transported volcanic dust and loess; these add to their original fresh mineral content derived from the volcanic dust and ash of Cretaceous and Oakville times. Hence, we find that the black lands originally were supplied sufficiently with plant foods from fresh unleached minerals, whereas their admixture of lime affords permeability and utilization of plant food content.

But these things are not true of other soils of Texas low plains, because the geologic history of their parent formations has been quite different. The same materials, except where bentonitic, have been used over and over again in building up new formations from the decomposition and disintegration of the older ones, there being many unconformities, overlaps, and shiftings of materials. In this complex and long continued sequence of events most of the mineral plant foods of the original source rocks have been leached out.

Also, most of the outcropping or surficial formations of Cenozoic age of the Gulf Coastal plain were deposited in ponds, estuaries, or lagoons with connate brackish water in the deposits. The saline or alkaline mineral content of these waters is deleterious to the growth of profitable vegetation. One of the most abundant constituents of the underground waters is the various sodium carbonates—sal soda, baking soda and trona, the latter being a combination of the other two; these constitute the worst of the "black alkalies." To a large extent they originate from the hydration and leaching of the abundant volcanic ash or dust in the formation of bentonite, but they are formed also by the familiar water-softening process of zeolitic base exchange. They compact clayey soils into impermeable hardpans except where there is enough gypsum to transform the deleterious sodium to the beneficial calcium carbonate.

A combination of four factors, geologic and climatic, produces a very high rate of destruction by erosion and transportation of the soil and subsoil of the low Texas plains. Most of the rocks are weak because they are poorly consolidated, and they are subject to speedy disintegration because of large admixtures of bentonite which slakes rapidly on exposed surfaces upon access of water. The degree of surface slope of general upland surface and drainage channels has been accelerated, with resulting increase in eroding and transporting power, by uptilt in late geologic time of the plains region, increasing the amount of fall in the direction of the Gulf. The fourth factor, the climatic one, is the high frequency of rainfall of cloudburst intensity, due to the large number of low pressure air masses or storms coming largely from the Gulf. Texas weather jumps far too frequently from drought to flood (with ratios between wettest and driest years varying locally between 3 to 1 and 17 to 1), and the amount of erosion and transportation accomplished in a flood produced by a cloudburst is many times greater than that in an average stream stage or that produced by a slower rate of rainfall.

Finally, we suffer a great handicap which is entirely climatic. The low plains region of Texas is, entirely legitimately, one of the hottest regions on earth. These plains are situated in the high pressure belt of descending and drying air, or horse latitudes. The Sahara, the Arabian, Persian, western Indian, Gobi and the Great American deserts are in the same belt of latitude, namely the heat equator of the earth. Moisture reaching Texas by way of the atmosphere during the nine hotter months of the year is of diverted-trade wind and modified-monsoon type, that is, from the Gulf of Mexico to the southeast, brought by the prevailing winds; for the three winter months the wind is northerly, from the interior cold, dry, high-pressure areas. The surface of the Texas plains is always hot—and hottest in the summer. The southeast winds, although moisture-laden from evaporation over the Atlantic, Caribbean and Mexican Gulf, become heated and undersaturated with moisture when they reach the hot plains of Texas and, instead of producing rain, do just the opposite, drink up by evaporation all the moisture which the land can afford. It is only the exceptional low pressure area, or Gulf storm, or the generally quite localized thunderstorm of the steppe climate type, which produces rainfall during the nine hotter months, most of it in the spring, soon after the "turn of the monsoon," that is, in May and April. The spring rainfall maximum is followed by a summer drought—during the hottest season. In most subtropical and tropical regions, where rainfall is abundant, the heaviest rains coincide with the hottest weather and the combination of highest heat with ample moisture makes great agricultural productivity. On the Texas plains, drought is often combined with the greatest heat.

The great average heat likewise favors abundance of the soil microorganisms, which destroy the humus in permeable soils, and other processes of humus destruction, like most other chemical action, are accelerated by high temperature. Humus is necessary in order to make a number of other plant foods available and because of its absorptive effects to check their removal by leaching. Likewise, too great quantities of microorganisms, favored by high heat, use up part of the plant food which under other conditions would be available for profitable crops. Hence, the effect of heat is to lower the fertility of open-textured soils, or such as are made permeable through drainage or methods of cultivation necessary for productivity. The effect is marked on bottom lands of alluvial soil, or soils which are heavy or relatively impermeable before cultivation. The permeability of such soils is increased through cultivation, the destructive microorganisms requiring moisture and air, as well as high temperature.

If one compiles a map of the United States showing various draft districts, he will find that the greatest percentage of rejections is in the low plains bordering the Gulf and the Atlantic between the Pecos River and the Carolinas. This merely confirms health statistics proving this part of the United States is the least healthful, which in turn confirms the medical, physiologic and hygienic facts, well known nearly everywhere except in Texas, that a combination of high pressure, relative humidity, and high temperature is unhealthful. The skin is the insulating cover of the human body, but dampness of air, such as found in Texas low plains, destroys the insulation, therefore making the real physiologic temperature effect much more severe than in other regions, both in the summer heat and the winter "northers." Little can be done about the heat, because really effective interior air-conditioning means dehydrating the air, which is too expensive to be practical at the present time. However, we can overcome the bad effects of the cold when Texans learn to do three things: (1) wear light-weight, full-length woolen underwear during "northers," (2) build their houses on the southern slope or at the foot of hills and ridges or south of a wall, protected from the north wind, and (3) build better houses. When these things are done generally the sickness and death rate in Texas will diminish materially.

There is also too much malnutrition in Texas. This is caused by the lack of a properly balanced diet and of vitamins; for example, meat from animals grown in Texas is deficient in vitamins. The three to four months of continued excessive heat in the summer is enervating. There is far too much malaria and hookworm.

A lot of the prevalent unhealthiness is properly attributable to the extremely low economic status of that part of the population who are not so fortunate as to possess pure white skins. The lack of health and of the world's goods of such persons is not one whit different from that of "backward" peoples in any of the other high-heat-plus-high-humidity regions on the earth, as anyone of adequate personal experience in these places can testify.

Only healthful folk are really vigorous, and it is apparent that one who successfully overcomes Texas soil conditions needs plenty of vigor. Much disease and sickness is really preventable and, therefore, inexcusable in a so-called "civilized" society.

Now, what does the foregoing all add up to? The year 1928 was one of average rainfall and of exceptionally good prices—in fact, too good to be typical or average. In that year the total value of all Texas crops and livestock sold amounted to eight hundred fifty million dollars. We will use this good year's production as better-than-average. Today we have a population of six-and-one-half millions. Simple division gives, therefore, a per-capita income from all soil products of $130 per Texan. That is less than bare subsistence. Petroleum and natural gas, to be sure, now yield more money than total crops and livestock but they are assuredly ephemeral; they are failing resources and from now on subject to the law of diminishing returns. What are we going to do when *they* are gone and, especially, when we assimilate the fact that during the last 80 years Texas agriculture, so far as statistics may be reliable, has been also a failing resource, subject to the law of diminishing returns?

Assuredly, something can be done to improve existing conditions. One of the wisest would be to move to a better climate during the hot, enervating months but, unfortunately, most Texans, including even the majority of the so-called "middle class," cannot afford to do this. The employment of suitable fertilizers will increase crop yields, although the flourishing microorganisms are robbers of fertilizers, at least to some extent. In eastern Texas—where average rainfall is greater than farther west—this can be profitably supplemented by irrigation, since even in the easternmost part of the State, with greatest rainfall, one crop out of five is lost or at least appreciably decreased by drought, with progressively greater and more frequent droughts farther west. However, adverse geologic conditions limit greatly the water supply available for irrigation. Utilization of surface water is limited by the lack of reasonably cheap dam sites for reservoirs. Underground waters are ponded down the dip of the rocks, and the rocks through which they percolate have large percentages of soluble salts which render the underground water unusable only a few miles from their surface intakes; therefore the underground storage of utilizable water, accumulated during the past, is limited to narrow belts near the surface outcrops of the underground aquifers. Also, the growing of quick-maturing food crops in spring and autumn, when there is more moisture and less evaporating heat, is certainly destined to supplant the production of cotton.

Locally, the clays which are not excessively bentonitic can be rendered more permeable, and hence more productive, by dynamiting them, as has long been practised in California. Also, where the soil is underlain by impermeable materials, sub-soil drainage or, in favorable places, tiling which has reclaimed much valuable bog and swamp-soil acreage in the glaciated regions, will be effective. Probably neither method will succeed with the bentonites or strongly bentonitic clays, because they swell and slake so much upon wetting that they rapidly resume their impermeability. Mixing ground gypsum with them might possibly produce the necessary permeability and other physical and chemical advantages, but, although North-central Texas possesses gypsum in abundance, extortionate freight rates will prevent its utilization by the coastal plains farmer. Deeper ploughing will help, especially if it can be done with a disc-like appliance which will not compact and render the subsurface less permeable, as the present "plow-sole" so often does in clayey soils. There is little of the original top soil now left in Texas, anyway, so we must make what we can out of original sub-soil.

The 1938 mineral production of Pennsylvania, exclusive of oil and gas, was $440,000,000. The 1939 mineral production of Texas, exclusive of oil and gas, was $56,000,000. Texas has six times the area of Pennsylvania and, if she produced minerals other than oil and gas at the same rate as Pennsylvania, that production would be $2,640,000,000 annually; or in other words, Pennsylvania produces 47 times as much of these minerals per unit area as does Texas. The great contrast is partly attributable to the enterprise and energy of the Pennsylvanians and in part to accessibility to markets and high per capita wealth. The geographic isolation of Texas, her great distance from markets, rendering transport costs extremely high, is, indeed, one of her greatest handicaps.

It will be a long, hard, discouraging and uphill struggle. It means much more hard labor, if an unfavorable climate will permit it. It means far greater average intelligence and the necessity, in order to produce it, of becoming really serious in education, abandoning our present far too easy and slipshod practices. And it means the expenditure of more capital which the average Texas stockman and farmer has not yet been able to accumulate for reasons quite obvious. Perhaps nothing else in the world is quite so conservative as capital, and the fact that Texas is neither a safe risk nor a profitable long term investment is known generally throughout the United States except in Texas itself. The more prosperous sections of the nation will neither be willing nor able to continue paying taxes for the improvement and support of Texas.

One of the besetting sins of the American is a too facile, unreasonable optimism—a tendency to deceive himself by looking persistently upon the bright side of things. All the ballyhoo of newspapers, chambers of commerce, realtors and other promoters imagining great potential riches which those, who have taken pains to find out, know are non-existent, deceives only the ignorant and affords excuse for procrastination to the indolent. Facts are often disagreeable, but sooner or later they must be faced and then something must be done about them.

The barbarian invasions which overwhelmed the Roman Empire, destroying the only unity Europe ever had, the overrunning of Eurasia from the Baltic Sea to the Bay of Bengal and from the Vienna Basin to the Yellow Sea by the Tatars, the migrations to the New World, Australia, New Zealand and Africa, the Russian advance across Asia, the emigration of two million Irishmen as a consequence of the great Potato Famine, and the attempts at expansion of Germany, Italy and Japan during the last half century are among those historical events which were produced largely by population pressure and claustrophobia. One would do well to read and ponder Malthus's famous "Essay on Population." War is certainly the worst of the crimes and miseries which Malthus attributed to increase of population beyond the means of subsistence, but all the others are abundantly manifest in these days.

The "Okies" began the migration from Texas and its environs during the last decade; hence, we are already confronted with the fact and not the theory. However, these United States are by now fairly well population-saturated. Brazil is the only country left in the New World capable of assimilating a large population increase, but, since Brazil's population is doubling every 30 years, by the year 1975 she should have a population equal to that of the United States now.

The good lands and climates of such vast areas as China, India and western and central Europe are full up and running over. Frontiers of colonization are running out. The consequences are graver than any man can foretell. Natural resources once depleted cannot be renewed by any sufficiently large scale processes yet known. Therefore, it is our task to make the most of what remains to us and this means radical changes in most human endeavors and relationships. Nothing less than a major earthquake is about to shake to pieces the strongest foundations yet built by human society. Through ignorance we are apt to perish. Somehow or other the human animal must become much more efficient, honorable, decent and tolerant of his fellows than he has been heretofore. The outlook has considerable of hope, because dire necessity is the greatest of all educators; it has proved to be the prime process through which the average human animal has ever learned very much. Sad experience is the greatest of all teachers and is likely to continue in the role of taskmaster until the average level of intelligence becomes much higher.

## The Soil Resources of Texas

W. T. Carter, Cooperating Divisions of Soil Survey, Bureau of Plant Industry, Soils and Agricultural Engineering, U. S. D. A., and Texas Agricultural Experiment Station, College Station.

Man's interest in getting from the soil, with the least effort, most of his necessities for livelihood probably began prior to the era of civilization. As his numbers increased upon the earth, however, and his needs led to a wider use of the soil, he began to note that differences in plant growth and production of food materials were related to certain observable features of soils and the soil environment, and thus he was led into a crude soil classification from which he learned to select and use the soils suited for producing the various crops he required.

With the passage of time and the development of government there appeared forms of land taxation, and hundreds of years B.C. there were established by some Chinese rulers systems of land classification which were devised to tax equitably the farm lands on the basis of the character and productivity of the soils. Throughout succeeding ages man has continued to use various forms of land classification for various purposes and continues to learn more facts about the soil which enable systematic adjustments in soil classification.

## SOIL CLASSIFICATION

The development of a consistent and scientific soil classification was long delayed by the failure to recognize that classification should be based on a knowledge of physical soil characteristics and their functions. This knowledge can be gained only by preliminary studies of undisturbed virgin soils in the field, and possibly the labor and expense required in making field studies, which require the making of excavations and borings to expose the soil profile in place, were contributary factors in delaying such basic studies. Doubtless the field of chemical research was too long thought to be adequate for solving the problems of soil and crop relationships, and too great a dependence was placed on chemical analyses without regard to the influences of the physical characteristics of soils on plant growth.

The present system of classifying the soils of the United States into broad groups according to their developed characteristics is largely the result of the original studies of the late C. F. Marbut; revisions and readjustments have been added by continued soil studies of American soil scientists.

Dr. Marbut's studies of American soils were made possible by the results of several years of soil survey investigations and mapping, a work that had been developed and carried on by the late Milton Whitney, long chief of the Bureau of Soils of the U. S. Department of Agriculture.

Dr. Whitney, Dr. F. H. King, and Dr. E. W. Hilgard were among the leaders of the pioneers in studying the physical and chemical properties of soils of the United States in the latter part of the old, and the beginning of this, century. Their work and that of some Russian and other European scientists influenced and aided Dr. Marbut in making his basic studies of soil genesis and morphology on which, he early realized, must be based the true scientific classification of soils. He recognized also the influence of the factors of the environment on the development of soil characteristics. From these studies some Russian and other foreign names have been introduced into soil nomenclature in this country, though as studies continue some of these are being replaced with names and terms in English.

It is probable that the more advanced studies in soil development in Russia were especially favored by the large uniform areas of smooth lands extending across varied zones of climate and vegetation associations, which enabled a ready correlation of these factors with soil characteristics and established a recognition of the influences of the several environmental factors on soil development.

With continued soil surveys and studies of soil characteristics by Federal and State agencies, there has been gradually developed more information on the classification of the soils of the United States, and the results of the more recent revisions to Dr. Marbut's original conception of the Great Soil Groups are incorporated in *Soil and Men,* the 1938 Yearbook of the U. S. Department of Agriculture.

### *Factors Governing Soil Development*

By extended studies of exposed soil profiles in the field, together with the correlation of these with the features of the environment, supplemented with laboratory work, soil scientists have determined that the processes of soil development are governed by the following factors: parent materials, climate, relief, natural vegetation, small animal life, microorganisms and time. A knowledge of the factors influencing soil genesis and morphology is important, not only in aiding in soil classification but also because of the relationship of these to soil fertility, productivity and suitability for particular crops.

