

PROCEEDINGS
of the
NORTH DAKOTA
ACADEMY OF SCIENCE

Founded December, 1908

VOLUME V
1951

PUBLICATION COMMITTEE

Rae H. Harris (*Chairman*)
Ralph E. Dunbar
Ernest D. Coon
J. Donald Henderson (*Ex Officio*)
G. A. Abbott (*Ex Officio*)

*Published jointly by the University of North Dakota
and the State Agricultural College*

September, 1951
GRAND FORKS, NORTH DAKOTA

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OFFICERS

President - - - Glenn S. Smith, Agricultural College
Vice President - - - Wilson M. Laird, University
Secretary-Treasurer - J. Donald Henderson, University
Historian - - - G. A. Abbott, University
A.A.A.S. Representative J. A. Munro, Agricultural College
Additional Members of Executive Committee:
Walter Knudson, Bottineau
H. E. Murphy, Dickinson

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U. N. D.  PRESS
GRAND FORKS, NORTH DAKOTA

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NORTH DAKOTA ACADEMY OF SCIENCE

ACTIVE MEMBERS — 1951

- Abbott, G. A. (Chemistry), University. Charter Member.
- Aldrich, Vernice M. (Agriculture), 428 Belmont Road, Grand Forks.
- Arnason, A. F. (Forestry), Commissioner, State Board of Higher Education, Bismarck. 1939.
- Banasik, Orville J. (Cereal Chemistry), Agricultural College. 1947.
- Bavone, Anthony L. (Sanitary Engineering), Minot. 1947.
- Beck, Lyle, (Dairy Technology), Agricultural College. 1950.
- Bliss, Harald N. (Ornithology), Grafton. 1951.
- Bolin, Donald W. (Biochemistry), Agricultural College. 1946.
- Bolin, F. M. (Veterinary Science), Agricultural College. 1948.
- Bonneville, David C. (Chemistry), N. D. Research Foundation. 1951.
- Bosch, Wouter, (Chemistry), Agricultural College. 1948.
- Bosch, Mrs. Wouter, (Chemistry), Agricultural College. 1949.
- Brentzel, William E. (Plant Pathology), Agricultural College. 1950.
- Brezden, William. (Chemistry), State Mill and Elevator, Grand Forks. 1945.
- Briggle, Leland W. (Agronomy), Agricultural College. 1950.
- Broberg, Joel W. (Chemistry), Agricultural College. 1948.
- Bryant, Reece L. (Poultry Genetics), Agricultural College. 1948.
- Buchanan, M. L. (Animal Husbandry), Agricultural College. 1950.
- Burr, Alex. C. (Chemical Engineering), Bureau of Mines, Grand Forks. 1940
- Cardy, James D. (Pathology), University. 1950.
- Carter, Jack F. (Agronomy), Agricultural College. 1950.
- Chetrick, M. H. (Chemical Engineering), University. 1947.
- Clagett, Carl O. (Biochemistry), Agricultural College. 1949.
- Conlon, Thomas J. (Agronomy), Agricultural College. 1950.
- Cooley, A. M. (Chemical Engineering), University. 1938.
- Coon, Ernest D. (Chemistry), University. 1923.
- Davis, Mildred L. (Nutrition), University. 1951.
- DeHoff, L. B. (Organic Chemistry), Agricultural College. 1950.
- Dinusson, William E. (Animal Nutrition), Agricultural College. 1950.
- Doubly, Mrs. Elma K. (Bacteriology), Agricultural College. 1950.
- Doubly, John A. (Bacteriology), Agricultural College. 1950.
- Douglas, Raymond J. (Animal Husbandry), Agricultural College. 1950.
- Dunbar, Ralph E. (Chemistry), Agricultural College. 1938.
- Edwards, Lawrence J. (Chemistry), Agricultural College. 1950.
- Ellman, Robert. (Fuels), Bureau of Mines, University. 1949.
- Estensen, Ernest V. (Psychology), Agricultural College. 1951.
- Evans, Norman A. (Agricultural Engineering), Agricultural College. 1950.
- Eveleth, D. F. (Veterinary Science), Agricultural College. 1944.
- Facey, Vera (Botany), University. 1948.
- Fischer, Robert G. (Bacteriology), University. 1948.
- Fleetwood, Charles W. (Chemistry), Agricultural College. 1948.

- Flor, Harold H. (Plant Pathology), Agricultural College. 1943.
- Fordyce, Ira V. (Chemistry), AGSCO, Grand Forks. 1947.
- Forster, Theodore L. (Dairy Technology), Agricultural College. 1950.
- Frank, Richard E. (Chemistry), University. 1949.
- Fredrickson, Ronald L. (Chemistry), Agricultural College. 1951.
- French, Harley E. (Anatomy), Dean Emeritus, University. 1911.
- French, Leslie A. (Engineering), State Highway Department. 1943.
- Gault, Alta R. (Physiology), University. 1949.
- Geiszler, Gustav N. (Agronomy), Agricultural Experiment Station, Minot. 1950.
- Gohman, Walter J. (Physics), Minot. 1951
- Goldsby, Alice. (Veterinary Science), Agricultural College. 1946.
- Gorz, Herman J. (Plant Breeding), Agricultural College. 1951.
- Graham, Charles M. (Internal Medicine), Grand Forks. 1951.
- Grimes, Ruby. (Mathematics), Agricultural College. 1946.
- Gustafson, A. A. (Bacteriology), Public Health Lab., University. 1950.
- Gustafson, Ben G. (Chemistry), University. 1939.
- Hagen, Irvn. (State Seed Dept.), Agricultural College. 1950.
- Hamre, Christopher J. (Anatomy), University. 1950.
- Hankerson, Kenneth L. (Mathematics), University. 1946.
- Harris, Rae H. (Agricultural Biochemistry), Agricultural College. 1938.
- Hart, Harry B. (Chemistry), Jamestown College.
- Hastings, R. C. (State Seed Commission), Agricultural College. 1950.
- Haunz, Edgar A. (Internal Medicine), Grand Forks. 1951.
- Hazen, Arlon. (Agricultural Engineering), Agricultural College. 1950.
- Heermann, Ruben M. (Agronomy), U. S. Dept. of Agriculture, Fargo. 1950.
- Helgeson, E. A. (Botany), Agricultural College. 1936.
- Hemphill, Perry V. (Agricultural Economics), Agricultural College. 1937.
- Henderson, J. Donald. (Physics), University. 1945.
- Higgins, Edith C. (State Seed Commission), Agricultural College. 1950.
- Hill, A. Glenn. (Mathematics), Agricultural College. 1946.
- Hoag, Donald G. (Botany), Agricultural College. 1950.
- Hoepfner, Jerome J. (Chemistry), Bureau of Mines, University. 1949.
- Hoffman, Glenn L. (Parasitology), University. 1951.
- Holland, Margaret Jean. (Pathology), University. 1951.
- Holm, Glenn C. (Veterinary Science), Agricultural College. 1950.
- Holtz, John C. (Chemical Engineering), Bureau of Mines, University. 1949.
- Hoyman, William G. (Phytopathology), Agricultural College. 1950.
- Hultz, Fred S. (Agriculture), President, Agricultural College. 1950.
- Hundley, John L. (Physics), University. 1930.
- Jensen, C. (Dairy Husbandry), Agricultural College. 1927.
- Kamps, Theodore. (Fuels), Bureau of Mines, University. 1949.
- Kaufman, Victor. (Physics), University. 1951.

- Kelly, Eunice. (Nutrition), Agricultural College. 1944.
- Kingsley, Allan F. (Agricultural Chemistry), Agricultural College. 1950.
- Kirk, H. H. (Biology), Supt. of Schools, Fargo. 1938.
- Kjerstad, C. L. (Philosophy and Psychology), University. 1937.
- Klosterman, Earle W. (Animal Nutrition), Agricultural College. 1948.
- Knoll, Clement. (Engineering), School of Forestry, Bottineau. 1949.
- Knudson, Walter L. (Biology), School of Forestry, Bottineau. 1950.
- Kohanowski, Nicholas. (Geology), University. 1949.
- Koons, Melvin E. (Bacteriology), Public Health Lab., University. 1943.
- Koth, Arthur W. (Metallurgy), University. 1939.
- Kube, Wayne R. (Chemical Engineering), Bureau of Mines, University. 1949.
- Laird, Wilson M. (Geology), University. 1941.
- Langford, Larkin H. (Animal Husbandry), Agricultural College. 1950.
- Larson, Edith E. (Biology), University. 1947.
- Lasley, Earl L. (Animal Husbandry), Agricultural College. 1950.
- Lauster, K. C. (Public Health), State Health Dept., Bismarck. 1944.
- Leraas, Marvin A. (Agronomy), Agricultural College. 1947.
- Light, Merle. (Animal Husbandry), Agricultural College. 1950.
- Loomis, Fred H. (Cereal Chemistry), Loomis Laboratories, Grand Forks. 1947.
- Lundy, John L. (Anesthesiology), Mayo Clinic, Rochester, Minn. 1940.
- Luper, Miltza (Medical Technology), Deaconess Hospital, Grand Forks. 1951.
- McBride, Woodrow. (Mathematics), University. 1950.
- McKean, William. (Biology), State Game and Fish Commission. Bismarck. 1947.
- McKenny, William H. (Ceramic Engineering), University. 1951.
- McMillan, William W. (Chemistry), N. D. Research Foundation, Fordville. 1947.
- MacDonald, John H. (Biology), Teachers College, Dickinson. 1951.
- Magnusson, Adelynn M. (Chemistry), University. 1951.
- Marwin, Richard M. (Bacteriology), University. 1949.
- Mason, Harry. (Physics), Jamestown College. 1951.
- Mattson, Harold. (Horticulture), Agricultural College. 1937.
- Mayoue, George C. (Plant Pathology), Agricultural College. 1950.
- Milberg, Morton E. (Chemistry), University. 1951.
- Miller, Cap E. (Agricultural Economics), Agricultural College. 1919.
- Miller, Clifton E. (Pharmaceutical Chemistry), Agricultural College. 1947.
- Miller, Leonard E. (Chemistry), University. 1951.
- Milligan, Edward A. (Anthropology), School of Forestry, Bottineau. 1951.
- Moberg, Wenzel. (Geography), Agricultural College. 1943.
- Moomaw, Leroy. (Agriculture), Experiment Station, Dickinson. 1943.
- Moore, Cyril C. (Chemistry), Teachers College, Minot. 1948.