The parent materials produced by the disintegration and weathering of the geologic formations furnish the skeleton of unconsolidated fine earth which carries the original minerals and constituents upon which the other factors of soil genesis act to develop the soil. Thus, the original parent rock determines largely the physical characteristics of the soil and its adaptability to certain crops; the kind of chemical constituents provided by the parent rock also determines the kind and amount of certain plant nutrients and, therefore, is in a measure responsible for the inherent fertility of the soil. Climate is an important factor in soil development in that it supplies the moisture and temperature necessary for breaking down the rock materials to unconsolidated particles; for influencing the chemical reactions within the fine earth which convert elements into plant nutrients; and for determining the types and amount of native vegetation and microorganisms which are important aids in developing parent materials into soils. The factor of relief is important, because soil development is influenced by drainage conditions on the surface as well as internally, and only on a freely, but not rapidly, drained surface can a normal soil develop. Time is an important factor, because a long period of undisturbed conditions is required for the development of a normal soil.

Thus, a normal soil is the product of the processes of development of many factors acting in conjunction and is a natural body differing from all other bodies in characteristics, functions and uses.

### *Classification of Soils on Developed Characteristics*

A soil is considered a normal soil when its characteristics express the maximum result of the regional factors of soil development, especially those of climate and vegetation, on the gently sloping surface of any ordinary parent material for a sufficient period for the biological forces to exert their full effect. Such soils occur in certain broad zones of climate and vegetation and are known as Zonal Soils, and the groups of related soils occurring in these zones are known as great soil groups.

Soils having well developed soil profiles, which were produced by the dominant influence of some local factor over the normal influence of climate and vegetation, are termed Intrazonal Soils. Such local influence may be due to parent materials, drainage, or other factors. While these soils occupy large areas of great soil groups, they also occur in relatively small bodies in other great soil groups made up largely of normal soils. Such soils are, for example, Rendzinas (Calcareous grasslands of deep development), and others.

Soils that do not have well developed soil characteristics because of some local factors are termed Azonal Soils. These also occur in large areas, such as alluvial soils and Lithosols (shallow or skeletal soils), which for lack of time have not developed a soil profile.

The smaller soil groups, the soil series, are composed of soils of similar physical and chemical characteristics and have an approximately similar arrangement of soil profiles but include soils which differ mainly in texture of the surface soil. These different soils of the series are called types and minor variations from the type are called phases. Soil type and phase are the units indicated in mapping soils in detail. In generalized mapping by reconnaissance on a small scale, combinations of soil types are mapped as soil associations, or soil complexes. Soil Surveys of both detailed and reconnaissance types have now covered about 87 percent of the total land area of Texas.

## *The Great Soil Groups of Texas*

Some of the great soil groups of the United States are still shown to occupy about the same range and names as originally given by Dr. Marbut, but more recent revisions in areas and nomenclature have given names intended to convey a meaning of the characteristics of the normal soils, while some large areas consisting mainly of Intrazonal and Azonal soils have been given the rank of great soil groups with names given that are used in other parts of the world.

Texas, with its vast expanse extending across several moisture belts from east to west, and temperature zones from north to south, encompasses large climatic zones ranging from humid to arid and temperate to subtropical. With these varied climatic conditions in different parts of the state and the wide range in character in rock materials which provide the soil parent materials, it is not strange that there have been found several hundred types of soil and many land types also, nearly all of which produce some kind of crops, either cultivated farm crops, or grasses, or trees, or shrubs valuable for the browse of range livestock.

Of the 20 or more great soil groups of the United States there are 12 represented in Texas, these consisting of extensive areas of various soil associations, series and types. Some, however, comprise small scattered bodies of Azonal and Intrazonal soils, while in places some very large areas of these soils occur. The Great Soil Groups occurring in Texas are as follows:

### *Humid Region*

Red and Yellow Podzolic
Reddish Prairie Soils
Rendzina Soils
Wiesenboden and Ground Water Podsol Soils

*Subhumid Region*
Reddish Chestnut Soils

*Semi-arid Region*
Reddish Brown Soils

*Arid Region*

Red Desert Soils
Miscellaneous soils of nearly all climatic regions
Planosols
Lithosols
Alluvial Soils
Sands
Bog Soils

*Soils and Crops of the Great Soil Groups*

Texas has a land area of 168,732,160 acres. About 16.5 percent of this, or 28,131,478 acres, was used for farm crops in 1939 according to the Census. This was about four million acres less than was reported by the Census ten years before. It is estimated, however, that in 1943 about 1,500,000 acres more were used for crops than in 1939, indicating a gradual increase.

Large areas of the various great soil groups are of soils that are inherently productive and are used successfully for crops, while some areas, although of soils that are fertile, are not usable in their present condition because of insufficient rainfall or water for irrigation, or because of inadequate drainage or for other reasons.

*The Red and Yellow Podzolic Soils.* The Red and Yellow Podzolic soils in Texas include about 34,000,000 acres of forested soils developed in the humid region in the eastern and north-central parts of the state in three separate geographic settings. The normal soils are light in color in the surface horizons and red, yellow or mottled in the subsoils, which are of textures ranging from sandy clay to clay under most soil types. The soils are acid, low in organic matter and in some essential plant nutrients; they are low to moderately productive but respond well to fertilization, and they are especially suited to vegetables, fruits, potatoes, vine crops, cotton, corn, sorghums, peanuts and many other crops. They are used mostly on small farms, where the chief commercial crop is cotton, but some farms also produce vegetables, fruits, sweet potatoes, berries, and other crops for market. These soils have developed from parent materials of various silicious formations on undulating to rolling surfaces with good drainage except in local spots, one of which, the "Flatwoods" of southeastern Texas, covers a rather large area.

*The Bowie-Kirvin Soils.* This association of soils, including also other series of soils of similar characteristics, occupies about 27,000,000 acres of rolling timberland in eastern Texas, this comprising the forested Coastal Plain section known as the East Texas Timber Country. The soils here have developed from unconsolidated sandy and clay beds of Quaternary and Tertiary formations.

* All estimates in this paper of farm land and crop land are based on Census data for the year 1939.

It is estimated from Census* data that about 4,700,000 acres were used for crops in this great body of forested land, and that 4,160,000 acres were classed as idle cropland and plowable pasture.

The proportion of land used for crops was about 20 percent for many counties, but in the "Flatwoods" section less than five percent of the total land area was used for crops. Probably an additional two million acres of land in the East Texas Timber Country could be used for crops without additional clearing.

*The Windthorst-Stephenville Soils.* The soils of this association are largely of forested fine sandy loams similar to the soils of the East Texas Timber Country. They are chiefly of the Windthorst, Stephenville, Nimrod and other series and occupy a geographic subregion known as Western Cross Timbers. The soils have developed from sandy clay and sandstones of the Lower Cretaceous and Pennsylvanian formations in the extreme western part of the humid region. Consequently, crops sometimes suffer from deficient moisture conditions, because rainfall is often irregular. The area, however, is farmed generally to cotton, corn, fruits, melons, peanuts and vegetables. The soils are moderately productive and respond to fertilizers when moisture conditions are favorable.

This soil association consists of about 4,750,000 acres, and it is estimated that in 1939 the total land used for crops was 807,500 acres while that which was idle land and plowable pasture amounted to 827,500 acres. Doubtless 300,000 acres of additional land could be placed in crops, although much of the land has become so greatly injured by erosion and exhaustive cropping that it is not sufficiently productive to use without considerable treatment and fertilization to restore fertility.

About eight percent of the total land area is of alluvial soils which are located along the streams originating within or near the subregion of Western Cross Timbers.

*The Tishomingo-Pontotoc Soils.* These soils comprise the lands of the 2,000,000 acres, relatively low, area of Central Texas known as the Central Basin. This area lies adjacent, on several sides, to the higher lying, rough lands of Edwards Plateau which is several hundred feet higher. The soils are mostly sandy, reddish in color and contain in places a great deal of stony material. They have developed from granite, schists, sandstones and limestones in different places over this small subregion, which has a growth of small oak trees and some scattered mesquite trees and shrubs. Only a little over one-fourth of the total area has soils sufficiently deep and free of stones to permit successful cultivation. Highly productive alluvial soils along streams amount to probably 50,000 acres or more, for three rivers pass through sections of this area. The soils of the smoother uplands and of the bottomlands are moderately to highly productive, although rainfall is irregular and in some seasons moisture is deficient. This is largely a stock farming and ranching section, and the crops grown include cotton, corn, and sorghums, some oats and other crops.

It is estimated that in 1939 there were 96,000 acres in crops in this subregion and that 24,600 acres were classed as idle cropland and plowable pasture. Doubtless many small areas of additional land could be placed in cultivation for producing peanuts, sorghums and other feed crops for local range livestock. More than half of the land is of stony Lithosols unsuited for any purpose except for the grazing and browsing of range cattle, sheep, and goats.

### *The Prairie Soils*

The treeless grasslands of the humid region of Texas are usually called prairies, while the grasslands of the subhumid regions are more commonly referred to as plains. In soil classification, however, the term Prairie Soils is used to indicate a great soil group largely of the North-central part of the United States which consists mainly of normally developed soils that differ from those of other grasslands. Typical Prairie Soils have dark surface soils that are neutral to slightly acid and are underlain by brown subsoils. True Prairie Soils have developed in a cool, moderately humid climate, under a heavy, course grass cover, from various kinds of parent materials that have been derived from rocks and unconsolidated materials of several geological formations. These soils are normally fairly granular and highly productive.

The soils of our humid grasslands in Texas, as a rule, are dark, mostly of heavy textures, and are generally highly productive. Consequently they are well suited to small grains, sorghums, corn, cotton, and many other crops, all of which are grown. Our soils of Texas, however, although having the general surface relief and appearance of the Prairie Soils are Intrazonal, for the most part, in that local factors influence the development of some dominant soil characteristics that do not occur in normally developed soils of the true Prairie Great Soil Group, and therefore the soils here differ from them and are included in different categories.

The grasslands of the humid region of Texas have a total area of nearly 27,500,000 acres and occupy four large, separate subregions of the eastern part of Texas known as the Reddish Prairies, Blackland Prairies, Grand Prairie and Coast Prairie.

### *The Reddish Prairie Soils*

*The Renfrow-Kirkland Association.* These soils occupy an area of about 2,200,000 acres in North-central Texas constituting the southern extension of a broad belt reaching southward from southern Kansas. The normal soils are reddish to brown in color, range from fine sandy loams to clay loams, and owe their color partly to the warmer climate and more complete oxidation and probably also to the parent soil materials which are largely of reddish shales, clays and sandstones of Permian and Pennsylvanian formations. The normal Reddish Prairie soils are not calcareous but are neutral to slightly acid and are quite productive. On very smooth surfaces, planosols (claypan soils) of the Kirkland and Hollister series—dark, heavy soils—have developed. The principal crops grown are wheat, oats, grain sorghums, corn and cotton. These soils lie at the western edge of the humid region and crops are occasionally injured by droughty conditions, because rainfall is sometimes inadequate to provide sufficient soil moisture.

It is estimated that in 1939 a total of 480,000 acres of land was used for crops and that 270,000 acres consisted of idle cropland and plowable pasture. Since this is a generally gently rolling area, it would seem possible that considerable more of this land could be used for crops, especially of small grains and sorghums.

*The Houston-Austin-Wilson Soils.* These soils occupy the subregion of eastern and central Texas known as the Blackland Prairies. The soils are chiefly of the Houston and Austin series which are classed as Rendzina soils. These are intrazonal, dark, granular, calcareous soils that have developed from soft calcareous formations of the Upper Cretaceous. They are mainly of fine texture and quite heavy. They are productive and well suited to small grains, sorghums, cotton, corn and many other crops but are not well suited to vegetables and fruits.

These soils occupy a narrow main belt reaching southwestward through eastern Texas and a smaller belt in South-central Texas, the total of the area consisting of 11,500,000 acres. These prairies include also the Wilson series of soils that are planosols which occur along the eastern side of the main prairie. These have developed from marls and clays that are less calcareous than the formations from which the Rendzinas have developed. They also are quite productive soils but, because of denser and more compact consistence, they are more difficult to cultivate. About 12 percent of the total land area of the Prairies is of alluvial soils and these are highly productive but are subject to occasional overflows which destroy or injure crops. These soils are mostly of the Trinity and Catalpa series and comprise calcareous fine earth washed from the local soils of the Uplands.

It is estimated that 5,635,000 acres (49 percent) of the Blackland Prairies was used for crops in 1939, and that there were a little more than 2,000,000 acres of farm land that was idle crop land and plowable pasture. Probably at least an additional 400,000 acres of this farm land could be used for crops. The soils of the Blackland Prairies are subject to severe erosion because most of the crops grown require frequent tillage. These soils have long been used for cotton and much loss has been sustained some years by the infestation of the *Phymototrichum* cotton root-rot which is especially prevalent on cotton growing on these dark calcareous soils. These soils do not, as a rule, respond profitably to the use of commercial fertilizers over a long period.

*The Denton-San Saba Soils.* The Denton-San Saba soils are also mostly dark Rendzina soils somewhat similar to those of the Houston series. They occupy Grand Prairie just west of the Blackland Prairie and are therefore in a slightly lower rainfall belt. The soils have developed from limestone of the Lower Cretaceous. Large areas are of moderately thin soils, and of shallow and stony soils, associated with areas of rough, stony limestone material. The deep soils are productive and are used for small grains, cotton, grain sorghums, corn and other feed crops. The non-arable stony soils are used for range livestock on ranches and for stock farming. A considerably larger proportion of the land is used for wheat and oats than on the Houston and associated soils of the Blackland Prairie. Soils of the Crawford series occur on this prairie in large and small areas. These are reddish and strong brown, heavy soils that are normally non-calcareous and of the Reddish Prairie soil groups.

There is a total of about 6,850,000 acres of land in Grand Prairie of which a very large proportion is of non-arable stony land and shallow soils. About 600,000 acres of the area are of dark, highly productive alluvial soils and these are largely in cultivation.

It is estimated that there were 1,370,000 acres of land of Grand Prairie used for crops in 1939, and that a little less than one-third of a million acres was in idle cropland and plowable pasture. Probably 600,000 acres of additional land could be placed in cultivation in this area, although possibly much of this would be in small areas scattered throughout the stony non-arable soils.

Rainfall is irregular during some seasons, and crop yields are sometimes greatly reduced by lack of moisture.

### *The Coast Prairie Soils*

The Coast Prairie is a flat, slowly drained belt of low grassland bordering the Gulf Coast. In Texas it has an area of nearly 7,000,000 acres. The soils are intrazonal in that they have not a true Prairie soil development, due to their development under high rainfall and slow drainage which causes a high water table and very wet conditions for considerable periods. Two different groups of soils occur, one of dark, generally heavy soils, the Lake Charles-Crowley Soils, and the other of light colored, sandy soils of the Edna-Katy-Hockley group.

*The Lake Charles-Crowley Soils.* These soils occupy the prairie, nearest the coast, which has an area of about 4,300,000 acres. They are mainly clay and clay loam soils, very dark to nearly black in color, with heavy dark subsoils. The soils are acid, although they have developed from the calcareous Beaumont Clay formation. They are intrazonal soils of characteristics quite similar to the group known as Wiesenboden soils and are inherently fertile. Where drainage is adequate they produce good yields of rice, corn, cotton and other crops. It is reported that crops respond to commercial fertilizers on these soils. Much of the rice production is on these soils and some vegetables and figs are grown commercially.

Estimates indicate that in 1939 a total of only 456,000 acres of the dark soils was used for crops and a total of 1,205,000 acres was classed as idle crop land and plowable pasture. Although most of the land is still used for the grazing of range cattle, the soils represent a large reserve of good land that eventually will become available for the production of many crops after satisfactory drainage has been provided.

*The Edna-Katy Soils.* The soils of this association occupy the interior belt of the Coast Prairie which is bordered on the north by the forested Red and Yellow Podzolic soils. This area comprises a total of about 2,500,000 acres, and outside of the main area there are many small spots of the Edna soils scattered throughout areas of the heavy dark soils. The soils of this group are of fine, sandy loams having heavy, clay subsoils, causing slow underdrainage, and they have some characteristics of Ground Water Podzols although developed under grass instead of forest. They have developed from non-calcareous sandy clay and clay beds of the Lissie formation. The Edna soils have such dense subsoils that they are classed as Planosols.