- Moran, Walter H. (Chemistry), University. 1928.
- Munro, J. A. (Entomology), Agricultural College. 1927.
- Murphy, H. E. (Chemistry), Teachers College, Dickinson.
- Nelson, Casper I. (Bacteriology), Agricultural College. 1915.
- Norum, E. B. (Soils), Agricultural College. 1948.
- Nystuen, Peder, A. (Animal Husbandry), Agricultural College. 1947.
- Oehler, Mrs. Alma. (Nutrition), State Mill and Elevator, Grand Forks. 1945.
- Ongstad, Orvin C. (Fuels), Bureau of Mines, University. 1949.
- Oppelt, Walter H. (Fuels), Bureau of Mines, University. 1949.
- Opton, Edward M. (Zoology), Agricultural College. 1946.
- Overn, A. V. (Education), University. 1949.
- Ovrebø, Gerhard, O. (Physics), Teachers College, Valley City. 1947.
- Owens, Paul R. (Floriculture), Owens Floral Co., Grand Forks. 1945.
- Parsons, Jesse L. (Bacteriology), Agricultural College. 1950.
- Pearson, Richard K. (Chemistry), University, 1950.
- Peterson, Robert H. (Chemistry), Agricultural College. 1951.
- Porter, Charles B. (Surgery), Grand Forks. 1951.
- Posin, Daniel Q. (Physics), Agricultural College. 1948.
- Post, R. L. (Entomology), Agricultural College. 1948.
- Potter, Loren. (Botany), Agricultural College. 1948.
- Potter, W. F. (Medicine), Dean of Med. School, University. 1948.
- Promersberger, William J. (Agricultural Engineering), Agricultural College. 1938.
- Reid, Russell, (Natural Science), State Museum, Bismarck. 1940.
- Riley, Kenneth W. (Chemistry), Marietta, Ohio.
- Robinson, Hugh M. (Botany), Teachers College, Valley City.
- Robinson, Roy N. (Physics), Public Schools, Minot. 1951.
- Rognlie, Philip A. (Mathematics), University. 1946.
- Rolzinski, Julian J. (Biology), Junior College, Devils Lake. 1950.
- Ruth, Elbert B. (Anatomy), University. 1951.
- Ryan, Floyd T. (Forestry), School of Forestry, Bottineau. 1951.
- Saiki, Arthur K. (Pathology), University. 1949.
- Sands, F. H. (Chemistry), Agricultural College. 1946.
- Saugstad, Stanley. (Entomology), Wild Life Administration, Bismarck. 1939.
- Schultz, J. H. (Horticulture), Agricultural College. 1948.
- Sebens, William P. (Agriculture), Greater North Dakota Association, Fargo. 1948.
- Severson, Donald E. (Chemical Engineering), University. 1949.
- Severson, Ronald G. (Chemistry), University. 1951.
- Sheppard, Mrs. Adele G. (Chemistry), 1018 Seventh Street North, Fargo. 1911 .
- Sheppard, Wyman. (Horticulture), East Grand Forks. 1943.
- Shoemith, Lloyd. (Soils), Agricultural College. 1950.
- Shrader, Ruth. (Anatomy), University. 1951.
- Sibbitt, L. D. (Cereal Technology), Agricultural College. 1946.
- Sisler, William W. (Plant Breeding), Agricultural College. 1950.

- Smith, Glenn S. (Plant Breeding), Agricultural College. 1930.
- Stafne, Gilbert J. (Farm Bureau), Fargo. 1948.
- Staley, Raymond C. (Mathematics), University. 1946.
- Stallings, H. Dean. (Library), Agricultural College. 1951.
- Steinmeyer, L. D. (Chemistry), School of Forestry, Bottineau. 1947.
- Stevens, O. A. (Botany), Agricultural College. 1910.
- Stewart, Donald L. (Chemistry), American Crystal Sugar Co., East Grand Forks, Minn. 1943.
- Stoa, Theodore E. (Agronomy), Agricultural College. 1950.
- Stokke, Orval R. (Bacteriology), State Health Laboratory, University. 1950.
- Stone, Edward J. (Dairy Husbandry), Agricultural College. 1950.
- Sudro, W. F. (Pharmacy), Agricultural College. 1911.
- Summers, Lawrence. (Chemistry), University. 1951.
- Svore, Jerome H. (Sanitary Engineering), State Health Dept., Bismarck. 1943.
- Taintor, E. J. (Agriculture), Taintor Seed House, Grand Forks. 1945.
- Thompson, John C. (Mathematics), Teachers College, Dickinson. 1948.
- Thompson, Matilda. (Mathematics), Agricultural College. 1947.
- Treumann, William B. (Chemistry), Agricultural College. 1946.
- Tsumagari, Yukio. (Pathology), University. 1951.
- Tuneberg, Everett O. D. (Chemistry), School of Forestry, Bottineau. 1949.
- Van Heuvelen, W. (Chemistry), State Health Dept., Bismarck. 1945.
- Waldron, L. R. (Agronomy), Agricultural College. 1910.
- Walster, H. L. (Director of Experiment Station), Agricultural College. 1920.
- Wardner, Arthur K. (Agricultural Chemistry), Flaas Farms Co., Grand Forks. 1938.
- Wendland, Ray T. (Chemistry), Agricultural College. 1948.
- Weyer, Albert E. (Zoology), Agricultural College. 1948.
- Whedon, Arthur D. (Zoology), Agricultural College. 1924.
- Wheeler, George C. (Biology), University. 1924.
- Whitman, Warren. (Botany), Agricultural College. 1950.
- Wiidakas, William. (Agronomy), Agricultural College. 1946.
- Wild, Robert L. (Physics), University. 1951.
- Wills, Bernt L. (Geography), University. 1949.
- Wischow, Russell P. (Cereal Chemistry), Agricultural College. 1950.
- Witmer, Robert B. (Physics), University. 1925.
- Witz, R. L. (Agricultural Engineering), Agricultural College. 1947.
- Zetter, Oscar. (Wild Life), State Game and Fish Dept., Bismarck. 1951.

NORTH DAKOTA ACADEMY OF SCIENCE

Minutes of the Forty-Third Annual Meeting

FRIDAY, MAY 4, 1951

The meeting was called to order at 9:30 a.m. in Room 18, Merrifield Hall at the University of North Dakota. Vice President Glenn S. Smith presided since illness prevented the attendance of the President, Dr. A. K. Saiki.

In his welcoming remarks Dr. Smith commented on the continued progress of the Academy. In congratulating the members for their active interest and support, he expressed confidence in the future and the expectation of even greater advances. After brief announcements regarding the program, the reading of papers was begun. The seven papers listed on the morning program were read and briefly discussed.

The following committees were appointed and asked to report at the business session on Saturday morning. Committee on Resolutions: C. E. Miller, Chairman; E. D. Coon and H. E. Murphy. Committee on Nominations: John L. Hundley, Chairman; R. E. Dunbar and E. H. Tuneberg.

Noon luncheon was served in the University Commons with the visiting members as guests of the University. Thirty-five visiting members were present.

The Academy reconvened at 1:30 p.m. in Room 18, Merrifield Hall. The papers listed on the program for the afternoon were read and discussed with the exception of No. 18 which at the suggestion of its author, Dr. Cardy, was omitted because of a shortage of time.

The Academy Dinner, a joint meeting with the Red River Valley Section of the American Chemical Society, was sponsored by the University Chapter of Sigma Xi. One hundred twenty-seven members and guests were present at this dinner held in the University Commons. Professor Arthur W. Koth, President of Sigma Xi, welcomed the guests and expressed the hope that all visitors would feel free to visit any or all departments on the campus. He assured them that local members would be glad to serve them in any way they could. He then introduced Professor A. M. Cooley, President of the Red River Section of the American Chemical Society, who announced that members of the A. C. S. would continue their meeting in the Chemistry Building immediately following the dinner program.

Dean R. B. Witmer, speaking for the North Dakota Academy of Science, briefly outlined the service that has been rendered to the Academy and to the State by Dr. G. A. Abbott in his forty years as Secretary-Treasurer of the Academy. It is largely due to his unselfish devotion and untiring efforts that the organization is flourishing today. As a small token of our esteem and appreciation a desk set was presented to Dr. Abbott. In his response Dr. Abbott was very modest in speaking of his contribution and was generous in his praise of other early members who helped him found and foster the organi-

zation. It was pleasing to hear him give his assurance that he would continue his active participation in North Dakota science. Our Academy is deeply indebted to Dr. Abbott.

Dr. Glenn Smith introduced the guest speaker, Dr. W. J. Breckenridge, Director, Museum of Natural History, University of Minnesota. His topic was "Becoming More Bird Conscious." Rather than a formal lecture in the traditional form, he showed colored motion pictures that he had taken and explained the pictures as they appeared on the screen in delightful entertaining manner. These included a study of some of the birds along the lowlands of the Minnesota River, a record of the private life of the wood duck, and scenes showing the migrations of water fowl in this general region. The beautiful pictures along with the instructive comments of Dr. Breckenridge were a treat for all present at the dinner.

SATURDAY, MAY 5, 1951

Assembly call at 9:15 a.m. Dr. Glenn Smith presiding.

The six remaining papers listed on the program were read and discussed after which the Academy went into executive Business Session.

The minutes of the 1950 meeting as published in the Proceedings were approved as printed.

The Report of the Treasurer was read and accepted.

Dr. Rae H. Harris, Chairman of the Publication Committee, gave his report which was accepted. To facilitate the work of the committee he asked for the cooperation of the authors in presenting their manuscripts in approved form. He expressed appreciation of the agreement by which the Administrations of the University and Agricultural College finance the publication of the Proceedings; without this financial help the Proceedings could not be published.

Dr. G. A. Abbott as Historian suggested publication of the history of the Academy in the Proceedings or in mimeographed form. He also recommended a history of other early scientific developments in the State.

The Committee on Resolutions consisting of Chairman C. E. Miller, E. D. Coon, and H. E. Murphy presented the following resolutions. The report was read by Dr. Coon and was unanimously adopted.

1. We express our appreciation to the University for extending its facilities to the Academy, and for the luncheons provided; and to the Press for giving excellent publicity to our meetings.

2. We extend our sincere thanks to our distinguished guest speaker, Dr. Walter J. Breckenridge, for his illustrated and most instructive address on "Becoming More Bird Conscious".

3. We thank the Red River Valley Section of the American Chemical Society for its joint participation in our meetings, and making it possible to share their guest speaker.

4. Our thanks are extended to the local Sigma Xi chapter for sponsoring the Academy Dinner.

5. We are especially grateful to the Administration of the Agricultural College and of the University for continuing the policy of financing the publication of the Proceedings of the Academy and to the members of the Committee on Publication for the excellent work they have done.

6. We regret the absence of Dr. Arthur Saiki from our meetings and hope for his speedy recovery. We also express our sympathy for two others of our members of the Academy. J. H. Seymour and H. L. Bolley, and recommend that our Secretary send a note of greeting from the Academy to each of these three members.

7. We record with deep sorrow the passing of two of our members Dean L. C. Harrington and Mr. Sewell Mason.

8. To the Officers and Committees of the Academy, we express our thanks for providing the excellent program of papers, the comfortable arrangements, and for the successful conduct of this highly interesting and profitable meeting of the Academy, especially to Vice President Smith and Secretary Henderson who were called upon to assume the extra load.

9. We urge all members to encourage the participation in the Academy activities by other institutions of higher learning in the State that are not represented at this meeting.

10. We are grateful to the weather man for better cooperation than we received last year and respectfully request his good will at future meetings.

The following were properly nominated and unanimously elected to membership in the Academy:-

Bliss, Harald N., (Biology), Public Schools, Grafton.

Bonneville, David C., (Chemistry), University.

Davis, Mildred L., (Nutrition), University.

Douglas, Ray, (Agriculture), Experiment Station, Dickinson.

Estensen, E. V., (Psychology), Agricultural College.

Fredrickson, Ronald L., (Biochemistry), Agricultural College.

Gohman, Walter J., (Physics), Teachers College, Minot.

Gorz, Herman, (Crop Breeding), Agricultural College.

Graham, Charles M., (Internal Medicine), Grand Forks.

Haunz, Edgar A., (Internal Medicine), Grand Forks.

Hoffman, Glen, (Parasitology), University.

Holland, M. Jean, (Pathology), University.

Kaufman, Victor, (Physics), University.

Luper, Miltza, (Clinical Chemistry), Deaconess Hospital, Grand Forks.

MacDonald, John H., (Biology), Teachers College, Dickinson.

McKenny, William H., (Ceramic Engineering), University.

Magnusson, Adelynn M., (Chemistry), University.

Mason, Harry, (Physics), Jamestown College, Jamestown.

Milberg, Morton L., (Chemistry), University.

Miller, Leonard E., (Chemistry), University.

Milligan, Edward A., (Anthropology), School of Forestry, Bottineau.

Peterson, Robert H., (Chemistry), Agricultural College.
 Porter, Charles B., (Surgery), Grand Forks.
 Robinson, Roy N., (Physics), Public Schools, Minot.
 Ruth, Elbert B., (Anatomy), University.
 Ryan, Floyd T., (Forestry), School of Forestry, Bottineau.
 Severson, Roland G., (Chemistry), University.
 Shrader, Ruth, (Anatomy), University.
 Stallings, H. Dean, (Library), Agricultural College.
 Summers, Lawrence W., (Chemistry), University.
 Tsumagari, Yukio, (Pathology), University.
 Wild, Robert L., (Physics), University.
 Zetter, Oscar, (Wild Life), Game and Fish Dept., Bismarck.

The Nominating Committee presented the following nominations:

President	- - -	Glenn S. Smith, Agricultural College
Vice President	- - -	Wilson M. Laird, University
Secretary-Treasurer		J. Donald Henderson, University
Historian	- - - - -	G. A. Abbott, University
A.A.A.S. Representative	-	J. A. Munro, Agricultural College

Additional members of the Executive Committee:

Walter Knudson, Bottineau
 H. E. Murphy, Dickinson

They also recommended that the present membership of the Publication Committee be continued.

By vote of the Academy the candidates listed were unanimously elected.

The meeting adjourned at 11:55 a.m. to hold the next meeting at the Agricultural College in May, 1952. Following adjournment, luncheon was served in the University Commons. Twenty one visiting members were guests of the University at this luncheon.

J. DONALD HENDERSON,
 Secretary-Treasurer.

SULFUR IN NORTH DAKOTA LIGNITE

III Humic and Resinic Sulfur†

Alex C. Burr and M. M. Jaffer

College of Engineering, University of North Dakota

This paper is one of a series dealing with sulfur in North Dakota Lignite. Two previous papers have dealt with the general problem and the resolution of the inorganic sulfur content.^{1 2} This paper deals with the resolution of the organic sulfur content into the humic and resinic fractions.

† Based upon a thesis by M. M. Jaffer, submitted to the Graduate Division of the University of North Dakota in partial fulfillment of the requirements for the Degree of Master of Science in Chemical Engineering.

behavior of each form thus differentiated. These methods of classification which are frequently used are:

The authors wish to acknowledge the willing and valuable assistance of Miss Adelynn Magnusson in the proximate analyses and Btu determinations; and of Mr. John Rasmusson on the field trip.

I. Introduction

Many efforts have been made to resolve the total sulfur content of solid fuels into component parts, and to explain the origin and

- A. Depending upon reaction during carbonization
 1. Fixed Sulfur—that remaining in the coke or char after carbonization.
 2. Volatile Sulfur—that eliminated during carbonization.
- B. Depending upon reaction during combustion
 1. Non-combustible Sulfur—that remaining in the ash after combustion.
 2. Combustible Sulfur—that eliminated during combustion.
- C. Depending upon reaction during analysis
 1. Inorganic Sulfur
 - a. sulfate sulfur
 - b. pyritic sulfur
 2. Organic sulfur
 - a. Humic sulfur
 - b. resinic sulfur

In this series of papers the third classification has been used.

II. The Samples

Eight samples of lignite have been used in the investigation. Table I identifies them and gives the proximate analysis on the air-dried moisture-free basis.

Table 1.—Proximate Analysis of Samples

Sample No.	Mine	County		Moisture	Ash	Volatile Matter	Fixed Carbon	BTU	Total Sulfur
1	Noonan	Divide	air dried	13.5	9.2	36.1	41.2	9662	1.340
			moisture free	—	10.6	41.7	47.7	11170	1.552
2	Columbus	Burke	air dried	16.1	12.3	35.8	35.8	8657	0.470
			moisture free	—	14.7	42.7	42.7	10318	0.563
3	Velva	Ward	air dried	20.8	7.5	34.0	37.7	8392	0.528
			moisture free	—	9.5	42.9	47.6	10596	0.666
4	Custer	McClean	air dried	20.2	5.0	35.9	38.9	8728	0.470
			moisture free	—	6.3	45.0	48.7	10937	0.590
5	Garrison Dam	McClean	air dried	16.5	7.5	39.5	36.5	8999	0.726
			moisture free	—	9.0	47.3	43.7	10777	0.861

6	Hazen	Mercer	air dried	20.0	5.4	38.8	40.8	8670	0.250
			moisture free	—	6.8	42.3	50.9	10838	0.313
7	Beulah	Mercer	air dried	22.6	5.5	33.3	38.6	8574	0.689
			moisture free	—	7.1	43.0	49.9	11077	0.792
8	Zap	Mercer	air dried	17.3	10.5	34.8	37.4	8689	0.905
			moisture free	—	12.7	42.1	45.2	10507	1.096

These samples were taken by the junior author while on a field trip, and were taken by the standard A. S. T. M. method. Previous data available indicates that the samples used, with the exception of No. 1, are representative within the limits of sampling error.

III. Methods of Analysis for Sulfur and its Forms

Standard methods of analysis were used throughout. Three to six determinations were made on each sample. Total sulfur was determined directly by both the Eschka and the turbidimeter methods. Except at very low and very high concentrations of sulfur, the agreement was good. Inorganic sulfur was determined directly by the Powell and Parr (PP) method and by the British Coke Research Association (BCRA) method. Fair agreement, within the sampling error, was found over the range covered. Sulfate sulfur was also determined directly by both PP and BCRA methods, and fair agreement was found. Pyritic sulfur was determined by difference, subtracting the directly determined sulfate sulfur from the directly determined inorganic sulfur.

Organic sulfur was determined by difference by subtracting the directly determined inorganic sulfur from the directly determined total sulfur. Resinic sulfur was determined indirectly by subtracting from the directly determined total sulfur the total sulfur remaining in the residue of the sample extracted with phenol. The difference represents the phenol-soluble, or resinic sulfur. Humic sulfur was determined by difference by subtracting the resinic sulfur from the organic sulfur.

IV. Discussion of the Results

The results of this investigation are presented in Tables II and III.

Table II—Forms of Sulfur in North Dakota Lignite

No.	Sample	Percent of Weight of Sample—dry basis						Total Sulfur
		Sulfate Sulfur	Pyritic Sulfur	Inorganic Sulfur	Resinic Sulfur	Humic Sulfur	Organic Sulfur	
1	Noonan	0.054	1.333	1.387	0.082	0.083	0.165	1.552
2	Columbus	0.030	0.053	0.083	0.005	0.475	0.480	0.563
3	Velva	0.047	0.174	0.221	0.061	0.384	0.445	0.666
4	Custer	0.222	0.082	0.104	0.048	0.438	0.486	0.590
5	Garrison Dam	0.057	0.190	0.247	0.132	0.482	0.614	0.861
6	Hazen	0.039	0.075	0.114	0.005	0.194	0.199	0.313
7	Beulah	0.046	0.133	0.179	0.013	0.601	0.613	0.792
8	Zap	0.092	0.784	0.876	0.035	0.185	0.220	1.096
	Average	0.048	0.353	0.401	0.048	0.335	0.403	0.804

Table III—Forms of Sulfur in North Dakota Lignite

No.	Sample	Percent of Total Sulfur—Dry Basis					
		Sulfur Sulfate	Sulfur Pyritic	Sulfur Inorganic	Sulfur Resinic	Sulfur Humic	Sulfur Organic
1	Noonan	3.5	85.8	89.3	5.3	5.4	10.7
2	Columbus	5.3	9.4	14.7	1.0	84.3	85.3
3	Velva	6.9	26.0	32.9	9.8	57.3	67.1
4	Custer	3.7	13.9	17.6	8.3	74.2	82.5
5	Garrison	6.7	22.0	28.7	15.4	56.0	72.4
6	Hazen	12.5	24.0	36.5	1.5	62.0	63.5
7	Beulah	5.8	16.9	22.7	1.6	75.8	77.4
8	Zap	8.4	71.5	79.9	3.2	16.9	20.1
	Average	6.6	33.7	40.3	5.8	54.0	59.9

Humic Sulfur/Resinic Sulfur=9.3

The following conclusions are reached after the study of Tables II and III:

- A. The total sulfur reported is well in line with the values previously reported for samples from adjacent mines.¹ (See Table II).
- B. The proportion of sulfur occurring as inorganic sulfur is in accord with previous results.¹ (See Table III).
- C. The proportion of total sulfur occurring in the sulfate form, probably CaSO_4 , is in accord with previous results.¹ (See Table III)
- D. The proportion of pyritic sulfur is in accord with previous results.¹ (See Table III)
- E. The proportion of organic sulfur is in accord with previous results.¹ In view of conclusion A and B and the methods of determination, this is to be expected. (See Table III)
- F. The foregoing conclusions indicate that, within the error of sampling, these samples are representative, at least as far as sulfur is concerned.
- G. The proportion of humic sulfur averages 9.3 times the proportion of resinic sulfur, although there is considerable variation in this ratio. (See Table III)
- H. The proportion of the total sulfur occurring as humic sulfur is much smaller when the proportion of pyritic sulfur is high. (See Table III)
- I. The proportion of total sulfur occurring as resinic sulfur shows far less variation and seems to be independent of the proportion of pyritic sulfur. (See Table III)

No similar data are available on other American lignites. However, comparison may be made with other American coals⁴; with Indian coals³, including a few samples of lignite; and with Chinese coals.⁵

Powell and Parr⁴ have reported data on Illinois coal. Table IV provides a comparison with North Dakota Lignite.

Table IV.—Sulfur in Illinois Coal
(Percent of total Sulfur—Dry Basis)
Calculated from Data by Powell and Parr⁴
Distribution of Sulfur

No. of Sample	Percent Sulfur	Sulfate Sulfur	Pyritic Sulfur	Inorganic Sulfur	Resinic Sulfur	Humic Sulfur	Organic Sulfur
1	2.68	1.5	52.0	53.5	15.6	31.0	46.6
2	2.18	7.8	72.5	80.3	6.9	12.8	19.7
3	0.64	0.0	26.6	26.6	31.3	42.1	73.4
4	2.14	2.3	33.6	35.9	15.9	48.5	64.4
5	5.00	26.2	40.5	66.7	15.5	17.8	33.3
6	3.31	0.3	62.3	62.6	15.1	22.3	37.4
7	1.02	1.0	78.2	79.2	9.9	10.8	20.7
8	1.40	0.0	53.5	53.5	15.0	31.4	46.4
9	0.94	2.1	33.0	35.1	12.8	52.1	64.9
10	1.20	20.8	33.3	54.1	12.3	32.5	45.8
Average	2.05	6.2	48.6	54.8	15.1	30.1	45.3

Humic Sulfur/Resinic Sulfur=2.0

In general, the sulfur content of Illinois coal is considerably higher than that in North Dakota Lignite. More significant is the much higher proportion of pyritic sulfur in the Illinois coal as compared with lignite. The proportion of sulfate sulfur averages approximately the same in Table III and V, and is extremely variable in both. A much higher fraction of the total sulfur occurs in the organic form in the lignite than in the Illinois coals. In both sets of data the proportion of sulfur in the humic form is distinctly higher than that in the resinic form, the ratio being 2.0 for Illinois coal and 9.3 for North Dakota lignite.

Majumdar has reported data on a number of Indian coals, including three lignites. A representative selection of his data is presented in Table V.

Table V.—Sulfur forms in Indian Coals and Lignites
Data of Majumdar⁸
Percent of Total Sulfur

No. Sample	Percent Sulfur	Distribution of Sulfur			
		Sulfate	Pyritic	Inorganic	Organic
1 Palana Lignite	3.02	8.7	14.0	26.7	77.3
Bikaner					
Rajputana					
2 Palana Lignite	9.09	46.4	40.1	86.5	13.5
Bikaner					
Rajputana					
3 Kashmir Lignite	0.54	11.1	24.1	35.2	64.8
4 Dishergarh	0.29	3.5	24.5	28.0	72.0
Raniganj					
5 Baraker	0.62	1.6	6.4	8.0	92.0
Jharia					

6	Makerwal Punjab	5.10	23.7	14.0	37.7	62.3
7	Naga Hills Assam	2.78	29.1	17.6	46.7	53.3
8	Naga Hills Assam	4.80	54.5	7.9	62.4	37.6
	Average	3.28	22.3	18.3	41.4	59.1

The total sulfur in Indian coals and Lignite is also higher than that in North Dakota lignite; however, the fraction in the inorganic form is about the same. Therefore, the fraction occurring in the organic form is about the same. The pyritic sulfur is distinctly lower in the Indian coals, and the sulfate sulfur distinctly higher than in North Dakota lignite.