All of the soils are acid and low in organic matter and in some plant nutrients. They are not very productive, although crops produce well under fertilization where drainage is adequate. The soils are suited to producing vegetables, small fruits, peanuts, melons, and other vine crops and also to cotton and corn where sufficient drainage is established. Less than ten percent of the land occupied by the soils of this group is cultivated, and most of the land is used for grazing. The grasses are of course types and, although an abundant growth occurs, they are not so highly nutritious as grasses on the dark heavy soils.

### *The Reddish Chestnut Great Soils Group*

The Reddish Chestnut soils occupy a belt more than 200 miles wide in places, reaching southward from central Kansas through western Texas to the Gulf. In Texas this zone of distinctive soil development comprises an area of about 70,500,000 acres. It includes large portions of the High Plains, Rolling Plains and Coastal Plain. It crosses the Edwards Plateau, but here the soils are chiefly Lithosols and little soil development has occurred on the limestone formations. The area lies in the subhumid region, but farming without irrigation is carried on successfully.

The normal Reddish Chestnut soils are dark brown in color and have non-calcareous upper horizons with generally heavy calcareous brown and reddish subsoils. Where developed from sandy parent materials, these soils are reddish; from calcareous unconsolidated materials they are darkest; and from limestone they are dark and include large areas of shallow soils. These soils are characterized by a zone of calcium carbonate accumulation which, where found as a white chalky material, is known as caliche.

The characteristics of the soils of this great soil group differ according to the environments of the several physiographic areas in which they occur. Differences of climate, elevation, parent materials and other factors have influenced local variations in soil development. The normal soils, as a rule, are highly productive and are used for many kinds of crops.

*The Pullman-Richfield Soils.* This association of soils includes dark, generally heavy soils of the High Plains in the more northerly sections. These soils occupy a total area of about 11,000,000 acres and include soils of several other series of somewhat similar characteristics. They have developed from calcareous clays of Tertiary and Quaternary formations, are highly productive, being especially suited to small grains, grain sorghums, cotton, and other crops, and are largely in use for growing wheat.

It is estimated that 4,742,000 acres of these soils were used for crops in 1939 and that 2,037,000 acres were classed as idle crop land and plowable pasture. Since only about 43 percent of the land was in crops, it seems that considerable additional land of the dark heavy soils group is available for cultivation in some parts of the High Plains.

*The Dalhart-Amarillo Soils.* This association of soils, also on the High Plains, comprises about 5,300,000 acres of smooth, highly productive soils. These are chiefly brown and reddish, fine, sandy loams and loams with permeable sandy clay subsoils. These soils have developed from the less calcareous, sandy beds of Quaternary and Tertiary formations. They are well suited to grain sorghums, cotton, corn, and some small grains and are used extensively. It is estimated that, in 1939, 1,600,000 acres of the soils of this association were used for crops, and 1,220,000 acres were classed as idle crop land and plowable pasture. It would appear that a considerable increase could be made in land used for crops on the soils of this association that are classed as idle crop land and plowable pasture. These sandy soils are well suited to peanuts and probably a much larger acreage of this crop could be grown on soils of this association.

*The Brownfield-Springer Soils.* The soils included in this association are mainly of loose, light, sandy soils in areas totaling about 4,500,000 acres in the southern part of the High Plains. These soils consist mostly of brown, fine sands and loamy fine sands with reddish or strong brown, sandy clay subsoils lying one to three feet or deeper beneath the surface. In places some areas of loose, light colored, deep, fine sand having a dune-like relief occur which are of the Tivoli series. These soils produce fair yields of grain sorghums and some other crops where the sandy clay lies 12 to 30 inches beneath the surface, but due to the drifting of the sandy surface soils in the winds, where placed in cultivation, these soils are not generally used for crops but are mostly used for grazing of range cattle. Some of these soils produce good yields of peanuts although the land becomes badly injured by soil drifting after peanuts are harvested. Less than ten percent of this land is used for crops. It seems probable that much of this land will never be used for farm crops. Corn has been grown successfully on some of these soils, and at one time considerable corn was shipped to outside markets.

*The Kimbrough-Arvana Soils.* These soils occupy an area of approximately 750,000 acres at the extreme southern end of the High Plains in western Texas. The soils are of brown and fine sandy loams and loams with very friable brown and reddish brown, thin subsoil layers of the fine, sandy loam or clay loam. These are non-calcareous soils resting on very hard stone-like caliche, the Kimbrough soils, having a depth of but a few inches, while the Arvana soils are more than 18 inches but less than three feet thick over the hard caliche. The soils are generally uncultivated, because they are so thin and the rainfall is so light that the land is best used for stock grazing. The soils support a moderate growth of grasses and afford good grazing. They have developed from old sandy beds of Quaternary and Tertiary formations.

*The Abilene-Foard Soils.* The soils of this association occupy the Rolling Plains section of the Great Plains Region of northwestern Texas, an area of about 7,808,000 acres lying east of the High Plains. The Abilene soils are dark, deep, generally smooth, non-calcareous, fairly granular soils developed from calcareous fine earth of Old Plains alluvium of the Quaternary and Tertiary formations. Other dark soils, associated and of somewhat similar characteristics, are of the Roscoe, Hollister, Foard, Tillman, and other series; the Foard soils developed on a smooth surface consisting of claypan soils with dense clay subsoils. These dark soils of the Rolling Plains are very productive, are suited to many crops, and are used extensively for growing cotton, sorghums, corn, and other crops. Some associated dark, sandy soils are used less for small grains than for grain sorghums. This area also includes quite thin soils which are developed over limestone of the Valera series.

Estimates indicate that, in 1939, 1,616,000 acres of these soils were used for crops and 437,000 acres were classed as idle crop land and plowable pasture. Probably at least an additional 200,000 acres of land of this association could be readily placed in cultivation.

*The Miles-Carey-Vernon Soils.* This association of soils occupies a total of about 8,500,000 acres in northwestern Texas, in large areas along stream valleys and in eroded Red Beds. They are chiefly sandy loam soils, the Miles soils having developed on old Tertiary and Quaternary beds and the Carey and Vernon soils from sandy beds, clays and shales of Permian formations. The smoother soils have characteristics represented by soils of the Miles and Carey series. The surface soils are brown or reddish, non-calcareous, with brown and reddish sandy clay subsoils. These soils are deep and moderately productive and are used chiefly for growing grain sorghums, cotton, and some other crops. They are well suited to peanuts, vegetables and fruits and to a limited extent to some small grains on the heavier sandy soils. The Vernon soils are Lithosols and are so shallow that they are not generally satisfactory for farm crops. Large areas of Vernon and other shallow soils, such as Quinlin soils, occur throughout this association. They represent greatly eroded areas of Permian Red Beds. A rather large proportion of the area included in this association consists of non-arable soils.

It is estimated that in 1939 over 2,000,000 acres of these soils were used for crops, and 840,000 acres were classed as plowable pasture. Probably 2,000,000 acres of additional land could readily be placed in cultivation, although most of the best land is already used for crops.

*The Monteola-Orelia-Goliad Soils.* This association of dark soils occurs in several large bodies of land having a total area of over 5,000,000 acres in that part of South Texas known as the Rio Grande Plain, the western or sub-humid section of the Coastal Plain Province. These soils are dark and productive, except for certain areas of shallow soils which are Lithosols of several kinds and are not suited for cultivation. However, the deep soils occupy large areas of smooth, deeply developed soils, most of which are calcareous and classed as Rendzinas although they lie within the zone of Reddish Chestnut soil environment. These soils have developed on calcareous clays of the Tertiary and Quaternary formations. They are of clay loam and clay textures for the most part. They are farmed extensively, some areas are under irrigation, and the crops grown are grain sorghums, cotton, some oats and other crops.

It is estimated that about 700,000 acres of this land were used for crops in 1939, and 280,000 acres were of idle crop land and plowable pasture. The remainder of the land was used for the grazing of cattle on the many ranches located throughout this region.

*The Victoria-Hidalgo Soils.* This association of soils lies in two main bodies near the Gulf Coast and has a total area of about 4,000,000 acres. These are also very dark, heavy calcareous soils of Rendzina character developed from the Quaternary formation known as Beaumont Clay. The soils are used for the production of cotton, corn, grain sorghums and, in the Lower Rio Grande Valley section, citrus fruits and truck crops are grown under irrigation. Estimates indicate that a total of about 800,000 acres was used for crops in these sections in 1939 and about 420,000 acres were of idle cropland and plowable pasture. In some sections such as parts of Nueces, San Patricio, and Kleberg counties and in parts of Hidalgo, Cameron and Willacy counties a very large proportion of the soils is used for crops, while elsewhere the proportion of crop land is very small and most of the soils are used for range cattle on large ranches. These soils are the basis for some of the most intensive farming, fruit growing and vegetable producing enterprises in the state. A very large proportion of the best land is already in cultivation in locations of the lower Rio Grande Valley, where irrigation is practised, as well as in the other counties farther north.

*The Duval-Webb Soils.* This association of soils occurs in two or three large areas in South Texas where they have a total area of approximately 3,700,000 acres. The surface soils are strong brown to reddish-brown, fine sandy loams, and have reddish-brown or brownish-red clay or sandy clay subsoils. These soils are non-calcareous and represent more nearly the true Reddish Chestnut soil development. They are quite productive and are used for growing cotton, corn, grain sorghums, and other crops, and in some sections, where irrigation is practised, winter truck crops are produced. These soils lie near the western limit of dry farming, but crops on them withstand droughty conditions well.

Estimates indicate that in 1939 about 220,000 acres of soils of this association were used for crops. Most of the land is still used for the grazing of range cattle on large ranches. The warm climate and the soils of this association which are so well suited for many crops indicate that more of these soils could be placed in cultivation if larger resources of water for irrigation could be located and made available.

*The Menard-Valera Soils.* These soils comprise dark, calcareous, generally thin soils, of the sub-humid section of the Edwards Plateau. This part of this great dissected limestone plain which lies within the zone of the Reddish Chestnut soil development has an area of about 9,500,000 acres. The soils do not have normal development on the limestone here, except in very small spots which, because of the absence of detailed soil surveys in this region, have not been identified and classified. The Menard and Valera soils are dark, calcareous Lithosols associated with great areas of stony, shallow soils and rough, stony land. Only on a few of the wider divides are the soils sufficiently deep to cultivate, and here rainfall is low and often insufficient for crops. The land used for crops in this section is very slight, and most of it is ranch land which supports a moderate cover of nutritious grasses and shrubs that afford good browse for livestock.

*Alluvial Soils.* In the total area of the Reddish Chestnut soils zone there are about 3,700,000 acres (5.2 percent) of alluvial soils in the flood plains of many small streams and several rivers. These soils are generally calcareous and highly productive and are generally in cultivation. On the High Plains, there is only a very slight amount of alluvial soils because there are few streams, but on the Rolling Plains there are about 1,960,000 acres, largely of reddish and brown soils of the Miller, Yahola, and Spur series. In the Edwards Plateau part of this zone the alluvial soils amount to about 480,000 acres, consisting of grayish brown soils mainly of the Frio and Blanco series. In the Rio Grande Plain the alluvial soils of this zone total about 1,267,000 acres and are chiefly of the Frio, Leona, Guadalupe and Zavala series.

The alluvial soils are well drained and calcareous. They are suited for corn, cotton, sorghums, alfalfa and other crops, and where cultivated they are used mostly for these crops. These soils do not occupy large areas in many places but do constitute important producing parts of many farms because of their productivity and generally favorable moisture conditions during the growing seasons.

*The Lithosols.* The principal areas of Lithosols (shallow soils) of the Reddish Chestnut Zone occur in the Rolling Plains area and in the Edwards Plateau.

In the Rolling Plains these areas consist mainly of rough broken land and shallow soils of the Vernon and Quinlan series. These areas occur chiefly in the Red Beds sections just east of the High Plains and on the steep rough land escarpment at the border of the High Plains. The shallow, reddish calcareous soils of the Vernon and Quinlan series (and some other soils also) occupy scattered small and large areas of non-arable soils amounting to probably about 3,000,000 acres, while the rough broken land has a total of about four million acres. These lands support a fairly good growth of nutritious grasses, and the broken lands and thin soils provide an excellent range for cattle which is used extensively for cattle raising on the many ranches and stock farms throughout this area.

The Edwards Plateau section of this Reddish Chestnut Zone occupies about 9,500,000 acres and it is estimated that at least 90 percent of this land is too stony and rough to be cultivated. This is a deeply dissected limestone plain and the soils are dark and very shallow, while many areas are of rough, stony land occupied by various grasses and shrubs which afford excellent grazing and browsing to cattle, sheep and goats. The land is all used for ranching to which it is well suited.

*Sands.* Scattered areas of deep sands occur throughout the Reddish Chestnut Soils Zone, this totaling about 4,500,000 acres.

These are of deep, loose, fine, non-calcareous quartz sand which supports a growth of coarse grasses and in places some small oak shrubs. The soils are generally unsuited to farming.

On the High Plains these deep, loose sands are now included in the Tivoli series and, occurring in several areas, amount to about 1,580,000 acres. These soils drift into dunes when the protective cover of grasses and other plants is removed.

A number of small areas of unknown extent also occur in widely separated locations over the Rolling Plains.

In the Rio Grande Plain and adjacent coastal areas these sands are mainly of the Nueces Series and amount to about 2,800,000 acres. They are loose, deep, fine sands which have a growth of coarse grasses and shrubs and, when the vegetation is removed, the sand drifts into dunes. The sand of the coastal islands is mainly dune sand which, mostly bare of vegetation, drifts in every wind. Small areas of Nueces fine sand have been cultivated for vegetables where simple windbreaks of brush or planted tall plants have provided sufficient protection to hold the soil and allow the production of moderate yields of some truck crops.

### *The Reddish Brown Soils*

The Reddish Brown soils occur just west of the Reddish Chestnut Soils Zone of occurrence and therefore have developed in a semi-arid climate with a lower precipitation and a thinner grass cover than where Reddish Chestnut soils develop. The soils of the Reddish Brown group develop under an average annual precipitation of from about 12 to 20 inches in various parts of farthest western Texas, and within this zone no production of crops is done without irrigation. The normal soils are light brown to reddish-brown in color and are neutral to slightly calcareous in the upper horizons, with brown or reddish-brown calcareous lower subsoils and an horizon of calcium carbonate accumulation beneath. Due to many variations in local features, such as geological formations, relief and climate, much of the soil development has been of such character as to produce intrazonal and azonal soils largely grayish-brown and calcareous, with no large amount of reddish color, such as soils of Rendzina character, and large areas of Lithosols.

The zone of Reddish Brown soil development includes about 23,500,000 acres of which approximately 8,100,000 acres are sufficiently smooth and the soils deep enough to be considered as arable and productive, while a total of nearly 15,500,000 acres comprises roughlands, stony, and shallow soils that are entirely non-arable.

The Reddish Brown soils zone of development occupies about 6,000,000 acres in the Rio Grande Plain, of which about 4,000,000 acres are arable, and about 600,000 acres are of alluvial soils.

The principal soils of the Upland are of the Crystal, Uvalde, Maverick and Brennan series, while the alluvial soils are mostly of the Laredo and Rio Grande soils with some Frio soils on the smaller streams. Some of the alluvial soils are irrigated from streams and farmed, while in a few places the soils of the Upland are irrigated from wells. The soils are moderately productive and the crops grown are cotton, corn, sorghums, vegetables and in lower Rio Grande some citrus fruits.

In the Edwards Plateau section the soil areas total 6,400,000 acres, of which 2,500,000 acres are of arable land although not used for crops. The arable soils of the Upland are chiefly of the Reagan, Tobosa, and Ozona series, while about 300,000 acres of alluvial soils of the Frio series occur along the small draws of the Edwards Plateau. Nearly 4,000,000 acres are of Ector stony soils and limestone roughlands on the Edwards Plateau and these areas, with areas of the smooth lands, also are all used for range for livestock.

West of the Pecos River valley in the Trans-Pecos region of Texas about 1,600,000 acres of Reagan soils occur which are arable but lack facilities for irrigation. Roughlands including stony mountains, hills and ridges of the Trans-Pecos area support grass nad shrubs and appear to be Lithosols within the zone of the Reddish Brown soils development. The stony soils from limestone are here chiefly of the Ector series while those from igneous rock are of the Brewster series. The grass and browse plants growing on the igneous rock areas are better for grazing, and as a rule more abundant, than on the limestone lands. All of these rough lands and non-arable soils of Trans-Pecos Texas total about 8,500,000 acres, and these are all used for cattle ranching, with some sheep and goats.

## *The Red Desert Soils*

The Red Desert Soils occur in the smooth arid basins and local dry plains of the Trans-Pecos subregion—an eastern extension of the Basin and Range Province. These soils are reddish to light brown in color and are calcareous in many places. They have moderately heavy clay or clay loam subsoils, are reddish to yellowish brown in color and are underlain by soft caliche of calcium carbonate and in places have also an admixture of considerable soft gypsum. The vegetation is largely of desert shrubs, especially of creosote bush *(L. tridentata)* and a few scattered grasses which in places attain a thick cover due to access of runoff water from local mountain slopes. These soils have developed under a rainfall averaging from about eight to fifteen inches in various places throughout the subregion. The soil parent materials comprise old valley-filling fine earth and gravel washed from the igneous and sedimentary rocks of local mountain areas.

The soils are chiefly of the Reeves and Verhalen series. The Reeves soils are light colored and have not developed very deep over the soft caliche, while the Verhalen soils, developed just below nearby mountain slopes, received considerable runoff water and are often found to have a thick growth of tobosa grass or some of the short grasses, whereas the Reeves soils have very little grass.

Associated areas of alluvial soils occur along the streams in relatively small areas, these being of the Gila series along Rio Grande, Pecos and Arno series along the Pecos River, and Toyah series mostly in the mountain creek valleys.

These soils of the Red Desert Soils Group (including the alluvial soils and soils of the Pecos valley east of Pecos River) comprise a total of about ten million acres of which the smooth and arable soils of the Reeves and Verhalen series amount to 4,800,000 acres, the alluvial soils to 507,000 acres; the remainder of soils, 4,660,000 acres, is too shallow, too gravelly or too sandy to be used for cultivation. Although the arable soils are physically arable, they are not all highly productive and some probably would not prove highly satisfactory for cultivation, even if moisture conditions were favorable.

Although large areas of these soils are generally productive, most of the crops are grown on the irrigated areas of alluvial soils. According to the Census, 146,000 acres were irrigated in this subregion in 1939.

Some of the Reeves soils have been farmed successfully under irrigation from wells from the Pecos River in Reeves and Pecos Counties and some from springs near Fort Stockton. The principal crops grown consist of cotton, alfalfa, some small grains and other crops. Where irrigation has been done from wells and from the Pecos River, some salt accumulation has resulted, although where underdrainage is free and water is used from stored reservoirs of mountain storm water the salt problem has not occurred. On Rio Grande the Gila soils, when affected by excessive salt accumulation, are flooded and the salts washed out. It is expected that the large reservoir along the Pecos River near the New Mexico border will store sufficient water to permit satisfactory irrigation on these soils.

All of the lands are in large ranches and are used for the grazing and browse of livestock, mainly cattle and sheep.

## SUMMARY

Of the nearly 169,000,000 acres of land in Texas about 135,000,000 acres lie within the humid and sub-humid climatic zones where farming can be carried on without irrigation on soils that are arable and suited for cultivation.

More than 52,000,000 acres have dark and largely heavy, deep soils that are highly productive and are used extensively for small grains, grain sorghums, cotton, corn, rice and many other crops depending on climatic and local factors which influence the production of particular crops.

More than 53,000,000 acres comprise sandy soils of moderate productivity; a considerable portion is arable and used for growing cotton, grain sorghums, corn, vegetables, fruits, berries, peanuts, melons and various other crops except small grains.

The remainder of the soils of the humid and sub-humid climatic regions, or about 30,000,000 acres, comprises non-arable soils such as stony and shallow soils, rough stony land, loose deep sands, and Coastal Marsh. Most of these soils are used for the grazing of livestock.

The semi-arid and arid sections occur in the extreme western part of the State and occupy about 34,500,000 acres of land. No soils are farmed here without irrigation; a very small portion of the land is irrigated from rivers and in some places from springs and wells. The smoother areas of moderately deep soils amount to over 13,500,000 acres, of which a considerable fraction has good productive soils suited to many crops; much of this will probably be farmed some time in the future in places where water supplies may be located and provided for irrigation.

The remainder of the land, over 20,000,000 acres, consists of stony, shallow and gravelly soils unsuited for cultivation and large bodies of mountains and other stony, rough lands, practically all of which, with the smooth soils adjacent, are used in large ranches for the grazing of cattle, sheep or goats.

The foregoing figures indicate that there are at least 50,000,000 acres of land in Texas that are non-arable and will always be used for the grazing of livestock, except for inclusions of small areas of farmland in spots scattered throughout or associated with the larger bodies of non-arable lands which may be used for producing supplemental forage for livestock.

The large areas of land physically suited for cultivation, that lie in the region where dry farming is not possible, certainly include large amounts of soils sufficiently productive to be utilized for farming where sufficient water can be found for irrigation.

Of the more than 100,000,000 acres of physically arable soils within the climatic zone where rainfall provides sufficient moisture for farming, there are many areas which, because of steep slope, erosion hazard, low fertility, slow drainage and other unfavorable conditions, may not be recommended for use except in those cases where correct practices, reclamation development, proper fertilization and other measures for developing and maintaining the best use of the soils may be profitably employed.

## Possible Mineral Resources of Trans-Pecos Texas

CHARLES LAURENCE BAKER, A. & M. College of Texas, College Station.

The large mining corporations and qualified mining authorities are fairly unanimously of the opinion that no important metal mines will be found in Trans-Pecos Texas. Their opinion is based upon the fact that only low-grade deposits, and very few of these, have ever been found. Also, many leading mining geologists, among them Waldemar Lindgren, hold that a tremendous molten magma advanced eastwards from the Pacific Basin during the Jurassic, producing in later Jurassic or early Cretaceous the Coast Range, Sierra Nevada and Lower California batholiths, and in successively later times the igneous activity manifested itself farther and farther east until finally, in mid-Cenozoic, it reached the eastern border ranges of the Cordillera between New Mexico and Tampico. In the eastern peripheral region the magma intruded thick limestones of the Paleozoic and Cretaceous, being greatly modified in composition by "stoping" or melting much of the limestone and dolomite, so producing alkali-rich igneous rocks in the eastern border province, one of the greatest known regions of these particular rocks. Also, the primary ore minerals are mainly sulphides and oxides and secondarily arsenic-antimony compounds and all these are among the earlier differentiates or precipitates from a magma. Therefore, it is quite conceivable that the magma was drained of most of its metals before ever reaching Texas.

Nevertheless, most of the mining authorities remain ignorant of a fundamental factor which is unique in Texas. This is that in other western states and in Mexico the discoverer of a mine owns it, but in Texas it is owned either by the State or by a private land owner. Texas law relating to the State lands is prohibitive of the prospector and discoverer and the private owner, spoiled by the large royalty which can be paid for oil and gas, demands a royalty or bonus or both, which cannot be paid for a mine. Therefore, no competent prospector or developer will waste his time in Texas.

Study of ore deposits has now demonstrated three essential conditions for profitable mines: (1) the presence of igneous rocks of favorable compositions; (2) the occurrence of favorable "host" or country rocks for ore bodies; (3) favorable hydrothermal alteration of either host or igneous rocks or of both.

Relatively little has been published concerning the igneous and contact metamorphic geology of Trans-Pecos Texas and much less on hydrothermal alteration, but considerably more is now known than has been published. Texas has given extremely little support to science and to geological science. Hence it comes about that most of what is known has not been paid for by the State, and when the individual has to spend his own time and money in order to satisfy his scientific curiosity he is not so very apt to broadcast his findings for the pecuniary benefit of others. The three Trans-Pecos districts of most promise have three of the most execrable topographic maps extant, and he who is foolish enough to devote his own time, talents and money to geologic investigation is seldom quite so foolish as to spend his time making an accurate base map which it is the business of the State to furnish him. Life is too short for one to waste most of his time making a base map when there are plenty of important places to work where satisfactory maps are available.

It chances that three men eminently successful in mining, Dr. W. B. Phillips, Dr. J. A. Udden and Mr. W. H. von Steeruwitz, all possessed of considerable experience in Trans-Pecos Texas, thought well of its mining prospects. It is also true that there are at least two districts out there where all the three essentials for mines occur together and at least two other districts where they probably exist together but which have not yet been searched for them. In one single Trans-Pecos mountain range there are monzonite and quartz-monzonite intrusives, the same as those that have carried more ore than any other kind of rock in the American West, contact metamorphic replacement deposits of metallic oxides and sulphides in limestone, also selective limestone replacement deposits distant from igneous contacts, metallic mineral-bearing fissure fillings and disseminated ores in porphyries. It would be difficult to find anywhere a fuller exhibition in one area of different types of ore deposits. That range also exhibits extensive wall rock hydrothermal alteration such as silicification and propylitization of andesites as well as the alteration of intrusive monzonitic porphyries accompanied by deposition of copper and molybdenum minerals.

It is quite true that most of the visible contact replacements are small, unprofitable remnants spared by erosion, and such replacements in favorable host rocks intruded by favorable monzonites on the sides of the intrusives are rather generally covered by alluvial fans or deposits of rock pediments formed during the Cabeza de Vaca lake regime of late Pliocene and early Pleistocene; yet one favorable limestone contact several square miles in extent on top of the intrusive is now known. The draining of Cabeza de Vaca lake has lowered the ground-water level hundreds of feet, which may have been favorable for the development of enriched oxidized ores (such as occurred for this reason at Shafter) or for secondarily enriched sulphide zones at or near the present water level.

Bleaching of igneous rocks, or staining or coloration by iron oxides and other minerals in sedimentary rocks at the surface has led at Tintic, Utah, to the discovery beneath the surface of immense silver-lead replacements in limestone greatly fractured with open spaces produced by thrust-ing. The same procedure probably can be used in the Cretaceous limestones of the Cordillera of eastern Mexico and Trans-Pecos Texas. Fast color photography is now possible and aerial colored photographs will disclose such areas in desert regions with good bedrock exposures.

The panic of 1907 was crucial to the American mining industry. Extremely few important mines have been discovered in the United States during the last thirty-five years, although several large tonnage low-grade or refractory ore bodies have been developed which were known already before 1907. Among these may be noted all the porphyry coppers and the deposits which cyanidization, flotation and other advances in metallurgy have made profitable.

It is a very extraordinary and largely unaccountable fact that with few exceptions, most of which are real triumphs of sound geologic deduction, the mines of the present and the past have been discovered by surface out-croppings. There must be many more ore bodies buried beneath the surface than are visible in the single plane of the surface. As a matter of fact, there are quite as many favorable surface indications for profitable ores underneath as sufficed for the wildcatter to discover many of the world's greatest oil fields, but the miner will not sink a hole on them. The reasons are worth relating. In the first place, the mining investor in the past was able to find a prospect which its owner did not realize was a mine, or else did not have means to develop, and hence was able to acquire it at a mere fraction of its real value. Being given it on the proverbial silver platter, the element of risk was greatly discounted. It is in the second place much more expensive to develop and produce metals than to develop and produce oil, the percentage of profit being very much less, except in the relatively rare and rich placers of gold, tin, platinum, diamonds, other gems and precious stones, which are the only poor man's mines.

The hope that future higher prices for metals may encourage drilling for hidden ore bodies is apt to prove a snare and a delusion. There is nothing we now use for which a substitute or something better cannot be found. Plastics, for example, will probably replace many or most of the metals now used.

There is at least a score of intrusive rock contacts with favorable limestones known in the Trans-Pecos country which might show tungsten if the fluorescent lamp were utilized. But, as usual, the cost of a lease or purchase, or the royalty asked, would prove prohibitive of profit. Tungsten has been known there for 60 years.

The Trans-Pecos Permian has great resources of dolomite suitable for magnesium but other deposits much nearer to market are plentiful also.

High-alumina clays or bauxite may exist in quantity in the Trans-Pecos region but perhaps not of the usual mode of origin nor in pisolitic form. One analysis of the altered rhyolite on a syenite contact shows a high percentage of alumina, and this happens to be the only analysis ever made in the entire region of a hydrothermally-altered rock. Certainly nephelite-syenites and syenites, the leading parent source rocks of bauxite, are abundant in this province. Although they have not been subject to moist tropical weathering which is necessary to form the usual type of residual bauxite, it should be noted as a strong possibility that the prevalence of sodium carbonate and bicarbonate waters in the igneous rocks may have leached both silica and silicates from igneous and sedimentary rocks, leaving as a residue large percentages of alumina, detectable only by chemical analysis. It would appear quite unscientific to think that bauxite is formed only through surficial weathering processes. Alkali carbonates are known to be important leaching agents of the silica in original minerals and the secondary aluminum silicates. Therefore large volumes of altered rocks near igneous intrusions should be tested by chemical analyses.

Wherever the writer has seen the basal beds of the volcanic series between the northern Barilla Mountains and southward to the head of Alamo de Cesario Creek, he has found them to be lacustrine with the flora of a sub-tropical climate. Whether they are bauxitic is not known, but their volcanic ash was rendered sufficiently permeable by the admixture of calcium carbonate to permit thorough leaching of silica content in the favorable climate. Also, the strata unconformably underlying these lake beds were long subjected to weathering in a warm, moist climate and their weathered parts may contain bauxite or high-alumina clays. These will be expensive to find because numerous chemical analyses are necessary. But if aluminum continues to be a necessary metal we must search for it under different conditions of origin than it has been found heretofore, unless it can be obtained sufficientlv cheap from ordinary clays.

Diatomite is probable in some of the lake or pond sediments associated with the widespread products of volcanism, which contain very extensive Fuller's earth, bentonite, and bleaching clays. The high cost of transport to market is unfavorable to the utilization of these and the excellent construction materials of the Trans-Pecos region.

However, in the final analysis prohibitive land laws and the exaction of extortionate royalties will continue to prevent any extensive development.

## Geologic Research: Necessity—Not Luxury

M. M. KORNFELD, Geologist, Houston.

Fundamental geologic research is facing a crisis during the war period, not only because the war has denuded the colleges and universities of students and faculties in geology, or that commercial organizations have lost men to the armed forces, but because for many years prior to World War II geologic economy, aided by increasing engineering discoveries, was extracting the maximum of efficiency from a steadily decreasing reserve of static geologic criteria and methods.

Today, the intellectual bankruptcy in geologic thought and action is only too painfully apparent. While chemists, physicists and engineers, keyed to problems of modern economy, have made tremendous strides, the geologist has been left behind. The chemist, the physicist, and the engineer have rarely left the laboratory—the geologist has rarely ever entered it. The distinction is important.

The need for research must be recognized well in advance of any possible emergency. In these fast-moving times no profession can fulfill its requirements by taking care of the needs for today—problems of the future thrust forward their demands for solutions.

The purpose of this paper is to demonstrate through the medium of petroleum geology a larger need for geologic research in general; steps toward research must be instituted *now* and cannot be delayed until after the war without serious consequences.

The price of leadership in a civilization that depends upon geologic resources is responsibility. This responsibility imposes a vigilant guardianship upon the trustees who manage our geologic inheritance.

Today in the field of petroleum, according to K. C. Solater (1), "All indications point to the probability of our having to resort to producing our fields beyond capacity, thus endangering our present reserves, to importing foreign oil, and, if necessary, to placing further restrictions on the use of petroleum products by the public."

Recently, a most significant paper appeared by Benjamin T. Brooks (2), petroleum technologist, in which he showed that the American petroleum industry had entered a new phase of its existence characterized by "(1) a decreased rate of finding of new oil fields, which rate of finding has been less than annual consumption since 1937 and in 1942 amounted only to about 20 percent of consumption, (2) a change from an oil-exporting nation, although at present, owing to the exigencies of war, we are exporting petroleum products to our allies and to our armed forces."

Moreover, as early as 1936 L. C. Snider and Benjamin T. Brooks (3) had accurately forecast a domestic shortage of petroleum as likely to occur in 5 to 8 years, that is, 1941 to 1944, owing to a decreased rate of oil finding. In this prophetic paper the authors made this revealing statement:

"The problem of whether or not the United States can produce enough petroleum to supply its own consumptive demand at any assumed demand rate and under any assumed price structure lies principally within the fiield of the geologist."