Young has reported data on Chinese coals, Table VI allows a comparison with North Dakota lignite.

Table VI
Sulfur Forms in Chinese Coals
(Percent of Total Sulfur—dry basis)
Based on Data of Young⁵

No.	Sample	% Sulfur	Distribution of Sulfur					
			Sulfate	Pyritic	Inorganic	Resinic	Humic	Organic
1	Shantung	2.86	8.8	38.8	47.6	4.9	47.5	52.4
2	Hopei	0.65	3.2	14.9	18.1	1.6	80.1	81.7
3	Hopei	1.43	5.6	56.3	61.9	0.8	37.3	38.1
4	Chahar	0.76	7.8	55.8	63.6	6.5	30.0	36.5
5	Hopei	0.78	2.5	28.7	31.2	7.5	61.3	68.8
6	Honan	0.84	9.6	26.5	36.1	9.6	54.3	63.9
7	Shantung	0.78	28.8	2.5	31.3	25.0	43.8	68.8
8	Hopei	0.97	12.5	14.6	27.1	20.8	52.0	72.8
9	Hopei	1.39	12.1	29.3	41.4	17.1	41.5	58.6

10	Anhwei	5.47	0.9	70.4	71.3	8.0	20.8	28.8
11	Anhwei	1.66	4.2	58.1	62.3	8.5	29.1	37.6
12	Shansi	0.57	0.0	14.3	14.3	1.7	84.0	85.7
13	Hunan	0.65	0.0	1.5	1.5	12.3	86.1	98.4
14	Chekiang	3.35	6.6	45.5	52.1	14.7	33.3	48.0
15	Kiangsi	0.54	0.0	14.8	14.8	11.1	74.0	85.1
	Average	1.51	6.8	31.5	38.3	10.0	51.7	61.7

Humic Sulfur/Resinic Sulfur=5.2

Table VII

Sulfur Distribution in Various Coals

	N. Dak. Lignite	Illinois Coal	Indian Coal	Chinese Coal
Total S	0.804	2.05	3.28	1.51
Sulfur Distribution				
1. Sulfate	6.6	6.2	22.3	6.8
2. Pyritic	33.7	48.6	18.3	31.5
3. Inorganic	40.3	54.8	41.4	38.3
4. Humic	54.0	30.1	—	51.7
5. Resinic	5.8	15.1	—	10.0
6. Organic	59.9	45.3	59.1	61.7
7 Humic/Resinic	9.3	2.0	—	5.2

Again, the total sulfur in Chinese coals is higher than in the North Dakota lignite. The fraction of the sulfur occurring in the inorganic form is slightly less in the Chinese coal than in our lignites. The proportions occurring in the sulfate and pyritic forms are similar. The proportion of Humic to Resinic sulfur is 5.2 in Chinese coals and 9.3 in the lignite. See Table VI.

V. Conclusion

From this comparison, it is seen that one outstanding characteristic of North Dakota lignite is the high ratio of Humic to Resinic sulfur. This fact may be related to the relative youth, in a geologic sense, of these lignites and to the absence of reactions due to great pressure during the coalification process.

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“BREAD STALING PROBLEMS, AND THE EFFECT OF POTATO FLOUR”

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The bread staling problem has interested cereal chemists for some time. Katz in Holland first studied the problem from the stand point of changes in crumb hydration. His chief stimulus was sociological, to eliminate the need for night baking so bread could be delivered fresh each day to the consumer. In 1917 the United States Food Administration estimated that the return of stale bread accounted for an annual loss of more than 600,000 barrels of flour, equivalent to 2,700,000 bushels of wheat. In normal times, annual losses have been as high as 3.0 to 4.7% of the total production. In time of war these losses have become very important because of the desirability of bread in field rations and have stimulated the search for staling preventatives.

During staling the compressibility of the crumb decreases while the ability of the crumb to imbibe water also falls. The amount of water soluble starch decreases with aging. Katz found that the volume of sedimented crumb from aqueous suspension varied inversely with age of bread. Cathcart later used centrifugal force to cause sedimentation rather than gravity, and thus decreased the length of time required for the determination. In America substantial losses have been attributed to staling. Analysis by X-ray has indicated a change from V-pattern to a B-pattern superimposed on a B-pattern as bread ages. Starch of stale bread is less subject to enzyme attack, and changes in crumb crumbliness also occur during staling. Laboratory methods have been devised, employing techniques based on these biochemical changes, to measure the staling rate of bread.

Probably the measurement of crumb firmness possesses the greatest value of any of the objective methods for determining crumb staling rate, although other methods likely yield more information regarding what is actually occurring in the crumb. It is surmised that staling consists essentially in a transfer of moisture from the starch

to the gluten content. No loss of moisture from the loaf as a whole necessarily occurs during staling.

An apparatus designed for detecting the tenderness of cooked macaroni objectively was employed for ascertaining crumb firmness in terms of force required to produce a constant depression in the crumb. Changes in bread crumb hydration were determined by preparing an aqueous suspension of comminuted bread crumb and determining the moisture content of representative portions of the centrifuged residue.

Briefly, it was found that cooked potato flour markedly increased crumb firmness, and tended to retard changes in firmness with age of bread. Potato also increased the hydration of the crumb but did not retard moisture loss from the crumb as the bread aged. Generally potato constituents improved water absorption and loaf volume, but impaired crumb color and texture slightly.

“A NEW METHOD FOR MEASURING CHANGES IN BREAD STALING BY CHANGES IN CRUMB HYDRATION”

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Since the staling of bread is a complex transformation, its progress is evaluated frequently in a quantitative way by measuring one or more of the several progressive changes in properties which take place as bread ages. As bread stales, the ability of the crumb to absorb water decreases. A photo-electric method was devised based upon this change in colloidal properties. The apparatus consisted of two photo-electric cells mounted at right angles to a voltage regulated light source. The cells were connected in parallel to a sensitive galvanometer with a variable resistance shunted across the line. Readings of the reflected light from the suspended crumb were recorded as changes in galvanometer deflections per unit of time. The optical system was enclosed to prevent any possible error from light leakage from an outside source.

As the hydration decreases, it is assumed that the specific gravity of the crumb is increasing. Therefore, if all other factors can be held constant, the velocity of the fall must be proportional to the specific gravity of the falling particle: however, a curvilinear relationship indicated the velocity is also influenced by differences in particle size. When the change of galvanometer deflection was plotted against time on a logarithmic scale an approximately linear relationship was obtained. It was noted that the slope of this curve increased as the bread staled. Values denoting the slope were used to express the staling rate of the crumb as the bread ages.

The hydration of the crumb was used for a comparison because

this property seemed to be most closely related to the value obtained by the proposed method. A highly significant negative correlation (0.620) was obtained between results from the two methods.

The following points were investigated for the standardization of the method: crumb preparation and concentration; replicability; method of bread storage; and the effect of different moisture levels of bread of the same age.

“THE LIQUEFYING POWER OF ALPHA AMYLASE ON GELATINIZED STARCH”

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A photo-electric apparatus was designed to record the gelatinization curves of starches heated at a uniform rate. Preliminary results showed that by using this instrument on gelatinized starch, it might be possible to quantitatively measure the liquefying activity of alpha-amylase.

The development of the method required information on the influence of gelatinization temperatures of starches, the kind or type of starch, pH of the substrate, substrate and enzyme concentration, reaction temperatures, and replicability of the results.

The use of a gelatinized, unmodified starch requires more care in preparation than a soluble starch substrate. Data, represented graphically, suggested optimum conditions for maximum alpha amylase activity. Optimum conditions which were selected are: gelatinization temperature—50° C.; pH 5.5; and substrate concentration 1.0%. The selection of these values was based upon:

1. Replicability at this temperature.
2. Attainment of definite end point.
3. Rate of change is fast enough to be almost linear, yet is slow enough to be read with accuracy on the photometer.
4. Minimum destruction of alpha amylase.
5. Wider range of operation permissible.

The substrate may be used immediately, but can not be used later than 5 hours after preparation. After five hours, enzymatic activity decreased due to retrogradation of the starch gel, rendering the substrate useless.

In the final analysis, an attempt will be made to evaluate an enzyme activity unit in a manner similar to Jozsa and Johnston, that is, an activity unit based on the milligrams of starch converted per unit of time. The data has shown that a suitable and easily duplicated substrate can be made from day to day. This will be used as a basis for a new method for the determination of alpha amylase. Further work will show whether the method has equal accuracy, greater range and sensitivity than the Wohlgemuth method which is most generally used.

ABNORMAL PATTERNS IN ELECTROPHORETIC PROCEDURES

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Optical analysis and photographic recordings of protein concentration gradients can be produced by electrophoresis. Before initiating protein analysis by electrophoresis, certain mechanical procedures are necessary. Loading and handling of the electrophoretic cell must be done with care since errors in assembly of these units may result in faulty patterns. Dialysis of protein constituents should be carried out for at least two to three days. Buffers must be made with care, and the ionic strength calculated exactly. All experiments should be carried out at approximately 1.5°C. Defects in the glass cell components will result in bizarre patterns.

Abnormal patterns develop as a result of the following difficulties: convection currents produce ripples in the Schlieren lens system; some proteins are not easily soluble at lower temperatures and must be analyzed at 20°C.; alternating current ripples in the power supply cause distortions of the patterns; improper greases for connecting the cell may mix with the proteins and cause abnormal patterns; curvature of the lamp filaments causes ghost images on the baseline; the silver electrodes should be coated when spotty or discolored, otherwise improper milliamperage results; certain anomalies may arise through interaction between various colloidal components; stationary boundary anomalies may be caused by the supernatant buffer of slightly lower ionic strength than that of the underlying colloid-buffer mixture; and the use of improperly saturated potassium chloride or potassium chloride of impure composition, will lead to differences in electrical potentials.

THE DIAGNOSTIC SIGNIFICANCE OF ELECTROPHORETIC SERUM PROTEIN FRACTIONS IN HEPATO-BILIARY DISEASES

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The serum protein fractions determined by electrophoresis (in 25 normal people, 139 patients with hepatic diseases, and 14 patients with other diseases) revealed diverse tendencies in different hepatobiliary diseases. The diagnostic significance of these tendencies and of various chemical and electrophoretic albumin/globulin ratios was investigated.

Serum albumin was markedly reduced in all hepato-biliary diseases, including obstructive jaundice in which the decrease paralleled the drop of the cholesterol ester ratio. The decrease was especially

marked in cirrhotics, and more so in those with than without ascites. However, in general, the albumin level had little diagnostic significance. The previously reported tendency of the alpha globulins to rise when the albumin level decreases was often absent, possibly due to failure of the hepatic cells to synthesize alpha globulins. This results in a wide spread of their distribution in hepato-biliary diseases. The beta globulins were, as a rule, elevated. The gamma globulins were elevated in most hepato-biliary diseases, only slightly in obstructive jaundice, somewhat more in acute hepatitis and in cirrhosis without jaundice. The total globulin level revealed little diagnostic significance because the alpha globulins were markedly elevated in obstructive jaundice and the gamma globulins in hepatitis and cirrhosis.

The erratic trends of the alpha globulins in liver damage render the electrophoretic albumin level diagnostically more informative than the sum of albumin plus alpha globulin (this sum follows more closely the results of the salt partition of Howe than does the electrophoretic albumin). The sum of beta plus gamma globulin (simulating Howe's globulins.) was more informative than the electrophoretic total globulins. Thus the albumin/globulin ratios as determined by electrophoresis and by the chemical method of Howe do not differ much in the diagnostic evaluation of hepatobiliary diseases, and especially in the differential diagnosis between surgical and medical jaundice. The electrophoretic albumin/gamma globulin ratio is, however, of value in the differential diagnosis of hepatobiliary diseases. This is of clinical importance, since by simple salt partition methods a ratio can be determined which is almost identical with the electrophoretic albumin/gamma globulin ratio.