One basic rule always operates when the law of diminishing returns becomes oppressive—research is a man-made device to discover the means and the methods to circumvent the natural downswing in results from standard procedures. Hence, two avenues of approach recommend themselves, either Nature's laboratories or those of man.

Heretofore, geologic research has been carried on by various workers on a haphazard, part-time basis, with little financial encouragement. As long as there was an economy of abundance, without necessity for rationing, it was possible to make headway in spite of too little research, with many shallow oil fields accessible to the drill. Today, that era has passed. With but little advance warning we have been confronted with demands that press our abilities.

We have penetrated the beds of the earth faster than we have accumulated ability to understand their geology. Engineering science has multiplied our powers without giving us the basic knowledge to utilize the compounded increase of technologic advances. Percentages of wildcat well failures have steadily increased. The pioneer geologist of yesterday has become the conservative business man of today proceeding cautiously where he used to advance boldly, hesitating to accept the risks piled up by the law of diminishing returns.

Consequently, the geologist is forced to knock on the doors of the experimental laboratory to restudy the forces of Nature. It is the writer's belief that the substitute for expensive wildcat wells is experimental research at a fraction of the cost of the present full-dress attempts to uncover oil production.

The time factor will not permit the happenstance research methods of the past. Research laboratories, research plans, and research groups must proceed on an organized full-time basis to win the race with consumption, especially in view of the fact that we are late in making our plans to meet the problems of the emergency. Then, too, the manpower shortage has affected the university and the commercial organization alike, making it difficult to provide the personnel for research work. Yet, somehow the forces must be set in motion to free geology from the static situation of the present to the possibilities of the dynamic geology of the future.

Therein lies the salvation of our problem of natural resources in general. The chemist, the physicist, and the engineer have made magnificent strides and are waiting for the geologist to catch up and provide the strategic basis for an integrated assault on world problems. If the geologist becomes aware of the danger of further delay in inauguration of research plans by private initiative, both science and industry can avoid alternative consequences of a character both far-reaching and different in scope than hitherto visualized.

The alternative is the entrance of governmental authority to provide both impetus and direction for coordinating scientific research. The Science Mobilization Bill is a symptom of that possibility. In these days of integrated world economies, regardless of political complexion, scientific groups cannot bask in the luxury of uncoordinated isolation, particularly when the industries they serve must receive stimuli of the most vigorous character in order to uncover the natural sources of supply for current and future demand. I know of no better way to hasten control by congressional authority than the present apathy in scientific circles and the almost total unawareness of the consequences of drifting without plan.

Moreover, geologists should realize now, before it is too late, that their possible failure to handle the problem of natural resource discoveries will inevitably place the leadership in the hands of the chemist, who, if forced to do so, can provide both natural and artificial substitutes for petroleum by known means and methods. Quoting Snider and Brooks again, from their 1936 paper: "The demand and price structure will depend on the methods of utilization and on the degree to which other substances may be substituted, at different price levels, for petroleum and its products. The alleviation of a petroleum shortage presents a series of problems of better utilization and the development of substitutes, the successful solution of which depends almost entirely on the efforts of chemical engineers."

Thus the geologists who permit the present situation to drift without correction will inevitably force governmental authority to assume control of scientific coordination of research. Further, every day that research work lags behind, emergencies of supply and demand force the chemist and the engineer to assume control of the strategy of handling future problems in petroleum, with geology thereby relegated to a secondary role.

For the benefit of those who correctly point out that natural and artificial substitutes for liquid petroleum are more costly to mine or manufacture, it should not be overlooked that, under the stress of controlled economy in wartime or other emergency, price is not the chief factor. For the simple truth is that governments are willing to pay almost any price for any needed commodity if the emergency requires it. And as we have seen in other resources, new research often reveals previously unknown better utilization of the artificial product to the disadvantage of dependence upon the natural resource.

Elsewhere, we see research groups already organized and functioning both for wartime and postwar needs. For example, in petroleum, TAC (Technical Advisory Committee), operating under the auspices of the PIWC (Petroleum Industry War Council), conducts and promotes voluntary cooperative research and development work in the fields of manufacture and utilization of petroleum products.

In the coal industry, as published September 23, 1943, Bituminous Coal Research, Inc., an affiliate of the National Coal association, has announced a new five year research program, contemplating an expenditure of $2,500,000. This work is a continuation of research begun in 1935 and seeks to develop smokeless stoves and furnaces, fully automatic home heating and cooling, gas from coal for the nation's pipe lines, radically improved railroad locomotives and chemical products.

Petroleum is only one of the numerous non-metals available for further research. Here in Texas the Bureau of Economic Geology is working on a budget of only $52,000 a year for research on all the geologic resources of the largest state in the Union, a pitiful financial expression considering the stakes involved and the possibilities of future utilization of Texas resources.

The time is ripe for a Renaissance in geology; a far-reaching appraisal of the fundamentals of the science; a never realized appreciation of the strategic nature of geologic analysis of human problems; a new glimpse toward unlimited horizons in geologic research; the key to the answers to questions concerning possible deficiencies in natural resources vital to the world's welfare.

Tomorrow the geologist may realize that he is the coordinator of physics and chemistry, the interpreter of engineering and geophysics, in short, the integrator of the earth sciences in general. The geologist can achieve the new stature that new and greater responsibilities demand. Never before was the planet as small as it is today. Never before have there been the possibilities inherent in greater ability to attack problems of natural resources with as many weapons available to the scientist. The way is clear to achieve results by the inauguration, on a vast scale, of research to offset the loss of precious assets in the most destructive war in human history.

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## The "Closed System" for Salt Water Disposal

I. W. ALCORN, Division Production Engineer, The Pure Oil Company, Houston.

The problem, stated broadly, is to determine the best positive means of disposing of the salt water at the lowest unit cost and without damage to plant or animal life or to underground resources. While there are many approaches to this general solution, let us narrow our consideration of it to the injection system. This offers ample room for the exercise of good judgment.

If the "Open System" is selected, it is then a matter of how elaborate a system to install. Thorough analysis of the economics, as well as the technical aspect, should dictate the solution. This may vary from the simple process of pumping the salt water from an open pit or gun barrel directly into the injection well to the most elaborate systems involving aeration, chemical treating, and filtering. No doubt some engineers are inclined to scoff at the simplified procedure; however, a superficial review of the literature and personal discussions may convince one that in many instances they are fully justified. It probably boils down to the degree of permeability of the disposal zone and the amount of water to be disposed of.

In theory, at least, we know that practically all oil field brines contain small percentages of iron in the form of soluble ferrous compounds, usually ferrous hydroxide. Unless this iron is kept in solution or removed, it will tend to precipitate in the form of a gel, clogging the face of the input zone.

Even though the water is aerated and filtered, it often retains or picks up additional iron which precipitates in the well. On the other hand, it is believed that the iron present in solution will remain in solution after injection, provided it is always blanketed with an inert gas such as carbon dioxide, nitrogen, or natural gas. Furthermore, the corrosiveness of the salt water is greatly reduced.

Essentially it is these considerations, aside from cost factors, that prompt the "Closed System." This presents a number of problems, the solution of which necessitates that the operator deviate somewhat from conventional production practices. From our own experience we have recognized two basic situations.

Case I—Single ownership of operation and of minerals.

Case II—Multiple ownership of operation and of minerals.

In Case I we eliminate all field stock tanks, flowing direct from well separator to a central oil treating and disposal plant. With this type of operation we may have wells that will not flow against sufficient back pressure in the separator to boost the fluid on into the central plant, or we may even have a pumping well. Also, it is very desirable, if not mandatory, to maintain individual well production records. To attain this we have provided small individual motor-driven rotary or centrifugal pumps at the separator discharge and actuated by float within the separator. Also, on the discharge of all separators is a fluid meter. By taking periodic shake-outs we can, with sufficient accuracy, estimate the oil and water production from each well daily. If the flowing well will withstand it we carry about thirty pounds per square inch pressure on the separator.

All parts of the closed system are connected with a field gas system and so equipped with regulators as to maintain a positive gas pressure of predetermined amount at all times.

From the central flow treater the clean oil flows to a battery of tanks and the salt water passes on to the filter tank thence to volume tank and the disposal well.

In the two years of operation of this system we have disposed of two million barrels of salt water by gravity. Currently, about 4,300 barrels per day are being disposed of in this way. This quantity, incidentally, represents approximately the capacity of the treater, filter, and the ability of the disposal well to take it by gravity.

Case II is of course similar in operation, except that we utilize stock tanks in order to gauge the oil run from each ownership. However, the oil or emulsion is not treated until after it is gauged and leaves the lease. One suction pump, centrally located, serves to gather all the fluid from the field stock tanks, discharging it into the central flow treater, filter, and volume tank as before. To achieve best results, the field gathering lines were revamped following development of the field, resulting in four main gathering lines manifolded at the suction pump and served by branches to the various tank batteries. This was all worked out beforehand and predicated on emptying a tank or tanks in a given length of time with twenty inches of mercury vacuum at the suction pump.

As before, all parts of the system are maintained with a small gas pressure to insure against contact with the atmosphere. The stock tanks are provided with vent lines and valves set at two ounces. In addition, tanks are equipped with outside gauge devices and the batteries with automatic shut-off. Only during the actual operation of gauging or thiefing is it necessary to open the gauge hatches. At such times there is a constant blow of gas into the tank and in addition the salt water is protected from the atmosphere by the oil blanket.

No salt water has been disposed of in the disposal well, because the production of salt water has been such that it could be handled in an open pit. However, the set-up is installed as described and actual disposal should be started in the near future. Tests on the disposal well indicate that such water will have to be pumped under a small head, however, because the disposal well is artesian but will take appreciable quantities under small pressure differentials.

While little in the way of results in Case II can be cited, it can be stated that in either case certain difficulties are to be expected.

In Case I we plugged back an abandoned oil well to 3,600 feet with a 100-foot plug. Perforations were made from 1,490 feet to 1,500 feet and squeezed to insure against contamination of fresh surface waters. Perforations were then made from 2,010 to 2,090 feet, from 1,770 to 1,880 feet, and from 1,600 to 1,640 feet, a total of 220 feet of formation opened with 1,100 holes 15/32" in diameter. The Spontaneous Potential curve on the electrical log indicated an average of 65 millivolts over the shale section. The well would flow back with fresh water in the hole and sand would come in. With salt water, the formation would take water. Sand has continued to be a source of trouble. After about five months of operation, the presence of anaerobic bacteria became noticeable and this has been the cause of considerable concern; however, it has not proved serious. The well has been acidized twice during the two-year period even though it has always taken the water by gravity.

Analysis of the input water shows a high concentration of dissolved solids, namely 10.56%. On the basis of 3,700 barrels, this would be equivalent to 140,000 pounds per day. If only 0.1% of the solids should be precipitated they would amount to 140 pounds per day. Therefore, it may be concluded that we can successfully retain these solids in solution since they would quickly plug up the sand if even a light precipitation occurred. Also, from the input water analysis, we have 106 p.p.m. of calcium sulphate. This may be the source of oxygen for the anaerobic bacteria *sporovibrio desulfuricans*, a sulphur-splitting microbiological organism. In less permeable sands we probably would have been in serious trouble long ago. Their appearance, to us at least, was entirely unexpected, and their presence constitutes a real problem.

Minor difficulties were encountered with the fluid meters due to foaming conditions and sand; however, for our purpose we obtain a sufficiently accurate estimate of the well's producing characteristics.

The electric power requirements were met adequately by installation of two 440-volt, 3-phase, 60-cycle, 20-kilowatt generating sets.

The maintenance requirement of the system is low and operations can be performed by regular oil lease labor.

*Conclusion:* The problem of salt water disposal involves many considerations. When the injection method is adopted, the selection of suitable input zones is of paramount consideration. The type of injection system used should depend on a complete analysis of the operator's individual problem. It is believed that the "Closed System" offers many practical and economic advantages where it can be applied, this being due principally to low cost, compact plant, elimination of constant aeration and chemical treatment, and minimization of corrosion.

Analyses of both the input brine and of the brine native to the input zone should be made, and they should be mixed in the absence of air to determine whether or not precipitation will occur.

Probably, the major problem of the "Closed System" is that of rendering the system sterile as to anaerobic bacteria. Minor improvements in the art of maintaining the system, particularly tank batteries, in operation in absence of air are to be desired.

In either type of injection system, the utilization of the brine input as the medium of water flooding seems to be a definite forward step.

## Geological Significance of Oil Field Waters and Their Relationship to Structure and Production

WALTER R. BERGER, Fort Worth.

It is the purpose of this short paper to give a resume of the results of a study, started in 1926, of oil field waters covering portions of nine states. It is hoped that conferences on oil field waters, such as this one, will lead to more thorough study and result in greater appreciation of the value of this type of data to the oil industry.

Study of water analyses in a number of structural basins has shown that a marked similarity exists between the iso-concentration contours and the configuration of the basin. This similarity is noted on general structural features as well as the position in relation to the rim of the basin. If sufficient proof can be shown that this similarity is to be anticipated, then there will be another tool as an aid in petroleum exploration.

The interpretation of connate waters should begin with the initial deposition of the water and should include changes that might occur between that time and its present association with the sediments. Some of the more important relations can be enumerated as follows:

1. A predominant portion of oil accumulation has been in sedimentary basins; therefore, our studies should not attempt to interpret waters from conditions expected in open sea or oceans.

2. Closed or partially closed basins can have stratification of waters within the basin—which would permit waters included in the sediments to vary in concentration and constituents in accordance with topography and position in the basin. Such stratification is shown in some present deep, land-locked seas.

3. Flushing of these waters can occur only after the uplift and provided that the deformation and following erosion presents an intake area of higher, and a discharge area of lower, elevation. One such occurrence has been shown by Crawford for the Montana-Wyoming area. Another is probably the San Juan Basin of New Mexico.

4. Basins in which flushing has not occurred to any great extent should show some relationship between the connate waters and structure, on the assumption that the greater amount of water movement from the horizon was accomplished by initial compaction, and that the present structures were incipient at the time of water inclusion.

In order to accept such a theory of water analysis interpretation, we shall have to start anew on the application of thought to these connate waters. Several of the theories which probably would have to be revised or discarded are the following:

(a) That ancient past seas were necessarily filled with water similar to present ocean water, because it is known that sea waters within a sea do vary from relatively dilute to highly concentrated types.

(b) The theory of concentration by contact of water with gases.

(c) That meteoric waters move great distances to the center of a basin, thereby creating a gradual alteration of water basinward from the outcrop (except in basins having an outlet as postulated by Crawford for the Wyoming area). Another expression of similar thought is the movement of water basinward by gravity through geologic time.

(d) That basin waters with low total solids indicate a period of erosion with resulting infiltration of fresh water. Many of these waters can readily be connate.

(e) That great alteration of original waters is necessary to obtain our present connate waters. Many of our high density connate waters can be interpreted as similar to and not much altered from the original water of deposition.

In the light of new information, we must be ready to "scrap" our old theories concerning connate waters and try to evolve concepts which fit the data at hand.

For illustration of the results of water analysis studies, West Texas presents a picture of a partly closed, or perhaps entirely closed, basin. Water analyses of the same general zone of dolomite show that there is a definite increase in concentration from the rim to the center of the basin, with lower concentrations on structural areas than in adjacent synclines. Comparison of water analyses shows that constituents vary sufficiently to infer structural areas. Both concentration and constituents of the waters can be used as new tools supplementing other means of petroleum exploration.

Other basins, such as East Texas, Illinois, Forest City, Appalachian and the Mid-Continent Arbuckle area, present sufficient analogy to the West Texas Basin to leave little doubt that further study will show similar characteristics. Each basin can be expected to differ as to degree of concentration and types of constituents present.

It is hoped that engineers and geologists having access to water analyses of both oil fields and nearby dry areas will study these analyses to throw further light on the theories presented.

## Salt Water Disposal Program in the East Texas Field

L. H. DIAL, Kilgore, Texas.

The East Texas field was recognized as a water drive field early in its development. Operators agreed that it would ultimately produce large quantities of salt water in the normal process of draining the underground reservoir of oil. In an active water drive field, it is possible to maintain reservoir pressure by limiting the withdrawal of fluid to a value equal to the rate of water encroachment. Eminent petroleum engineers have estimated this value at approximately 625,000 to 650,000 barrels per day (1).