SCIENTIFIC NOMENCLATURE IN THE HANDBOOK OF NORTH DAKOTA PLANTS

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The author of a botanical paper, if not primarily concerned with establishing the identity of the plants discussed, must adopt some authority for the names used in his paper. The most common method is to accept those used in a well known manual. If this manual has been some years in print, changes will have been made and some may have been generally accepted. It becomes a question whether or not to follow the old book literally and thus use names which are actually quite out of date. Usually the author has a few ideas of his own and especially in cases of doubt he will feel either free or obligated to follow his own judgement.

In the present case Gray's Manual was being revised and the date of appearance of the new edition was unknown. The old one was more than forty years old and many changes were being made. Many

revisions had been published in Rhodora by the author of the new edition, by his students and associates and also by others with whose views he might or might not concur.

A decision was made to approach the nomenclature of the new Gray as far as possible. This was made easier by the recent list of Minnesota plants by Tryon and Moore which had allegedly brought the names up to that point. After checking through this list a number of names remained in question. Actually the new Gray appeared in July and the Handbook in December. It would have been possible to have inserted a list of addenda but so many questions would have remained that it seemed best to make no comment and leave the corrections for a later date when the results of various studies would be further tested.

West of the Missouri River we find a number of species which belong to the Great Plains and do not occur in eastern or even central United States. The great majority of North Dakota plants are species which occur in central or eastern United States or have a transcontinental distribution. The range of Gray's Manual includes Minnesota but not North Dakota. Thus eastern North Dakota is essentially included without guarantee. The author was not familiar with Minnesota and its treatment obviously lacks the detail given to the New England states.

The Manual recognizes numerous varieties, these oftentimes admittedly "confluent". The Handbook mostly ignores these as beyond its scope. There was also the more complicated question of whether these varieties extend through North Dakota or whether its forms represent still other varieties or species not yet described. To attempt to include them (as well as many species names in the Manual) would involve a thorough restudy of much of the material.

A few examples would illustrate some of these various difficulties. Our common native dock has been called **Rumex mexicanus**. Reehinger separated it from the plant as **R. triangulivalvis**. The present writer hesitated to use the latter name for no very good reason and in this he chanced to be upheld by the Manual. The status of **Steironema** was a puzzle. The genus was maintained in the Minnesota list but many authors combined it with **Lysimachia**. The Handbook, usually conservative, followed the latter course which is maintained in the Manual.

In other cases the results were not so fortunate. The Red-seeded Dandelion had been changed from **Taraxacum erythrospermum** to **T. laevigatum**, an older name. The manual restored **erythrospermum** on the basis that **T. laevigatum** is a different species. The Goatsbeard which has become so widely established in North Dakota had been shown to be not **Tragopogon pratensis** but a different species for which the name **T. dubius** was used. The manual, however, uses **T. major** which is regarded as distinct from **T. dubius**. Our Marsh Skullcap, had been considered the same as the European **Scutellaria galer-**

iculata. One reviser considered it distinct and used **S. epilobifolia**. This had not been too well accepted and it seemed likely that the Manual would follow the more conservative view. However, it appeared as **epilobifolia**, "differing consistently from the Eurasian **S. galericulata** in the low pebbling of the nutlets", a seemingly trivial character.

Authors continue to differ on specific and generic limits and on application of rules. This was further illustrated by the appearance in February 1951 of a revised edition of Hitchcock's "Manual of Grasses of the United States". Our Yellow Pigeongrass had long been known as **Setaria glauca**. In 1916 this was rejected as applying to an entirely different plant and since that date **S. lutescens** had been generally used. The new Gray goes back to **S. glauca**, branding **lutescens** as "invalid" though it is retained in the new Hitchcock. This case has recently been discussed by Reeder (Rhodora Jan, 1951) in favor of **glauca**.

In like manner our Stinkgrass had progressed from **Eragrostis major** through **E. megastachya** to **E. cilianensis**. It now slips back one notch in one book but not in the other. Sheep's Fescue appears in the new Gray as not native to America but a similar western species, **Festuca saximontana** is recognized as native. In 1950 we collected specimens in McHenry County which seemed distinctly native. These are the same species as that of Europe according to the new Hitchcock which gives no cognizance to **saximontana**.

NUCLEAR TRACKS AS PRODUCED IN CONTINUOUSLY SENSITIVE CLOUD CHAMBERS AND PHOTOGRAPHIC EMULSIONS

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INTRODUCTION

The primary effect of nuclear particles, whether produced in cosmic rays, natural and artificial radioactivity or nuclear explosions, is ionization. By ionization, we mean the removal of negative electricity from an atom or molecule, leaving the atom or molecule with a net electric charge.

These ionized atoms may be detected by several devices. Two of these devices, cloud chambers and nuclear emulsions, will be discussed in this paper.

The evidence for the nuclear particles is thus a trail of water droplets formed on the charged ions which are left in the wake of the nuclear particle as it traverses the cloud chamber or a track of developed silver grains in the photographic emulsion.

All cloud chambers operate on the principle of maintaining a supersaturated vapor region in which condensation takes place upon ions

formed by charged particles traversing the supersaturated medium. Since the expansion type cloud chambers produce this supersaturated region through the cooling effect of an adiabatic expansion it is essentially intermittent in its action.

Many modifications of the expansion cloud chamber have been successfully developed but they all contain the inherent defect of being insensitive during the greater portion of the operating time.

As nuclear phenomena are random in nature and must be treated statistically it seemed highly desirable to have some means of providing a continuously sensitive cloud chamber where this randomness could be uniquely shown. Some method other than adiabatic expansion had to be applied in order to construct an apparatus capable of maintaining a continuously sensitive region in which tracks of all events would be visible.

To this end Alexander Langsdorf, Jr. made a notable contribution¹ but his chamber was too complicated to be universally useful. Recently, however, others² have developed a continuously sensitive cloud chamber which is relatively simple in design and construction.

CONSTRUCTION OF CONTINUOUSLY SENSITIVE CLOUD CHAMBER

The cloud chamber to be reported on here operates upon the principle of thermal diffusion of alcohol vapor from a warm to a cold surface. Within the chamber is a horizontal region of supersaturated alcohol vapor where condensation takes place upon ions.

The chamber is 9 x 9 x 5 inches and is constructed entirely of non-magnetic materials. The top and bottom are sheet aluminum. Three of the rectangular sides are plexiglass while the back side is bakelite. The bottom is coated with black asphaltum which makes a good background for viewing tracks from a plexiglass window in the top while the black rear wall permits easy viewing of verticle cosmic ray tracks. The chamber may be illuminated from either side by a collimated beam of light. Black velvet soaked with alcohol and fastened to the underside of the aluminum cover serves as a vapor source. Diffusion of alcohol vapor takes place vertically downward when the bottom plate is cooled by contact with dry ice. The dry ice is held against the underside of the chamber by another plate forced upward with compression springs on the legs of the chamber. Extending downward into the chamber are bakelite rods, one in each corner, which support a grid. This whole grid assembly is fastened to the cover and is removed from the chamber with the cover. This permits access to all the parts and to the inside of the chamber itself. The grid is kept at a positive potential with respect to the top and bottom. An electric field of about 100 volts per centimeter is maintained in the upper and lower regions of the chamber.

As the chamber is put into operation condensation starts taking place upon dust particles present in the atmosphere of the chamber. This causes a general rainfall and continues for a few minutes until all the dust has been removed. As the temperature of the bottom

approaches that of dry ice a supersaturated region is formed in the lower half of the chamber. It is within this sensitive region that tracks of nuclear particles are visible.

A study of cloud chamber photographs may enable one to determine the type of particle creating the track. Since charged particles are bent in a circular path when traveling at right angles to a magnetic field, additional information can be determined by placing the cloud chamber in a magnetic field.

Tracks of nuclear particles from naturally radioactive substances and cosmic ray activity are easily observed within this cloud chamber.

PHOTOGRAPHIC EMULSION TECHNIQUE

Another method of detecting and recording nuclear particle events is the photographic emulsion technique.³ Fine grained emulsions that are sensitive to nuclear radiations are being produced by Illford Company and Kodak, Ltd., in England and by Eastman Kodak Company in America.⁴

These nuclear track plates, as they are commonly called, are manufactured in a standard size of 1x3 inches which is a convenient size for microscopic study. The plates have emulsion on one side ranging in thickness from 10 to 300 microns. The emulsions are essentially mixtures of gelatin and silver bromide and differ from ordinary photographic emulsions. In the nuclear emulsions the grains are very fine and are separated by gelatin where as in the ordinary photographic emulsion the grains are in contact.

These nuclear emulsions are either exposed to a source giving off nuclear particles or are impregnated with a natural radioactive substance. In either case the charged particles traversing the emulsion alter the silver grains and make them developable. The resulting tracks are then observed under magnification and the characteristics noted. This information may lead to a determination of the type of particle causing the track and the energy associated with it. Even though a nuclear track might be long in air it will be very much shorter as recorded in the emulsion because of the high stopping power of the nuclear type emulsion. These plates are suitable for cosmic ray study by exposing them to cosmic radiation at high altitudes.

Standard Eastman NTA plates covered with emulsion 50 microns thick have been used by the author. Some of these plates have been soaked in a 1% thorium nitrate solution for a few minutes in the dark room, rinsed and dried, and kept in the dark for sufficient time for alpha particles emanating from the thorium atoms while disintegrating to be registered in the photographic emulsion. When processed, these plates exhibit under the microscope, typical thorium stars as will be shown.

NTA plates have also been exposed to and impregnated with a weak source of Polonium which is a radioactive material emitting alpha particles.

With special fission sensitive plates the author plans to study individual nuclear explosions.

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NORTH DAKOTA VOLATILE OILS II—CORIANDER OIL

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During the past several years the School of Pharmacy at North Dakota Agricultural College has been studying the production of certain volatile oils with the possible view of large scale development. It is the purpose of this paper to present data describing Coriander Oil, a volatile oil obtained by steam distillation from the dried ripe fruit of *Coriandrum sativum*. This volatile oil is of considerable importance as a condiment and flavor.

The coriander fruit was grown on the experimental farm at North Dakota Agricultural College and was harvested in late September with a calculated yield of 980 pounds per acre. Steam distillation yielded 0.38 per cent of volatile oil on a moisture free basis. No cohobation of the aqueous distillate was carried out.

TABLE ONE

PHYSICAL CONSTANTS OF CORIANDER OIL

	North Dakota Coriander Oil	U. S. P Grade Coriander Oil
d_{20}^{20}	0.8688	0.863 to 0.875
$(n)_D^{20}$	1.4610	1.4620 to 1.4720
$(a)_D^{20}$	+10.1°	+8° to +15°
Solubility in 70% alcohol	3 volumes	3 volumes

EXPERIMENTAL

Physical Properties. The oil was a pale yellow liquid with a sweet odor and a characteristic taste. The physical constants of the oil after drying over anhydrous sodium sulfate are recorded in Table I, and for comparison average values of U. S. P. grade Coriander Oil are included.

Chemical Properties.

Acid Value:- Negligible.

Alcohols:- Coriandrol was identified through its p-nitrobenzoate derivative, m.p. 234-235°, and authentic sample of coriandrol p-nitrobenzoate melted at 234-235°. A sample of the oil was acetylated and the saponification value of the acetylated product determined in the usual manner and calculated as Coriandrol gave a value of 49.1 per cent.

Phenols:-Negative.

Aldehydes:- A sample of the oil when treated with a solution of 2, 4-dinitrophenylhydrazine at room temperature gave an orange-red colored precipitate which after recrystallization gave crystals melting at 96-97°. The literature (1) reports citral 2, 4-dinitrophenylhydrazine to melt at 96-97°. The presence of citral may be explained by the oxidation of coriandrol. No quantitative estimation of citral was attempted.

Esters:- Saponification of the oil with alcoholic potassium hydroxide in the usual manner showed the presence of 8.1 per cent of esters calculated as coriandrol acetate.

CONCLUSIONS

1. Coriander Oil of U. S. P. quality can be obtained from the fruit of *Coriandrum sativum* in yields which are economically feasible.
2. The volatile oil contains 49.1 per cent of coriandrol and 8.3 per cent of coriandrol acetate.

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CORIANDER FRUIT—A POTENTIAL LIVESTOCK FEED

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The production of Coriander Oil by steam distillation of the dried ripe fruit of *Coriandrum sativum* gave as a by-product large quantities of the exhausted fruit. From an economic viewpoint, utilization of the spent fruit would materially aid in the furthering of the volatile oil production program in North Dakota. A survey of the literature(1) disclosed that on the European continent the spent ripe fruit of *coriandrum sativum* had and is being used as a livestock feed. Since no mention was found of a similar use in this country, it was felt that

a chemical analysis of the fruit after oil removal would provide data of value in determining its possible use as a supplementary livestock feed.

A representative sample of the fruit after completion of steam distillation was dried to constant weight in a circulating air oven and used for the subsequent chemical analyses. The results of the several tests are listed in Table I and the procedures used were either those official in the United States Pharmacopoeia or the Methods of Analysis—A. O. A. C. All results are expressed on a moisture-free basis. The ash and acid-insoluble ash analyses were carried out in the usual manner(2). Approximately 2 gram samples were used and incinerated at a low temperature until a carbon free ash was obtained. The determination of acid-insoluble ash was accomplished with diluted hydrochloric acid.

The filtrate from the acid-insoluble ash was tested for anion and cation constituents which might normally be present in a plant or fruit. Positive tests were obtained for iron, sulfate, potassium, calcium, aluminum, phosphate, and magnesium. Chlorides were identified on a separate sample. A negative test was obtained for selenium (3).

Total nitrogen was determined by the Kjeldahl Method. (4). Two gram samples were used for this determination. The figure listed in the table is the average figure obtained from duplicate assays. The value for crude protein was obtained by multiplying the result of the total nitrogen determination by 6.25 (5).

The figures for the carbohydrate analysis were determined according to the technique outlined by the A. O. A. C. (6). A 25 cc. aliquot was taken for the reducing sugar determination using copper sulfate and alkaline tartrate solutions as the quantitative reagents. No invert sugar was found after inversion of the original hydroalcoholic extract with hydrochloric acid. Starch was determined by the A. O. A. C. procedure (7).

The amount of crude fiber (8) was determined on the material residues left after extraction with ether in the fat determination. The value for fat was taken to be the same as the total ether soluble extractive (9).

TABLE ONE
CHEMICAL ANALYSIS OF CORIANDER FRUIT

Ash	4.21
Acid-insoluble ash	1.62
Nitrogen	2.11
Crude protein	13.19
Crude fiber	47.85
Fat	8.05
Reducing sugars	2.06
Starch	15.51
Volatile matter	5.36

CONCLUSIONS

1. A chemical analysis of the spent ripe fruit of *Coriandrum sativum* has been made.
2. The absence of selenium has been established.
3. Plans are under way to have feeding tests carried out using the exhausted Coriander Fruit as a supplementary feed.

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SOME TYPE DIFFERENTIAL FERMENTATION REACTIONS OF PASTEURELLA MULTOCIDA

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Introduction

Specific information as reported (1), (2), (4), (8), (10) is often uncertain in regard to the biological properties of the species *Pasteurella multocida*. Authorities (*ibid*) agree there is a certain homogeneity in the species. However, many investigators (3), (5), (6), (7) show the species contains bacterial types possessing a variety of properties, which is confusing. It seems that a differentiation of all possible types within the group and a study of their character is essential to a fundamental understanding of the species.

Previously, the bacteria in the group were distinguished as to source, (8) that is according to the species of animal having the hemorrhagic syndrome. At present, these bacteria are all placed in the species of *Pasteurella multocida* (1) regardless of the animal source. Attempts of others (3), (5), (6), (9) show that differentiation of types within the species by either serological or biochemical means is not accomplished with uniformity. However, Rosenbusch and Merchant on the basis of the fermenting capacity of d-xylose, l-arabinose, and dulcitol were able to distinguish two fermenting types. From the data of Roberts, the same substrates differentiate

three fermenting types. It would appear that other types may be differentiated by the fermentations of these substances.

Procedures

The use of these three fermentable compounds permits eight possible combinations of fermentation reactions. Consequently, the possibility of detecting eight types on this basis is limited by the number of substrates used. Accordingly, the use of these three substrates permits the following possible combinations of fermenting-types.

TABLE I

Possible Fermenting-Types on Three Substrates								
Substrate	A	B	C ¹	D	E ³	F	G ²	H
d-Xylose	+	+	+	—	—	—	—	+
l-Arabinose	+	+	—	—	+	—	+	—
dulcitol	+	—	—	—	+	+	—	+

(1) Roberts Type I; Merchant Type II

(2) Roberts Type II

(3) Roberts Type III; Merchant Type I

As seen in the table, the lettering of the possible fermenting-types is entirely arbitrary.

The cultures we have studied have shown differences in cultural characteristics, as, for example, smooth, rough, mucoid, moist, dry, browning, or blacking of the medium, and fluorescence. For the most part, these cultural characters do not lend themselves for precise differentiation of types. We have attempted to differentiate biochemically twelve cultures of *Pasteurella multocida*. Their capacity to ferment d-xylose, l-arabinose, and dulcitol was determined and they have been typed according to the previously mentioned scheme.

Cultures I, IV, V, XIII, XV, XVII, XVIII, and XIX were obtained from the Veterinary Department of North Dakota Agricultural College. Cultures number 398, 53, and 656 were obtained from Lederle Laboratories, Inc. The cultures were maintained on Scott's medium (9) at 37° C. Their fermenting capacity was tested separately on 1% each of d-xylose, l-arabinose, and dulcitol, on indicator-nutrient agar at 37° C. Observations were made during several weeks incubation. Repeat tests were carried out. The results are shown in Table II.

TABLE II

I	—	+	—	R-II	G
VI	—	+	—	R-II	G
V	—	+	—	R-II	G
XIII	+	—	—	R-I;M-II	C
VX	—	—	—		D
XVII	—	+	—	R-II	G
XVIII	+	+	+		A
XIX	+	+	—		B
398	—	+	—	R-II	G
53	+	+	+		A
656	—	+	+	R-III;M-I	E

Discussion

The results show that Cultures I, IV, V, VI, XVII, and 398 correspond to Roberts Type II and to our fermenting-type G. Culture XIII corresponds to Roberts Type III; Merchants Type I, and fermenting type E. Cultures XV, XVII, XIX, and 53 do not correspond to any of the Roberts or Merchants Types. These four cultures are differentiated into three additional types according to the type-fermenting scheme; namely, types A, B, and D. Thus far we have bacteria in the species falling into fermenting-types A, B, C, D, E, and G, but none in F or H.

These results are not presented as final. The number of cultures studied is not significant as to whether there are more than the eight possible fermenting types. It may be necessary to use additional differentiating substrates. Nevertheless, the results strongly suggest that the species can be further differentiated on a biochemical basis.

It is our aim to study a more comprehensive list of cultures on this basis, as well as to investigate various serological methods of type differentiation.

Conclusion

Twelve cultures of *Pasteurella multocida* were differentiated into six fermenting types on the basis of their capacity to ferment d-xylose, l-arabinose, and dulcitol.

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METHODS OF STUDYING BACTERIAL RING-ROT OF POTATOES

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Ring-rot of potatoes is a bacterial disease of the Irish potato. It is a disease chiefly of the vascular system which in the growing plant

results in wilting of stems and frequently, chlorosis of the leaves. This is due to the presence of masses of the casual organisms in the vascular system serving as mycotic emboli to choke off the maintenance of turgor in the tissues and to interfere with the distribution of nutrients. In the growing tubers the vascular ring is infected increasingly as it develops. In storage the organisms become more and more plentiful in the vascular ring until finally it involves most of it. Pressure on the tuber will force from the ring a creamy exudate composed of masses of the casual organism. Such tubers when used for cutting for seed pieces become the means of continuing the disease in succeeding crops.

The organism, classified as *Corynebacterium sepedonicum*, is a gram +, non-spore forming, pleomorphic, very small rod-shaped organism. In its microscopic appearance it would be classed as a diphtheroid; hence, its classification.

Because of the great financial loss involved in this disease, due to the fact that diseased potatoes are not acceptable or certifiable as seed stock, a close check has been made of all plantings which were destined for the seed trade. Inspection heretofore has involved the elimination of fields in which were found plants showing the symptoms of wilt and chlorosis so characteristic of ring rot of potatoes. Stems and leaves as well as tubers from such rogued plants have been sent to laboratories for closer microscopical examination. The finding in the juice from stems and/or the finding in the vascular ring of young tubers of "gram positive, non-spore-bearing, minute rod-shaped organisms" has been considered as evidence corroboratory to field inspection. It has been assumed that this test was completely valid because of a lack of information concerning any other microorganisms of this character in association with such a plant disease.

Materials submitted for examination in the North Dakota Agricultural College laboratories* in 1947 gave evidence of such organisms from stems and from tubers. Seven different isolations from such plant materials were cultured and studied with the view of determining whether, (1) they were actually *C. sepedonicum* varieties more or less capable of producing the disease, or, (2) organisms in no way related to *C. sepedonicum* and not representing in fact, or in potentiality, a disease agent of potatoes.

Tests were run in the greenhouse by Dr. Wm Hoyman using seed potato pieces and inoculating the same with emulsions of pure, viable cultures of all test organisms. The stem isolates did not cause typical symptoms of the disease in the potato plants. But neither did many of the strains which were freshly isolated from diseased tubers and were undeniably pathogenic strains of *C. sepedonicum*. Substituting other members of the Solanaceae (tomato plants, etc.) for potatoes

* This work was done by Miss Helen Fowler the summer of 1947 during the short absence of Dr. Wm. Hoyman, Investigator of Plant Diseases for Experiment Station and State Seed Laboratories.

did not give much better results and possesses the disadvantage of non-specificity.

Examination of the plants (either potato or tomato) which had been inoculated by the various strains showed the organisms of the inoculum present in the vascular portions of the stems. However, they were present in much larger numbers when the stems showed wilt and other symptoms. Pure cultures of the original inoculums were obtained from the stems by plating technique and by single cell isolation.

Interesting changes in various aspects were observable, such as size, motility, ease of cultivation, but fundamentally the recovered strains were identical with those originally used.

The answers to these questions involve the use of various methods (1) cultural, (2) morphological, (3) cytological, (4) and serological.

(1) **Culturally**, *C. sepedonicum* is a fastidious organism which up to a few years ago has resisted ready isolation and culture. Our own efforts in culturing it upon media prepared from potatoes originally recommended by Burkholder (Cornell 1940) were not satisfactory. Krumwiede's Triple Sugar medium finally proved fairly acceptable and yielded us information necessary to advance the problem. More recently, one of us, (Parsons) has developed a special medium, litmus milk agar, which has permitted a rather sharp differentiation of the leaf-isolates from pathogenic tuber-strains of *C. sepedonicum*. Reports of these cultural and differential studies will be forthcoming soon.

(2) **Morphologically**, studies have consistently shown this organism which has been recognized by all its observers as pelomorphic, is even more variable than such a loose term implies. There is a teleological value indicated in its oft recurring form variations, and its morphological variations seem to possess a strain correlation to nutritional variations as well. One can hardly speak of a life-cycle, yet size and transfusion through the vascular system of the host seem correlated. A report of these studies will follow.