At present the Railroad Commission of Texas permits the East Texas field to produce 383,000 barrels of oil when reduced to a calendar day basis. In the production of this oil the field produces about 365,000 barrels of salt water per day. This is a withdrawal of 748,000 barrels of oil and water per day. It was considered feasible to reduce the net withdrawal without curtailing oil production by returning the salt water to the sand whence it came. A field-wide salt water injection program called for the cooperation of all operators to make it a success.

Meanwhile, it was evident to many, not directly interested in the production of crude oil, that salt water produced in the East Texas field was polluting streams and rivers, killing fish and rendering the water unsuitable for industrial and agricultural purposes. The City of Beaumont found that its water supply was being made unsatisfactory by salt water from the East Texas field.

Thus from these needs was born the East Texas Salt Water Disposal Company, with a twofold purpose: (1) to maintain underground reservoir pressure, and (2) to prevent pollution of surface drainage.

The technology of salt water disposal, as practised by the East Texas Salt water Disposal Company, involves many branches of engineering, prominent among which are: Chemical, Mechanical, Metallurgical, Electrical, Civil and Petroleum. It is not the intention to discuss in this paper the details of each branch but rather to give an overall view of the program.

There are at present 61 salt water disposal wells in the East Texas field. The East Texas Salt Water Disposal Company owns and operates 22 wells and other companies operate 39 wells.

In general, the water is taken directly from the lease gun barrels through a network of pipelines and collected at central treating plants. The water usually carries a small amount of oil which must be removed. This is accomplished by passing the water through one or more skimming basins. It is important thoroughly to separate the oil from the water, because any precipitate which subsequently forms in the salt water will have a film of oil about it that will prevent the solid particles from settling and clarifying the water.

After the oil has been removed, the water is brought into intimate contact with the air, either by passing it as a thin sheet over a roughened concrete slab or by passing it through a spray tower. Oxidation of the iron in solution takes place and a finely divided iron oxide forms. This causes the water to assume a red and muddy appearance.

To hasten the precipitation of the small iron oxide particles, alum is fed into the water by constant feed and proportioning devices. Occasionally it is necessary to use lime, also, to control not only the pH of the water but also to reduce the supersaturation of calcium carbonate.

Equally as important as stabilizing the salt water is the sterilization process. Large numbers of bacteria and algae are found in East Texas water. If permitted to grow and multiply, they would form jelly-like masses which would eventually plug the disposal wells. Sterilization is accomplished by the addition of chlorine. The chlorine may either be purchased in cylinders or generated directly by the electrolysis of the salt water. The latter method has been found to be entirely satisfactory and highly desirable from an operational point of view.

The electrolysis of sodium chloride is accomplished by passing a large direct current of electricity through the water between carbon electrodes. Using five-plate submerged electrodes, it has been determined that between five and six volts are required to drive 500 amperes through the water. Not only is chlorine liberated, but also oxygen. The free oxygen aids in the aeration of the water.

The machinery used in the generation of the low voltage, high amperage direct current depends upon the location of the plant. If electric power is available, copper oxide rectifiers are used; otherwise gas engine driven generators are employed.

After coagulation, the salt water enters the main settling basin which is usually of "Gunite" construction. Over and under deflection baffles and inlet and outlet slotted headers aid materially in the sedimentation process. The pit is approximately 70 feet wide, 137 feet long, and eight feet deep. The water enters one end through a slotted pipe extending all the way across the pit. This distributes the water evenly and reduces channeling to a minimum. The water enters near the bottom, because the clarification process is aided by introducing the water-bearing solid particles at a low point.

Approximately one-third of the length of the reservoir from the inlet is an over and under baffle. By skimming the clearest water off the top of the first section and introducing it into the second section near the bottom, the sedimentation process is further aided. Likewise, over and under baffles are placed about two-thirds of the length of the pit and finally a slotted outlet header similar to the inlet header takes the clear water out of the pit. The outlet header differs from the inlet header in that it is located high in the pit in order to receive only the clearest water near the surface.

The clarified water is then passed to the pressure sand filters, after which it is sparkling clear, sterile and ready for the disposal well.

The heart of the disposal system is the disposal well. The East Texas Salt Water Disposal Company has completed its wells in several different ways but has now more or less adopted the following procedure:

1. The surface hole is drilled to approximately 110 feet, where 10¾" casing is set and cemented with 50 sacks of cement.

2. After the cement has set for a minimum of 24 hours, a 9⅞" hole is drilled to the top of the Woodbine sand, at which point the diameter is reduced to 6¼" and the hole carried to the base of the sand.

3. An electric log is then run and the casing seat selected at the base of the first shale break below subsea depth 3320 feet which was the original oil-water interface.

4. Seven-inch casing is then run to the casing seat and cemented with 150 sacks of cement. After the cement has set a minimum of 48 hours an official Railroad Commission test is made.

5. If the casing test is satisfactory, the cement plug is drilled and the 6¼" hole from the casing seat to the total depth is underreamed to eight inches in diameter. The underreaming is done by reverse circulation using gas lift to remove cuttings.

6. The well is then flowed by gas lift until thoroughly cleaned.

7. A string of five-inch OD cement lined tubing, the bottom of which is equipped with a hookwall packer, is run into the hole and the packer set as near the botton of the seven-inch casing as is practical. The well is then completed for the disposal of salt water.

In spite of all the care taken to prevent it, sooner or later the disposal well will plug up and not take water in a satisfactory manner. The method used to clean out depends on the plugging material. Generally speaking, a well can be cleaned out by backflowing it at a high rate using gas lift followed by an acid treatment and backflowed again. If the well is in such bad condition that it fails to respond to this treatment, it will probably be advisable to underream the sand section to remove the plugging material on the sand face. This is the more expensive method of restoring the intake capacity of a disposal well and is used only as a last resort. However, it is usually effective.

In the early days of operation, the Salt Water Company attempted to keep its wells clean to the extent that water would flow into the sand by gravity without the use of injection pumps. The costs were excessive, and it soon became evident that economy of operation dictated the use of a pump when the well failed to take water in sufficient quantities by gravity alone. The economical limit of pumping varies considerably, but in general when the pressure reaches 500 pounds per square inch the well requires cleaning out.

Corrosion is an ever present problem. Pipelines, pumps, and indeed all the equipment which comes in contact with salt water must be designed to withstand severe corrosion. Asbestos-cement pipe has been found to be particularly suitable in the handling of salt water. In addition to being corrosion resistant, it also offers immunity to tuberculation and electrolysis, two forces which reduce the useful life of pipe.

Another kind of pipe which has been used with success in a limited field of application is a wood fiber, coal tar product. It is corrosion resistant also, but it cannot be used except on gravity lines and then only where the pressure does not exceed fifteen pounds per square inch.

Where high pressures are required, cement lined steel pipe has been found to be most satisfactory. The cement lining protects the steel from the salt water on the inside, but the outside is subject to soil corrosion. Laid in ground impregnated with salt water, the steel cement lined pipe has a very limited life as compared with either the asbestos-cement pipe or the wood fiber coal tar pipe.

The problem of finding proper materials for pumps has been a vexing one in view of the fact that the desired critical materials are almost unobtainable. Monel is wanted for rods in reciprocating pumps and shafts in centrifugal pumps. Nickel-iron alloys are wanted for pump liners and impellers. Substitution of various other materials has failed to produce anything that could be termed entirely satisfactory. Pumps made of iron and of zincless bronze are the best immediately available.

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# The Micro-Flora of Several West Texas Oil Field Brines and Their Relation to Corrosion

FRASER H. ALLEN, Department of Petroleum Engineering; and ELOISE McCABE, Department of Bacteriology; The University of Texas, Austin.

Bacteria which can reduce sulfates to hydrogen sulfide have been isolated from many oil field brines. This fact leads to the hypothesis that much of the sulfide corrosion of petroleum production equipment in the West Texas oil fields may be of bacterial origin.

*Experimental Methods and Results*

Five samples of oil field waters were obtained from representative stages in the handling of these waters during petroleum production operations. The sources of these samples are indicated below.

A. Sample of water taken under aseptic conditions at the well head of a producing oil well in the World oil field of West Texas.

B. Sample taken from the gun barrel on a lease in the Yates field of West Texas.

C. Sample taken from the water in a 1,000 barrel lease stock tank in the Yates oil field.

D. Sample of water from the final injection water storage pit in the Toborg field of West Texas.

Nutrient broth and agar were used for culturing heterotrophic bacteria from the water samples. The medium used for the culture of *Thiobacillus thiooxidans* was that described by Waksman (14). *Vibrio desulfuricans* was cultured under anaerobic conditions in a medium described by Beckwith and Moser (5). All cultures were incubated at room temperature. The following bacteria were isolated from these cultures.

| *Source of Sample* | *Organisms* |
|---|---|
| A. Well head | No isolation |
| B. Gun barrel | *Thiobacillus thiooxidans, Bacillus cereus, Vibrio desulfuricans* |
| C. Lease stock tank | *Thiobacillus thiooxidans, Micrococcus* (sp.), *Achromobacter* (sp.) *Vibrio desulfuricans* |
| D. Injection water storage pit | *Thiobacillus thiooxidans, Vibrio desulfuricans* |

It will be noted that only a few species of heterotrophic bacteria were recovered. This is apparently due to the toxicity of the hydrogen sulfide which was present in all samples. The waters were all cultured for aerobic iron bacteria with consistently negative results, and it is suggested that those autotrophs may also be sulfide-labile.

The sulfur bacteria which were recovered are of two general types. The members of the genus *Thiobacillus* are true autotrophs and derive their energy from the oxidation of sulfur, thiosulfates and organic sulfur compounds to sulfuric acid. These organisms are found widely distributed in the soil and natural waters. They are capable of living in N/10 sulfuric acid and their metabolism in oil field waters is characterized by a continual drop in the pH of the waters. The other type of sulfur bacteria, *Vibrio desulfuricans,* derives its energy from the oxidation of organic materials and at the same time reduces sulfates to form hydrogen sulfide according to the following general equation.

$$2C + (M)SO_4 + H_2O = (M)CO_3 + CO_2 + H_2S$$

where C represents the organic substrate and (M) represents a metallic ion. Baars (1) demonstrated that the organism is capable of utilizing a large number of organic compounds as sources of carbon, and it has been suggested that in the presence of petroleum *V. desulfuricans* may be capable of oxidizing the hydrocarbons with a corresponding reduction of the sulfates which are present in the water phase (8). Nitrogen is probably derived from the petroleum, where it is usually found in traces.

Organisms of this kind were discovered in 1895 by Beijerinck (6) when he became interested in the source of the iron sulfide which makes swamp mud black. In 1904 his student, Van Delden (12), succeeded in obtaining pure cultures of the sulfate-reducing organism which he named *Vibrio desulfuricans.* The organism has also been known under the generic names of *Spirillum* and *Microspira.* It has been isolated from water which is associated with crude petroleum in the reservoir by Bastin and Greer (2, 3), Ginsburg-Karagitsheva (7), and Ginter (8). The first two of these investigators checked the surface waters and drilling fluids for the presence of *V. desulfuricans* with negative results and concluded that the organism was a natural contaminant of the water in the reservoir.

Early papers on the micro-flora of oil field waters considered *V. desulfuricans* to be a non-spore-forming bacterium. This provoked much heated speculation as to whether the organisms could remain alive through geologic time at such great depths. Starkey (11) carried out extensive investigations and found that *V. desulfuricans* produces spores which are relatively resistant to heat in a number of artificial media. These observations of sporulation indicate that the organisms may exist as spores when conditions in the petroleum reservoir are not favorable to cell growth.

*Corrosion Produced by Sulfur Bacteria*

The most predominant bacteria which were recovered from these samples of West Texas oil field waters are the sulfur-reducing and sulfur-oxidizing bacteria. These organisms are of little interest from a public health viewpoint, but they should be of great concern to the petroleum engineer since both these types of sulfur bacteria produce very severe corrosion of steel and alloy pipe. Hadley (9) reports that bio-corrosion by sulfur bacteria is second only to stray-current electrolysis in severity of pipeline corrosion. Reinfeld (10) conducted extensive investigations on sterile plates of chromium, nickel, chromium-molybdenum, and copper alloy steels which were immersed in oil field brines containing micro-flora similar to those of the waters which were examined in the present work. Reinfeld reports that the chromium steels were the most stable to bio-corrosion and that "the losses of metals in water with natural micro-flora were thirteen times greater than in the same water which had been previously sterilized." Since the anaerobic sulfate-reducing bacteria are frequently present in the water which is produced with the oil from the reservoir it appears that much of the severe corrosion of oil well tubing may be traced to bacterial activity. Such a condition represents a very difficult engineering problem, because there is no simple way of inactivating the bacteria which are already present in the reservoir and the well itself is constantly being contaminated as the reservoir fluid is produced. Once the reservoir water is brought to the surface, the problem of disinfection is less acute.

The sulfur-oxidizing bacterium *Thiobacillus thiooxidans* requires the presence of free dissolved air or oxygen to produce sulfuric acid. For this reason its activity is probably retarded in the "closed system" method of handling oil field waters for reinjection into the formation.

The "closed system" of handling oil field waters does not allow the water to come in contact with air. Under these anaerobic conditions the second type of sulfur bacterium, *Vibrio desulfuricans,* causes the corrosion of steel and alloy pipe, usually with the severe pitting which is characteristic of sulfide corrosion. The exact mechanism of this type of bio-corrosion presents a promising field for future research. According to the theory of von Wolzengen Kuhr (13), *V. desulfuricans* is capable of constantly depolarizing the iron surface involved, thereby permitting rapid corrosion. There appears to be some substantiation of this hypothesis since corrosion has been observed to occur at the fastest rates when the living organisms are present. As mentioned earlier in this report, *V. desulfuricans* produces hydrogen sulfide as one of the chief products of its metabolism. This acid is then free to form ferrous sulfide from the ferrous ions which dissolve from the anodic areas of the iron. The insoluble ferrous sulfide is precipitated as highly cathodic areas on the iron surface which further aggravate the corrosion. Beckwith (4) has shown in the laboratory that cathodic protection is ineffective against this type of bio-corrosion.

Although the importance of these anaerobic sulfate-reducing bacteria in corrosion is well known, much fundamental work remains to be done in determining the mechanism by which this corrosion proceeds.

## CONCLUSIONS

1. Sulfur-oxidizing and reducing bacteria were observed as common contaminants of the West Texas oil field waters which were examined.

2. The metabolisms of these two types of sulfur bacteria are known to produce highly corrosive conditions, and it is probable that much of the "sulfide" and "acid" corrosion of petroleum production equipment is a result of their activity.

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## Army Specialized Training Program—Basic Geography

L. S. PAINE, A. & M. College of Texas, College Station.

Geography has been reborn, but it required a world-wide catastrophe in the form of war to induce the birth. In the process, the science underwent a metamorphosis, so that the present philosophy differs from that of bygone days. And it is fortunate for geography that this is so. Geography was fast becoming a misfit in the family of sciences, a misfit because it was no longer justifying its existence as a separate mental discipline. The old time orthodox geographer was prone to attempt to explain all aspects of human action or behavior in terms of environment, with particular emphasis upon the physical factors. Even this line of reasoning was not as pathetic as the teachings of those geographers who continued, and still continue, to write a description of a place or thing and label it "geography." Is it any wonder that the scientific world was fast becoming disgusted with geography as a science? But a new light is shining, a light to guide enlightened geographers along the path of service.

The new philosophy of geography places emphasis upon critical analyses of man's actions, both positive and negative. In other words, a true understanding of the precepts of geography enables the student of human problems to classify the problems of man and to find their causes. To this end, he may not stop with an analysis of the immediate and obvious geographic influences but must consider as well the more distant factors, including those of a non-geographic nature. This lies properly within the scope of the geographer because all human actions, regardless of cause, occur within a geographic setting. Without consideration for the geographic setting, the study of non-geographic influences becomes futile. To arrive at a true valuation of human problems, the man must be considered as a part of his environmental complex. The study of man removed from his environment becomes about as valuable to society as the vermiform appendix is to the individual.