(3) **Cytological**: You will appreciate how orthodox we of the biological sciences become, probably in self defense, when we prepare our systems of classification. The term Corynebacterium is an illustration of such a case. *C. diphtheria* is the normal reference type of which we think. *C. sepedonicum*, however, may or may not belong in this category. It forms chains, probably buds, produces what resemble microconidia or cysts containing nuclear structures, etc. It offers a good field for investigation.

(4) **Serological**: No methods excel the serological methods for delicacy of operation, degree of sensitivity and value in the determination of genetic relationships.

We have found that these bacterial cells serve as good antigens for producing antisera in rabbits. Such sera in normal titration against their **homologous** strain of bacteria possess rather high titers in the tube agglutination test.

CHART I

Bacterial Antigen	Dilution of Homologous Antiserum								Control
	1-10	1-20	1-40	1-80	1-160	1-320	1-640	1-280	
1	4+	4+	4+	4+	3+	2+	2+	+	-
3	4+	3+	3+	3+	3+	3+	2+	+	-
18	3+	3+	2+	3+	2+	2+	2+	+	-
ATC	4+	4+	3+	3+	3+	3+	2+	+	-

In **heterologous**, or cross titration tests, a distinct variation in strain relationship is indicated.

CHART II

Antigen (H)	Serum No. 3 (Microtechnique) Dilution of Antiserum			
	1-20	1-40	1-80	Control
ATC	—	—	—	—
18	—	—	—	—
Canadian	—	+	—	—
7	+	+++	+	—
3	4+	4+	4+	4+
4a	3+	4+	2+	—
4c	—	—	—	—
6	3+	2+	—	—

(We have found that these sera retain a large part of their titer strength for 8 or 9 months in the refrigerator.)

Spot plate microscopic **agglutination** tests serve as effective checks on the tube tests, are even more accurate in that degrees of agglutination can be better observed, and the time required is usually a matter of one-half to five hours.

Use of antigens with or without removal of the H. antigen gives further information.

Conclusions

In the absence of specific data which time and other factors make undesirable to present at this time we may say —

1. By the usual greenhouse tests the stem isolates of *C. sepedonicum* do not produce potato ring rot.
2. However, they are definitely strains of *C. sepedonicum*.
3. By certain cultural, morphological and serological methods these strains can be differentiated from pathogenic strains.
4. The possible potentiality for producing the disease remains to be determined.
5. From the broad standpoint of microbiology the group *C. sepedonicum* presents one of the most interesting groups of bacteria we have seen in forty years of experience.

STILBESTROL, RESULTS OF ITS USE ON GROWING-FATTENING SWINE

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The growth stimulating effect of stilbestrol, a stilbene-derivative having female hormone activity, on beef heifers, beef steers and fattening lambs has been demonstrated at various stations. This compound has also increased fat deposition in cockerals and resulted in increased feed efficiency in above mentioned livestock. Four experiments have been conducted in the Animal Husbandry Department using pigs of various weights and both sexes. Twelve and twenty-four milligram pellets were implanted subcutaneously. All pigs were fed alike on practical swine rations and records kept of weight and feed consumption. Results of these experiments indicate that under conditions of treatments used, stilbestrol is not practical for use in swine. The results are variable. There appeared to be a saving in the feed required per pound of gain, however, in some cases growth rate was adversely affected as compared to untreated controls. Four out of eleven gilts had a prolapse of the uterus. Other pertinent facts and physiological effects will be discussed.

VITAMIN B₁₂ AND STREPTOMYCIN FOR RAT GROWTH

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Male, weanling rats of the Sprague-Dawley strain were used to determine the value of adding crystalline vitamin B₁₂ and/or streptomycin to a good practical type swine ration. The basal ration fed included corn, soybean oil meal, meat scraps, alfalfa meal, yeast, bonemeal and salt. Six rations were studied. They were: basal; basal plus 26 micrograms crystalline vitamin B₁₂ per kilo; basal plus 50 milligrams streptomycin per kilo; and basal plus 26 micrograms B₁₂ per kilo with either 10, 50 or 10 milligrams streptomycin per B₁₂ kilo. Ten rats were fed on each ration for a period of 28 days. All rats were caged, fed and weighed individually. The rations were fed ad lib and the feed consumption for each rat was determined. The rats on all six rations made exceptionally good gains with a lot average gain per rat of 5.6 to 6.0 grams per day. The grams of feed required per gram of gain varied from 2.54 to 2.69. Statistical analyses of gain per rat and feed required per unit of gain showed no significant differences between the six rations studied. The weanling rats used either had a liberal store of vitamin B₁₂ at the start of the experiment or the basal ration fed supplied an adequate amount of this vitamin. The addition of an antibiotic did not improve the basal ration fed in this experiment.

THE EFFECT OF ADDING B₁₂, FOLIC ACID AND METHIONINE TO A PLANT PROTEIN RATION LOW IN METHIONINE

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Chicks one week old were divided into 20 different lots and fed a basal ration low in methionine. Each lot was fed different combinations of methionine, B₁₂ and folic acid. In the first feeding trial of 18 lots of chicks the addition of B₁₂ and methionine improved the growth rate. In the second feeding trial 20 lots of chicks were fed B₁₂ but did not show the improvement of growth rate shown by the first feeding trial. The reason for this discrepancy may be that these chicks in feeding trial No. 2 had sufficient reserve of B₁₂ to carry them through the experimental feeding period.

THE PRECIPITATION OF AMINO ACIDS FROM BLOOD FIBRIN HYDROLYZATE BY THE USE OF DIBENZOFURAN-2-SULFONIC ACID.¹

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Recent studies by Wendland and Smith² have shown that dibenzofuran-2-sulfonic acid will precipitate most of the amino acids from aqueous solutions. Quantitative data on the solubilities of the amino acid salts of the sulfonic acid indicated that the reagent may be useful in the precipitation and isolation of amino acids from protein hydrolyzates.³

The work reported here concerns the use of dibenzofuran-2-sulfonic acid (hereafter designated DBF-2-S) as a reagent for the precipitation and isolation of amino acids from blood fibrin hydrolyzate.

¹ This study was aided by a grant from the Research Corporation of New York.

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EXPERIMENTAL

Blood fibrin (100 g.) was hydrolyzed for 24 hours with 6 normal hydrochloric acid, the humin removed, and the filtrate decolorized with charcoal. Most of the hydrochloric acid was removed by vacuum evaporation, the balance by treatment with lead acetate trihydrate,⁴ after which the excess of lead was removed by precipitation with hydrogen sulfide. To remove accumulated acetic acid vacuum evaporation was again employed. During this concentration a precipitate was formed and removed (Fraction No. 1). The filtrate was diluted to 500 ml. and treated with DBF-2-S for precipitation of the amino acids. 7.15 g. of DBF-2-S was added to precipitate the amount of phenylalanine assumed to be present.⁵ After heating to effect solution, then cooling at 0-2°, the precipitate was removed. Thereafter, 2.0 g. of the acid was added to precipitate a second fraction which was collected after chilling at 0-2. The process of successive additions of 2.0 g. of the acid following by heating, cooling and removal of the precipitate by filtration was repeated until fifty-seven fractions had been collected.

a. Identification of Fraction No. 1.

Fraction No. 1 gave a positive millon's color test for tyrosine. Data given in Table I shows it to be almost entirely dl-Tyrosine.

TABLE I

A COMPARISON OF FRACTION NO. 1 WITH dl-TYROSINE

	Wt. g.	M. P.°C	M. P.°C N-Benzoyl Derivative	% Nitrogen
Fraction No. 1	2.1	d270—3	195—8	8.02
dl-Tyrosine		290—5	197	7.73

b. The Study of The Individual Fractions By Use of Paper Partition Chromatography.

Paper chromatographic analysis⁶ of the fractions collected showed the degree of separation of the amino acid sulfonates that was achieved and it also provided a means of identification of most of the constituents present.⁷ Table II lists the fractions collected and the probable amino acid DBF-2-S salts.

⁴ Biochemical Preparations, 1, 10 (1949), H. E. Carter, Editor.

⁵ The phenylalanine DBF-2-S salt was found to be least soluble of all those formed from the amino acids studied. Hence it was assumed that it could be precipitated first.

TABLE II
Amino Acid DBF-2-S
Salt Present M, P.°C

Fraction No.	Wt. g.	Salt Present	Found	Lit. ⁶
2-5+	7.1			
6	3.3	leucine	221	220
7	4.1	leucine++	217-22	220
8	2.4	leucine, lysine	206-32	
9	1.7	lysine	237	228-30
10	2.3	lysine	237	228-30
11	2.3	lysine	237	228-30
12	2.6	lysine	237	228-30
13	2.0	lysine	237	228-30
14	2.3	Lysine+++	237	228-30
15	1.5	lysine plus trace of leucine and/or iso-leucine	205-37	228-30
16	1.6	leucine and/or iso-leucine plus trace of lysine	205-37	
17	3.3	leucine	217-22	220
18	2.5	lysine, arginine	230-37	
19-49	87.6	A mixture of about seven salts, Among them are: aspartic acid, cysteine arginine and/or histidine		

CONCLUSION

This investigation has shown that dibenzofuran-2-sulfonic acid will precipitate a significant amount of amino acids from blood fibrin hydrolyzate. It has been found possible to isolate about 50% of the lysine as lysine DBF-2-S, about 26% of the leucine as the DBF-2-S salt, and a substantial quantity of a mixture of amino acid DBF-2-S salts.

- + Fractions 2, 3, 4, and 5 did not give a color when the paper chromatogram was developed with ninhydrin and were thus assumed to be the lead salt of DBF-2-S.
- ++ The yield of leucine DBF-2-S, that appeared free from contamination, was about 26% of theoretical.
- +++ The yield of lysine DBF-2-S, that appeared free from contamination, was 49% of theoretical.

⁶ One-dimensional chromatograms were run with phenol-water solvent using ninhydrin as the developing agent.

⁷ Identification of an amino DBF-2-S salt was considered established when the Rf value of the unknown amino acid salt corresponded to that of a known amino acid DBF-2-S salt.

X-RAY DIFFRACTION STUDIES OF MINERAL MATTER IN NORTH DAKOTA LIGNITE

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I Introduction

Lignites contain approximately ten percent ash, the actual amount depending upon their geological history. The elements present in the burned ash must of necessity be present in the natural fuel, but not necessarily in the same chemical combinations. In the accepted quantitative "wet" chemical method of ash analysis¹ the ash is analyzed in its ignited state, and no attempt is made to analyze the ash as it is present in the original fuel. In reporting the constitution of these ashes, it is customary to report all substances in the oxidized state. This method is adopted primarily because it is reasonable to expect oxides, and consistent quantitative results are obtained with this assumption. However, it should be realized that the actual composition of these minerals will be much different in the natural lignite, and that these oxides may not actually be present, as such, in the burned ash. Various other methods have been used² for identification of mineral matters in coals. Among these is the mention of the possibility of X-ray identification, but little work along that line has been attempted.

II Apparatus and Experimental Procedure

The patterns were taken with a G. E. Type VWC, X-ray diffraction apparatus using MoK α radiation monochromatized by a ZrO₂ filter. The powdered ignited-ash samples were loaded in a thin-walled pyrex capillary of diameter 0.05 cm. and separated from a calibrating sample of powdered NaCl by a cotton plug. These capillaries were then sealed in a flame, and placed in position in the conventional cassette of 8 inches radius supplied with the Type VWC unit. The diffraction patterns of the natural lignite presented more of a problem in that long exposure times were needed to bring out the very weak mineral patterns. This necessitated better collimation, by means of guarded slits, to cut down the general background scattering, and the placing of ZrO₂ filters before the collimating slit to reduce fluorescent radiation from the sample. In order to decrease the exposure time of the natural lignite sample, it was found necessary to compress the lignite in a hydraulic press, and to cut a wedge shaped sample from the resulting briquet. The natural lignite patterns required an exposure time of about 48 hours, while the ignited-ash patterns could be obtained in 8 hours.