Now, apply this line of reasoning to nations. International friction arises as a result of policies which are formulated when leaders remove man from his environment. Or, to put it more concisely, wars are the result of the inability or unwillingness of leaders to see the basic causes of unrest in a nation. One example will illustrate the point. Italy entered World War I on the side of the Allies after definite promises of territorial gains as a reward. However, she was grievously disappointed. Disregarding allied reasons for breaking faith, the fact remains that Italy needed, but did not receive, a reward for her cooperation. As a consequence she has been a trouble maker ever since. In 1926 Italy established what was virtually a protectorate over Albania. In 1935 came the war of aggression against Ethiopia. Were these acts executed solely to aggrandize an avaricious dictator, a would-be Caesar? A very brief survey of geographic influences in Italy will suggest another reason.

Agricultural conditions in Italy are definitely not favorable to the support of 44½ millions of people. Even though 87% of her land area is used, production is insufficient. As a result of the rainfall regime in all parts of Italy, the Po valley excepted, relatively few highly productive crops are raised. Cereals, therefore, become important. Wheat is grown on over one-third of the arable land. In spite of this, about one-third of Italy's demand is supplied by imported cereals. While Italy has numerous river valleys and basin plains, much of the level land is poorly drained. Most of Italy is mountainous. The farming operations of the country yield an estimated yearly income per farmer of about $250. This is in line with the gross income of many Negro sharecroppers of East Texas. It is only slightly higher than the income of Japanese farmers.

In the field of industry, Italy is even more poorly situated. She has a little coal, just about enough to fill the needs of the United States for one year. Unfortunately, it is lignite and unsuited to most industrial needs. Her coal must be imported from England or Germany. Metallic minerals are present in considerable variety and sufficient quantity. However, lacking fuel, their development has been slow and costly. Petroleum is lacking, also. With water power, Italy can manufacture a few types of goods relatively advantageously. The textile industry is an example. However, she can hardly hope to compete with the United States, England, or Japan, in textiles. So what have we in the fields of industry? Low output at relatively high cost in spite of cheap labor. It is estimated that the output per industrial worker of Italy is in the neighborhood of $600 per year. Compare that with a figure of nearly $2500 for the United States, or even $1000 for Great Britain. The Japanese industrial worker turns out a product valued at about $500 each year. The per capita income of Italians is the lowest of all the rated nations of Europe, namely about $125 per year. Compare that with the following figures: United States $600, Great Britain

$475, France $300, Germany $275, Japan $100. Is it any wonder that Italy has provoked incidents so frequently?

The foregoing statements are made without any intention to excuse Italy's international brigandage. They are made as simple statements of fact, facts which apparently the world leaders following World War I did not have, or, more probably, refused to heed. Failure on the part of the leaders of the dominating powers to heed these facts has led directly to World War II. In the postwar settlement Italy was considered as an entity entirely removed from her geographic environment, and so the job has to be done over again.

What, now, is the sense of all this rambling? Simply this—strange as it may seem, some person connected with the war department has a head on his shoulders and knows how to use it. Some day a monument should be erected to this man who was not too lazy to think and not afraid to put his thoughts into action. This man visualizes a need for leaders in the near future, a need far surpassing any need the world has ever seen, and he hopes that through a definite type of training the necessary leaders can be produced. He hopes that these men will have the vision to analyze critically the problems of nations, an analysis which bears in mind the fact that today no nation can live by itself. He hopes that these leaders will be moved by cold scientific fact rather than by sentiment. He hopes that they will think in terms of a world family of nations rather than a world made up of a motley assortment of nationalistic groups, each one striving to get the most in the shortest period of time in spite of its own or other nations' needs. In short, he hopes to promote the development of statesmen rather than of a group of grasping politicians. The idea applies to domestic as well as to world relationships. Someone must do the work and who can do it better than the man who understands it?

You are all familiar with the ASTP courses in geography—two hours of physical, two of economic and three of political. This selection of course material and this division of time may not be well balanced. All teachers of geography bemoan the fact that there is not enough time for a finished course in any one of the three fields. As a matter of fact, more than the necessary amount of time is allotted to physical geography. In the thinking of the man who outlined the program there was an essential place for those parts of physical geography which help in an understanding of the problems of mankind. If properly organized, the vital parts could probably be presented in one-half of the allotted time. As it is, we criticize the program because we do not have enough time to discover all the ways in which mountains are formed. The influence of the mountain upon man is the important aspect, so why waste precious time upon impractical factual material? We are at war and time is a vital factor. Why should we waste precious minutes proving to our satisfaction that the students can demonstrate with facility the spherical shape of the earth? It is doubtful if, at the end of the term, we have any more of a potential statesman than at the beginning. In all probability fully two-thirds of the student's time has been devoted to cramming his brain with facts which he will never use. He will spend the rest of his time trying to work out the valuable ideas, and he will have no time in which to use them.

The criticism of physical geography does not apply with equal force to the course in economic geography. The outline for this course is too full for the time allowed, but few portions could be eliminated without loss. There is a serious criticism, however, in the character of the textual materials available. Most of the textbooks are filled with so much "garnished tripe." Some of them do not even present a lucid description. The basic analyses are almost entirely lacking. This lack can in part be overcome by a competent instructor, but qualified teachers are few and far between, and fewer still are available for the temporary war teaching jobs. As a result, students often fail to grasp the essential point of view and many go away bewildered by a vast array of disconnected facts. The fault lies not with geography but with geographers. It is possible that a good course in the principles of geography, with emphasis upon the economic side, would do more to present the basic philosophy of the subject than the two specialized courses.

The all-important aspects of ASTP basic geography are developed in the third term's work in political geography. Here are presented basic cause and effect. Here is found the result of the operation of geographic, as well as non-geographic, principles. Here is where the student comes face to face with stark reality, with the stern problems of life over which the individual has no control. He has an opportunity to see why some nations have so much and others have so little. Here he finds the stuff from which wars are brewed and discovers that he is in reality his brother's keeper, from a national point of view. He finds out that it does not pay to believe all he hears. If he does not leave this term's work with a more sympathetic attitude toward other nations there is something radically wrong with him or with the instructor. It is not to be assumed that all national and international problems will be cleared up for him, but his attitude should render him capable and willing to view both sides of the story.

Unfortunately, there are very few men today who are qualified to teach political geography, and there is no political geography textbook on the market. This means that the political geography teacher must spend as nearly 24 hours a day in study as is possible. The factual material is almost unlimited. The job is to sort it out so that it may be used.

In conclusion, let me state that the ASTP geography teacher faces a responsibility far greater than that of the teacher in normal times. He is working with a highly selected group of students but under rather unsatisfactory conditions. If the teacher should become discouraged at times he should look into the future where he might possibly see some of his students occupying positions of responsibility. Then, if on the last day of the term, as the boys leave the room, he should chance to overhear a remark such as "boy, that was a good course" he will have received the earthly reward of the faithful teacher.

**Other papers listed on the programs of meetings**

1. Microorganisms in Oil Field Waters. By Fred Barkley and F. B. Plummer, The University of Texas.

2. Recent Volcanoes of Mexico. By F. M. BULLARD, The University of Texas.
3. The Need for More Hydrology. By PAUL WEAVER, Gulf Oil Company, Houston.
4. Specialized Training and Reassignment. By W. A. VARVEL, A. and M. College of Texas.
5. U. S. Bureau of Mines Strategic Mineral Program. By A. B. NEEDHAM, District Engineer, U. S. Bureau of Mines, Austin.
6. Recent Geological Deposits in the Vicinity of San Antonio. By H. B. PARKS, Chief, State Agricultural Research, San Antonio.
7. Some Cretaceous Fossils of Hunt County. MARY ROBERT, East Texas State Teachers College, Commerce, Texas.
8. The East Texas Tomato Industry. CHARLES A. SULLIVAN, Wells Schools, Wells, Texas.

# SECTION V: CONSERVATION

## ABSTRACTS

**Losses and Control of Crop Pests**—W. H. MECOM, Freeport Sulphur Company, Freeport, Texas. The worst of the crop pests, at least as far as we in Texas are concerned, is the insect. Insects wreak havoc and destruction in many ways. The losses to Texas cotton growers from insects are very great. Government authorities estimate that the average annual lint loss in this state amounts to 960,000 bales. They estimate that the loss in linters for munitions reaches 37,440 tons annually, that the cottonseed oil loss for food and fats totals 68,710 tons annually, and that the cottonseed meal loss for meat and milk amounts to 216,000 tons annually. These losses mean, too, that more manpower is required to raise our wartime cotton requirements, that more land is needed which otherwise could be used for growing other essential crops.

The five major established insects that cause this damage are, in the usual order of their appearance in the cotton field, the cotton flea hopper, cotton boll weevil, bollworm, cotton leaf worm, and cotton aphid.

In waging war against these insects, the grower should first turn to natural methods of combatting them. He should make the best possible use of these methods before resorting to the chemicals and other artificial weapons that science and industry have devised. There are several things he can do. One is clean cultivation, another is to plant as early as possible. Other natural weapons against insects are good preparation of the land, close spacing, fertilization when needed, and destruction of stalks as early as possible.

Weather conditions and heavy emergence of over-wintering insect populations may more than counteract these sound natural control measures. The grower must then resort to the control methods that have been created in laboratory and test tube.

The proved method of control of the cotton flea hopper consists of dusting with 325-mesh dusting sulphur. The accepted method of control of the boll weevil is dusting with calcium arsenate, at the rate of about seven pounds per acre, at five-day intervals. A mixture of two parts sulphur and one part calcium arsenate may be applied at the rate of fifteen to eighteen pounds per acre to control flea hopper and boll weevil if both are present. The cotton bollworm can be controlled by dusting with cryolite, calcium arsenate or lead arsenate, while the worms are small, at the rate of about eight pounds per acre. The cotton leaf worms are easiest to control while young and can be killed by dusting or spraying with calcium arsenate, lead arsenate or Paris green. For the control of the cotton aphid, it is now recommended, in humid areas, that nicotine be added to the calcium arsenate dusts.

**A Progress Report on Our Waterfowl Studies in Eastern Texas**—HILBERT R. SIEGLER, Biologist, Texas Game, Fish and Oyster Commission. Data concerning the winter activities of waterfowl, management techniques and economic significance which are gathered in Texas will have a wide application due to the geographical position of the State between the deep South and the West, and because of its varying and ecological types. Our present waterfowl study has been in progress since 1938 in 37 inland counties of eastern Texas. These counties were treated as one unit since they will require a fairly uniform management technique.

There are 610 streams in the 37 counties under consideration. The larger streams have large populations of mallards and wood ducks during the winter months, and Red River harbors some Canada geese. The 17 streams most important to waterfowl traverse a distance of 3400 miles.

The only large lake in the region is Caddo Lake which has a total area of about 110 square miles of which 52,800 acres lie in Texas.

There are at least 222 lakes and marshes in eastern Texas which are twenty acres or larger. Of these, 75 are natural river bottom lakes and 147 are artificial. The State, Federal government, or municipalities own 18 of these; sporting clubs have control of 58; and 139 are under private ownership. The public is allowed to hunt and fish on at least 71, while eight lakes are recognized as waterfowl refuges. These lakes alone give the 37 counties under consideration about 76,300 surface acres of water.

Eastern Texas is the recipient of ducks and geese from two of this continent's major flyways—the Mississippi and the Central flyways—since both border in this region. A thumb-nail sketch of the waterfowl picture in this region is as follows: In June and July wood ducks and occasional pairs of mallards are the only ducks present. Some blue-winged teal appear the first part of August and thereafter quickly increase. Pintails, pied-billed grebes and the American coot appear the last part of August. Pintails top the list by the end of September while blue-winged teal populations decline. In October the American coot population abruptly rises to first place. Between the middle of October and the first week in December at least twenty different species of ducks and geese can be seen in eastern Texas. Scaups, ring-necked ducks and pintails are the most numerous migrants during this period, although a spectacular goose flight takes place the last two weeks in October. Mallards, which first appear around October 15, show only a slight increase until the first cold spell about Thanksgiving time when their numbers show an abrupt rise to surpass in number all other species combined during December and January, while the ring-necked ducks rank second in numbers. Pintails again become numerous toward the end of February, while mallard flocks begin to decline. The greatest variety of waterfowl species passes northward through eastern Texas during March, but by the end of April most species have left while the American coot again leads the list, although blue-winged teal and shovelers are still common. Thereafter wood ducks once more reign supreme with only an occasional pair of mallards to keep them company.

Non-game waterfowl species in eastern Texas during the winter months besides coots and grebes are double-crested cormorants, the great blue heron (probably Ward's), and the American bittern. The common loon and the white pelican are regular autumn visitors, while the brown pelican is a rare visitor. The American and snowy egrets and the little blue heron establish rookeries during the summer months. Large numbers of water turkeys or Anhingas also raise their young at many of these rookeries. Purple gallinules and least bittern invade eastern Texas during May. The green heron is a common summer resident. Some of both yellow-crowned and black-crowned night herons nest in eastern Texas. In July, this region is visited by numerous wood ibises. On rare occasions the roseate spoonbill is also a visitor.

**Wild Turkey Restoration in Eastern Texas**—COLEMAN NEWMAN, Biologist, Texas Game, Fish and Oyster Commission. The wild turkeys in eastern Texas were almost exterminated before restoration activities were begun.

The range suited for turkeys has been greatly reduced due to agricultural development and lax forestry practices.

In view of numerous releases of Rio Grande turkeys and the complete failure of all but two re-stocking attempts, it appears that liberations made in the same procedure would be useless. However, a change in release management might bring about more favorable results.

The propagation of eastern turkeys from pen raised wild birds can be done successfully. The results of the releases have not been definitely determind, but it is thought that they will be satisfactory.

**Forests for Today and Tomorrow**—PAUL W. SCHOEN, Chief, Division of Forest Management, Texas Forest Service, A. & M. College, College Station, Texas. Today the forests are contributing a full share toward winning the victory for the United Nations. Last year the volume of wood used in the war effort exceeded even that of steel which was next in line. It has been said that wood is the only vital war material for which a successful substitute has not been found.

Figures, recently released, show that the 1942 lumber production was in excess of 36 billion board feet and that amount does not include the home uses which never enter such compilations of data. To list all the essential uses to which this lumber was put would include items ranging from ordinary tent pegs to huge airplane hangars and from the drawing pencils and paper used in drafting plans to the completed battleship built from those plans.

As conservationists, we are interested in the growing and harvesting of forest products to assure the future of our woodlands. As scientists, we are interested in the development of wood uses.

Our forest lands in Texas and in the nation will produce and will continue to produce, even with the drain resulting from the present demand, adequate forest products if we keep out fire, practise reasonably good forest management in harvesting, and reforest where necessary. Our efforts towards conservation must therefore concern themselves principally with education that will be translated into desirable practices.

The war effort has done much to advance the science of using wood more effectively. It has been noted that we are entering the "plastics era." That the trees of our forests will play a very important role in this era has already been proven by the many new uses, both announced and unannounced, which are the result of the war effort. "Impreg," a laminated wood and resin product, "compreg," similar but compressed to one-third or one-half its original size, and "hydroxylin," a valuable lignin and cellulose plastic are a few war born wood products.

Our forests were the only tangible wealth visible when our forefathers landed on the shores of this continent. Their use was limited only by the tools at hand. The same forests have been a source of real wealth throughout the development of our nation, with their use increasing as we added to the tools by which we have been able to utilize them. In the future, the forests of Texas and the nation will continue to yield unmeasurable wealth if we use them wisely and, through scientific developments, broaden the field of uses.

## PAPERS

# The Wild Turkey in Texas

WALTER P. TAYLOR, Leader, Texas Cooperative Wildlife Research Unit, College Station.

The wild turkey is one of the most important game species in Texas; indeed it is one of the few species of which Texas produces more huntable individuals than any other State. The Annual Report of the Texas Game, Fish and Oyster Commission for the fiscal year 1941-42 records 3,936 turkeys killed in the course of shooting preserve operations during the season. Many turkeys are known to be killed on other lands than shooting preserves, and it is perhaps not wide of the mark to estimate that at least 8,000 turkeys were killed in Texas during the season. H. L. Blakey, wild turkey specialist, U. S. Fish and Wildlife Service, asserts that the Texas harvest of wild turkeys about equals the take in all the other wild turkey states put together.

The domestic turkey is derived from the wild turkey of Mexico (*Meleagris gallopavo gallopavo*). As Mosby and Handley have pointed out, the first definite records of turkeys under domestication in Mexico date from 1519 when Cortez referred to the bird. This doughty warrior may have been the first to transport turkeys from Mexico to Spain, although some records indicate the introduction of the wild turkey in Europe as early as 1498. The spread of the bird throughout the continent of Europe was rapid. It had apparently become fairly common prior to the early 1600's when the English colonists established themselves in Middle North America. The colonists from Europe brought the wild turkey with them to North America at an early date.

All the wild turkeys in North America, and indeed all living wild turkeys in the world, belong to two genera, each of which has a single species. The ocellated or Yucatan turkey (*Agriocharis ocellata*) is one of these and our own wild turkey (*Meleagris gallopavo*) is the other. Ours in Central and South Texas is the Rio Grande wild turkey (*Meleagris gallopavo intermedia*); the eastern wild turkey (*M. g. silvestris*) is thought to occur in the eastern part of the State and the Merriam turkey (*M. g. merriami*), now extinct in Texas, was formerly found in the Guadalupe Mountains. Efforts are being made to restore the last-named in the Davis Mountains.

While the former range of the wild turkey in Texas is not fully known, it appears to have occurred widely in all suitable forested or varied portions of the State. At present it is restricted to the Edwards Plateau country and South Texas, although there is a remnant in eastern Texas, and the Game, Fish and Oyster Commission has introduced a considerable number of the birds at various points in its former range.

As an object of sport, the wild turkey is of outstanding importance. Those landowners or operators who can advertise wild turkeys as well as deer on their holdings have a distinct advantage in marketing their hunting leases. Some sportsmen prefer wild turkey hunting to any other type of sport.

The problem of maintaining the wild turkey in suitable numbers on the Edwards Plateau is a difficult one. According to Blakey, approximately 500 species of native plants occur in this region, which are known to produce food for wild turkeys in other portions of its range. In the Texas Hill Country, however, grazing by cattle, sheep, and goats has seriously reduced the variety and abundance of these plants and so distinctly limits the food available to wild turkeys. V. L. Cory of the Texas Agricultural Experiment Station has listed 36 species of plants, some used by wild turkeys, which have been very largely eliminated from large portions of the Edwards Plateau region by grazing. The resulting shortage of feed for wild turkeys probably accounts in part for their tendency to leave the higher portions of the Hill Country in winter and drop into canyons, near at hand or far away, where a more generous food supply may be available.

Artificial feeding of corn, oats, wheat, milo, and other materials in winter has been tried with some success as a means of stabilizing the movements of turkeys on the Edwards Plateau, but there are obvious difficulties and disadvantages. For example, the procedure closely resembles baiting, which, in the case of waterfowl, is prohibited by law. Planting of oats and other winter grains in suitable places is highly favorable to wild turkeys and may be unequivocally recommended, but it cannot be done on any large scale in the Edwards Plateau country because of the rocky and stony character of the soil. The most promising means of helping to stabilize the wild turkey population is in better regulation of the range and improved adjustment of grazing animals to it, so that a greater quantity of food will remain for livestock and, incidentally, for the various game species including the wild turkey. Conservative grazing would also help provide improved nesting cover for the birds.

The Texas Agricultural Experiment Station, in cooperation with the Texas Cooperative Wildlife Research Unit (Agricultural and Mechanical College; Texas Game, Fish and Oyster Commission; United States Fish and Wildlife Service; American Wildlife Institute) and individual interested ranchmen, is ascertaining the effects of large fenced plots, from 100 to 500 acres, on wild turkey nesting and activity.

A continuation of present over-heavy stocking of some parts of the Edwards Plateau region will likely result in the reduction of its productive capacity for livestock as well as take parts of the area out of production for wild turkeys.

The high value of the wild turkey as a member of the Texas avifauna, and as an object of sport, is not fully appreciated by ranchmen, sportsmen, or scientists. The biologist has a real responsibility for drawing public attention to the problems of wild turkey maintenance and to the need for their solution. In this instance game laws are probably less important than improved range management taking into account the interrelations of soils, plants, and animals.

# The Present and Proposed Natural History Programs of the Houston Parks and Recreation Department

VICTOR A. GREULACH, The University of Houston, Houston.

In the past, Houston has been far behind most cities of similar size in providing its citizens with scientific educational and recreational facilities such as a good zoo, museum of natural history, and outdoor nature recreation. Steps to remedy this situation were taken during the summer of 1943 by Mr. C. C. Fleming, the new Director of Parks and Recreation. The writer was asked to help organize a natural history program for the department and was placed on the staff as part-time Supervisor of Natural Sciences. A Natural Science Committee was established to act as a planning and advisory group.

During the last six months of 1943 the program was initiated on a modest but successful basis. Nature leadership was provided for the playgrounds conducted by the department. A Nature Guide School was conducted on Saturday mornings between July 10 and August 28 for the benefit of playground directors and other interested individuals and had a registration of 26. A nature trail was constructed in Hermann Park, and several playground groups constructed their own nature trails. Steps have been taken toward the establishment of a community forest. A staff of ten volunteer curators, each a specialist in his field, was set up to assist the curator in charge of the Museum of Natural History, Mr. Val Gesner, to rehabilitate the present small museum. A vast amount of work has been done in eliminating specimens not related to natural history and excess duplicates, and in classifying, identifying and rearranging the remaining specimens so as to be as interesting and scientifically arranged as possible in the limited space available.

On November 19-21 a Nature Fair was held in Hermann Park, at which time the museum and nature trail were opened to the public, and guide service was provided in the zoo. An exhibit building included exhibits of nature collections and crafts made by playground and school groups, flowers by the Federated Garden Clubs, and displays by various state and federal organizations interested in conservation and natural history, as well as a replica of a woodland scene, using living plants set up by the Houston Outdoor Nature Club. Other features included natural history and conservation moving pictures, nature games, woodcraft demonstrations, campfire singing, and views of planets through a telescope. The fair was designed primarily to introduce the program to the public and is estimated to have attracted from 20,000 to 30,000 visitors.

Considerable progress was made in planning a postwar program, which will be detailed later, and which received enthusiastic approval when outlined to the Park and Recreation Board and presented to a group of civic leaders and city officials at a meeting of the Parks and Recreation Council. A committee of civic leaders was set up to plan the financing of the postwar program.

Although many individuals and groups have contributed to the successful initiation of the natural program in 1943, particular credit should be given to the members of the Houston Outdoor Nature Club, who individually and as a group have contributed freely of their time and skills.

The plans for 1944 call for continuation and expansion of the projects begun in 1943. Nature trails and trailside museums are to be constructed in all the principal parks. The Nature Guide School will be expanded into a year-around School of Natural History. The zoo will be rehabilitated insofar as possible under present conditions. The natural history collections of the Houston Public Library will be considerably expanded. Guidebooks to the zoo, museum and nature trails, and handbooks for the identification of local plants and animals will be published

While such plans involve a considerable amount of work they require only small amounts of material and money. The postwar plans, on the other hand, will involve the use of considerable money and what are now critical materials. These plans are for a $3,000,000 public science center, which will be located principally in Hermann Park. A $1,000,000 museum of science, to replace the present museum, will incorporate the most modern ideas in museum construction, display, and activities. An aquarium to cost $600,000 and a planetarium for which a like sum is allotted will be constructed nearby. The present zoo will be completely rebuilt at an approximate cost of $500,000. A $300,000 botanical garden and arboretum, including a wild life sanctuary, is planned for Memorial Park, where more space, better soil and drainage, and more existing specimens are available. This unit in particular will be subject to considerable future expansion as additional funds become avialable.

Since the city would have considerable difficulty in financing this program and other numerous postwar projects, the finance committee is making plans to secure most of the $3,000,000 in the form of benefactions and public subscriptions.

The value of such a program to the citizens of Houston and of Texas should be much greater than its cost. The recreational, educational, and cultural advantages are obvious. The scientific staffs of the various units will contribute to the welfare of the region both through research on problems of local interest and as sources of authoritative information and advice. Interest in the conservation and use of our natural resources should be greatly increased.

## Observations on Some Aspects of Recreation and Wildlife Conservation

SGT. JOSEPH M. HEISER, JR., Detachment, Medical Department, Brooke General Hospital, Fort Sam Houston, Texas.

All of us are familiar with the remarkable progress made in recent years in the scientific management and administration of our wild game and fish. The question of "good hunting" in the future hinges upon the old-fashioned law of supply and demand. With the supply angle of the equation now beginning to reach its limits of development (if, indeed, it has not already done so) the only other method of attacking this problem lies in decreasing or diverting the demand.

Psychologists tell us it is better to say "Come, let us do this!" than "Don't do that!" Pressing needs of the times have forced us to develop substitutes for many methods and materials no longer adequate under present circumstances. It is not in the nature of the American people to do without, when by the exercise of native perseverance and resourcefulness they may replace or supplement an old idea with something new and possibly better.

No doubt most of us have noticed how many sportsmen, unwilling to remain inactive after they have taken their allotted share of the annual game crop, have turned to such non-consuming activities as wild life photography, mineral collecting, or the making of comparative bird counts, as highly satisfactory substitutes for their curtailed sport with gun and dog. This is a most significant trend, and it becomes all the more so when we appraise its possibilities for the younger generation, whose habits have not become fixed and who eagerly take up new and stimulating explorations.

For some twenty-five years past, the observation of bird life along our Texas Gulf Coast has furnished satisfying diversion for much of my own leisure time. During the past several years, I have made a special effort to take along on field trips as many boys of high school age as my car would accommodate. Without exception, these youngsters were ready and eager to repeat this experience every time they were given an opportunity to do so.

On these trips, the spirit of the chase was brought out by discussing the largest number of species that might possibly be identified and recorded and by striving to beat the best previous seasonal record or the record established by observers in some other section of the state or in another state. Naturally, Houston boys are eager to prove themselves better hands at such a bird round-up than the lads of, say, Dallas or Fort Worth. And of course it would be unthinkable to let sharp-eyed observers in California walk off with the highest list of birds observed in a single day or totaled up for a year of bird chasing in every promising spot of woods, or marsh, or sandy beach.

Somewhat as an experiment, I worked up a card to be kept by each boy as a record of the results obtained on our birding expedition, and the names of those participating. The face of the card bears this statement:

"This certificate of membership in the Bull's-Eye Club is presented to John Henry Doe on the basis of the qualifications set forth on the back of this card."

The statement on the reverse is as follows:

"The hand is quicker than the eye. Quicker, often, than either is the wild bird or animal in its native haunts. To identify, in a short time, any considerable number of birds *in the field* implies commensurate knowledge and experience in wild life lore, as well as energy, skill, and keenness of perceptions. Many times, accurate identification must be made on instant sight—a bull's eye on the first shot. By reason of having bagged a list of — birds on a single day (——————), in the —————— region, in company with those whose names are signed below, the bearer of this card has affirmed his association in the universal outdoor fraternity whose password is good-fellowship, whose field extends to the horizon, and whose satisfactions are limited only by the measure of individual aptitude and enthusiasm."

Signed by other fellows of the group, the card becomes for its holder a reminder of a grand day's experiences afield. The propaganda intent of its wording may be a little obvious, but there is no danger in using direct language with young people when the purposes are frank and logical.

This little bit of personal experience is mentioned only because I believe the psychology behind it, if carried forward by interested leadership, can (to use a current term) "condition" our young people to the fullest and most practicable use of our wild life resources and make them future collaborators rather than critics of our wild life authorities.

Because their approach to the subject is principally from the recreational angle, I believe that our game wardens and management experts are in a good position to give momentum to the adoption of this type of wilderness recreation. It is a pleasure to note that wild life authorities in Texas have been among the leaders in such advanced work. Houston members of the Academy appreciate especially the initiative displayed by Captain E. T. Dawson, of Secretary Will Tucker's staff, whose cooperation with high school biology classes, science clubs, and other groups of young people in the Houston area has produced notable results.

As can readily be seen, this sort of program is intended to appeal more to people who seek zestful action and competitive sport outdoors than to those who are already stimulated by scientific and aesthetic interests. I hope this will not cause it to be looked upon with disfavor or indifference by scientists, artists, writers, and lovers of nature. After all, our duty today is to perpetuate for all the people opportunities for the year-round enjoyment of recreation afield similar in spirit and effect to the traditional wilderness sport of our forefathers. If we can achieve this in substantial measure, the causes of scientific progress and aesthetic appreciation will benefit accordingly.

In closing, I should like to place emphasis upon an aspect of this subject of special concern to one who has worn the uniform of the United States Army in two world wars.

Terrible new weapons and methods of modern warfare have stressed the importance of keeping open-minded and abreast of the times. Yet we know from reports of our fighting men in the jungles, deserts and mountains of foreign lands that marksmanship and skill in the care and use of the rifle are still essential characteristics of a good soldier. It would be natural to grasp this fact as an argument for greater game-shooting privileges. On sober second thought we realize that it should, instead, serve as the basis for serious consideration of the actual problem we have to solve.

Our pioneer forefathers became expert riflemen through the necessity of supplying game for the family table and driving the hostile savage from their door. Nowadays, our game officials, supported by the proofs of science, tell us that our game-shooting opportunities will henceforth be definitely restricted. If we are wise, we will face at once the fact that the traditional skill of American men in the use of firearms can no longer be acquired and maintained solely in the pursuit of our limited wild life crop.

We might ponder for a moment the plight of the average American boy, stirred by advertisements describing the shooting adventures of Kit Carson and Daniel Boone but telling nothing of the difference between wilderness conditions in their day and ours. Turned loose with his treasured gun, the boy is driven, baffled and rebellious, from the city park or the neighbors' shrubbery, where he has been happily popping away at songbirds. In the natural course of events this boy often becomes the man who makes life miserable for the local game warden and the state officials, alike. He constantly berates authorities over the lack of game to satisfy his wants and stirs the sports writers to take up his complaint; he ignores the bag limits and the closed seasons when he can get by with it; and he poaches constantly and contemptuously upon the posted property of sportsmen's clubs whose exclusiveness he resents. Many civic-minded citizens profoundly dislike the gun in the hands of youth for reasons they have not taken the trouble to weigh and remedy. Parents refuse to buy their sons the eagerly-wanted rifle or put off the purchase until constant nagging forces them to give up in disgust.

The good soldier and the real sportsman both know that the gun should be a symbol of manliness and willingly-accepted responsibility rather than the mark of loose thinking and careless action. A few years ago, children in the cities had to play baseball in the streets, and from this there came broken windows, fractured limbs, and other troubles. We did not ask the children to give up baseball. Instead, we built baseball diamonds throughout the city, and that difficulty was settled. We could not make the American boy give up his gun even if we wanted to, which most of us certainly do not. We owe it to him, and to our conception of good citizenship, to provide conditions under which he can enjoy his gun with a feeling of pride and responsibility in its ownership.

This is a matter which touches in some degree various phases of wilderness recreation, wild life conservation, preparedness for national defense, and juvenile delinquency. As a layman eager to support the endeavors of specialists in these vital fields, may I mention briefly my thoughts on a three-point plan of action:

First, our young people should be frankly informed that our game supply is no longer a freely-gushing, inexhaustible spring, but a scientifically produced crop to be harvested according to rules from which all of us benefit and for which all of us are responsible. Second, attention should be given to every possible form of non-consuming wilderness recreation, especially during the closed seasons when the desire for zestful activity next to nature is just as strong as ever, even though pursuit of game with gun and dog is temporarily taboo. One of the most far-sighted and significant programs of this kind ever undertaken is that being inaugurated in Houston, Texas, of which we shall hear more from my distinguished fellow townsman, Dr. Victor Greulach, of the University of Houston.

*(See "The Present and Proposed Natural History Programs of the Houston Parks and Recreation Department," in this volume. Editor).*

The third point of my suggested plan (which I feel sure my comrades in the armed services would approve heartily) is to establish throughout the length and breadth of our land properly sponsored organizations to encourage the practice of skeet and target-shooting and to organize local, state and national rifle contests in much the same way that amateur baseball and football competitions are now arranged.

There would be many difficulties encountered and ironed out in "pushing" a broad-scale program of this kind. Yet I feel most earnestly that a plan embracing the substance of these three points would enhance all the potentialities for individual welfare, civic betterment, and commercial expansion inherent in our wild life resources and our ancient urge for contact with the wild.

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