Since most of the mineral matter in pulverized lignite or its ash is randomly distributed as tiny crystals, it was possible to identify some of these crystalline forms by X-ray diffraction powder patterns. The method³ is well known and tables⁴ listing the diffraction lines of 1000 crystalline substances were used to identify some of the com-

pounds present in the lignite. These diffraction patterns are in a sense the "finger prints" of the compounds, since the angular positions of these diffraction lines are governed by the d-spacings between parallel planes of atoms in the crystal (i. e., Bragg's law), and the relative intensity of various lines is dependent upon the number of planes contributing to those lines. The combination of diffraction lines arising from the various possible d-spacings in the crystal, and their relative intensities, is found to be unique for a given compound.

The d-spacings were computed, the relative intensities obtained visually, and the patterns identified by comparison with the published data⁴.

III Results and Discussion

The identified compounds have been listed in Table 1 along with some of the chemically identified substances for comparison. It should be noted that these two identifications are not for the same sample of ash, although both are for a North Dakota lignite char ash. The identification of iron pyrite and quartz in the natural lignite sample verifies results obtained by petrographic methods. However, in the lignite char briquet the iron pyrite has been changed to iron sulfide, and no evidence of a bentonite structure remained. The comparison of the chemical and X-ray identification of the ignited ash is interesting in that the X-ray patterns show approximately equal amounts of Fe_2O_3 and Fe_3O_4 , whereas it is customary to report the chemical result as Fe_2O_3 .

Many other compounds could have been listed as possibilities from our patterns, but it is always possible, when a large number of compounds are present, that fortuitous agreement could lead to false identification. This is especially true of the weaker diffraction lines. We hope to continue these X-ray investigations of the physical nature of lignite and lignite ash.

TABLE I

COMPOUND	IDENTIFICATION	CHEMICAL ANALYSIS*	OTHER
I. Natural Lignite—			
FeS_2	Yes—Pyrite		Optical Methods,
SiO_2	Yes—Alpha Quartz		
Bentonite	Possible		
FeSi	Possible		
II. Lignite Char Briquet—			
FeS_2	No		
FeS	Yes		
SiO_2	Yes—Alpha Quartz		
Bentonite	No		
CaO	Yes—weak		
CaS	Yes—weak		
$3\text{CaOAl}_2\text{O}_3$	Possible		
ZnAl_2O_4	Possible		

III. Lignite Char Briquet Ash—

SiO ₂	Yes—Alpha Quartz	20.55%
Al ₂ O ₃	Yes	9.88%
Fe ₂ O ₃	Yes	5.37%
Fe ₃ O ₄	Yes	Reported as Fe ₂ O ₃ Ash is Magnetic
CaO	No	25.4 %
SO ₃	No	22.82%
CaSO ₄	Yes—Strong (Anhydrous)	Reported as CaO and SO ₃
Mg Fe ₂ O ₄	Possible	
MgO	No	9.75%
		Total 93.78%

* Chemical Analysis obtained from Brewer and Ryerson. Ind. Eng. Chem. Vol. 27, 1935, p. 1047-53; and others. (This chemical analysis is **not** for the same sample of lignite char as was used for this investigation.)

IV Acknowledgements

Appreciation is expressed herewith to Dr. J. C. Holtz and Mr. J. Hoepfner of the U. S. Bureau of Mines for supplying the lignite samples and for many helpful discussions.

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- ² Sprunk and O'Donnell, Mineral Matter in Coal, Tech. Paper 648, U. S. Bureau of Mines, (1942).
- ³ Compton and Allison, X-rays in Theory and Experiment, P. 361, Van Nostrand and Co., New York, N. Y.
- ⁴ Hanawalt, Rinn, and Frevel, Ind. Eng. Chem., Anal. Ed. Vol. 10, No. 9, 451 (1938).

SUMMARY

AN OUTBREAK OF LEPTOSPIROSIS CANICOLA
INFECTION IN NORTH DAKOTA, INVOLVING NINE
MEMBERS OF ONE FAMILY

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Cases of Leptospirosis canicola, or "Canicola fever", are relatively rare, about 100 cases being reported in the world literature, with eight cases in the United States.

This report covers nine additional cases, seen in one family living in Grand Forks during the Spring of 1950. This family, the parents and seven children, lived under very poor conditions in a converted boxcar, without plumbing. The quarters were rat-infested and the family kept a dog.

All members of the family became ill within a period of one month.

All has loss of appetite and enlargement of the liver. The majority showed clinical jaundice. Three had mild meningitis. Laboratory studies showed moderate to severe liver damage. Agglutination tests showed significant titres for *Leptospira canicola*.

Leptospira canicola produces a characteristic disease in dogs. Surveys show that 0 to 40% of dogs in various areas may harbor the organism, excreting them freely in the urine.

Leptospirosis may be an important disease in North Dakota. No detailed studies of dogs, rats, and other rodents have been made in this state.

Control measures used in Grand Forks are briefly described.

It is hoped that public health agencies, physicians, and veterinarians will become more aware of this problem and define its importance in this State.

ARTERIO-VENOUS ANEURYSM, TEMPORAL ARTERY

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The motion picture depicts the operative treatment of an unusual case of arterio-venous aneurysm of the scalp.

Arterio-venous aneurysm, of fistulas, represent abnormal communications between arteries and veins. They are of two main types: Traumatic aneurysms result from penetrating wounds inflicted by knife, gun-shot, or similarly produced lesions. Congenital aneurysms result from faulty differentiation of the common embryonic anlage of the primitive vascular system.

The present case probably represents a traumatic arterio-venous aneurysm. The patient age 52 sustained a right scalp injury in an automobile accident about 25 years ago. Twenty years ago a mass of dilated veins appeared in the right scalp region and gradually became very extensive. The patients only complaints were the pulsating mass and a swishing noise in the right ear on exertion. The physical examination was essentially negative otherwise, and it is noteworthy that the blood pressure was 146/72.

Operative treatment was carried out in two stages. First the right external carotid artery was ligated in the neck. Sixteen days later a large mass of dilated vessels was resected through an extensive scalp incision. The color film shows both procedures in detail.

GEOLOGY OF NORTH DAKOTA IN RELATION TO OIL

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There is considerable interest in the geology of North Dakota at this time because of the recent find of oil in the northwestern part

of this State. Most of the interest as far as oil is concerned is in rocks of the Paleozoic Era. These rocks do not crop out in the State so they are known only from deeper wells which have been drilled for oil and gas in the State and in adjacent states and provinces of Canada. It would appear that a fairly complete Paleozoic section is present with apparently all periods in North Dakota, although the rocks of each period do not entirely cover the state in every instance.

The dominant structural feature of North Dakota is the Williston Basin. This is an area of rather indefinite boundaries centering just east of Williston which has been downsinking during much of geologic time since the beginning of the Paleozoic. There have accumulated in this basin an estimated 14,000 feet more or less of sediments.

The periods which appear to have the best possibilities of oil production are the Devonian, Mississippian and the Ordovician. The present oil strike is probably in beds of Devonian age. Oil shows have also been noted in several wells in the Mississippian and the Ordovician but so far no oil in commercial quantities has been noted in North Dakota. Other formations, especially those of the Jurassic and the Cretaceous of the Mesozoic era also should be considered as possibilities from the standpoint of possible oil production.

UTILIZATION OF ASPEN (*POPULUS TREMULOIDES*) FROM THE TURTLE MOUNTAINS

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I. Reasons for the Study.

There are 100,000 acres of woodlands in the Turtle Mountain area of North Dakota. Based on numerous surveys throughout this area by Mr. Ryan, Farm Forester, these acres are capable of producing 20,000 cords of wood annually. Very little of the wood is being harvested. A few fence posts of unsatisfactory durability, small quantities of lumber, and few hundred cords of fire wood comprise the harvest. With these facts in mind, the authors began an investigation into the possibilities of further utilization of the products of these woodlands.

II. Factors involved in the Problem.

In 1886 a tremendous forest fire swept through the Turtle Mountains, destroying almost the entire woodland growth. With the exception of a few scattered pockets and Masonic Island in Lake Metigoshe, the entire area was denuded of what must have been a great hardwood forest. It is now covered with dense growths of Aspen, and the very density of growth has prevented the development of any trees of a size suitable for lumber production. The trees are short in stature and small diameter; thus the problem was **narrowed down** to either their use as fence posts or the utilization of the fiber of the wood. The latter use was first to be investigated.

III. The Use of the Fiber.

Considerable progress has been made in the development of a building material by using a process discovered by Mr. L. P. Dove, of Boulder, Colorado, a former member of the faculty of the University of North Dakota. The product obtained by combining wood fiber and Portland cement, with the addition of chemicals to create a favorable binding condition, is known as Porolith. The process has successfully bound sawdust, shavings, and even waste paper. Experiments with the formula revealed that several modifications had to be made to insure a satisfactory product using Aspen fibers as a base material. The original formula specified that wood fiber with 25% moisture content might be used, but it was revealed that the high moisture content allowed leaching out of organic compounds which prevented setting of the Portland cement.

It was found that Aspen fibers must be dried to a moisture content of from 5%-6% before satisfactory results were obtained. The reduction of water in the fiber by the drying process necessitated addition of water to the mixture to obtain sufficient plasticity for molding purposes. Also, it was found that some type of press must be used, rather than hand tamping, to obtain a satisfactory product for commercial uses. The type of material will lend itself satisfactorily to production by machinery similar to that used for the production of cement blocks, and the material may be processed into fiberboard by the use of rollers or roll processes. An estimated ten million board feet could be produced annually from the raw materials available.

IV. Comparison of Properties.

The Porolith product as prepared by Dove shows a density of 25-60 pounds; our product from 41-54 pounds. Tensile strength, depending on material used by the Dove process, varied from 100-450 psi. Our product showed a strength of 325 psi. Transverse and racking strength and elasticity were similar in both cases. The Dove process showed a shrinkage on curing and drying slightly more than concrete; our product had no measurable shrinkage. Both products show extreme resistance to water, fire and fungi attacks. The Dove process shows insulation value as .30 to .45, depending on density. Insulation value of our product varied from .54 to .65. Air-curing time varied from seven to fourteen days. This curing time could be reduced to a minimum by a steam drying process.

The wood fiber for use in the product is obtained by separation of the fibers through grinding of wood bolts in a hammer mill or a wood defiberizer. All parts of the tree may be used for obtaining fiber, with the exception of the smallest twigs, leaves and roots. The product may be molded into blocks, planks or boards; and beams may be made by reinforcing with steel rods or netting. As a building material it can be sawed, nailed, glued, bolted and screwed together much the same as wood.

V. Treatment of Aspen for use as Fence Posts.

In addition to the study of Aspen fiber for building material, we have begun to experiment with the treating of Aspen fence posts. Considerable research has already been done along this line at the University of Minnesota and the Great Lakes Experiment Station. In his Lake States Aspen Resort No. 1, Z. A. Zasada states that the average life of a treated post is from two to six years. They have successfully treated posts with cresote and oil, using pressure, which have lasted for fifteen years. Costs of such treatment are, however, too, high; and further reseach has been recommended. The two problems involved are: to lower costs and to prevent deterioration of the staples and wire.

At the present time work is going ahead on the treatment of posts, using pyridine as the main preservative. Penetration of the green wood is very good, and preservation, based on extremely short tests, seems to be adequate. Costs are still high, but large scale production of the mixture should bring them down to a satisfactory level. However, it will take several years to determine the actual preservative value.

THE MODIFICATION OF TALL OIL FOR USE IN PROTECTIVE COATINGS

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Tall oil, a by-product of the Kraft paper manufacture, is composed of approximately 50% fatty acids and 50% rosin acids and can therefore be used in the manufacture of varnishes and paint vehicles. In our investigations tall oil was modified in two ways, e. g. 1. by transforming it into long oil alkyd resins and 2. by a styrenation and a consequent esterfication.

For the preparation of alkyds, tall oil fatty acids were used in single and double distilled form and distilled rosin acids were employed also. The alkyds were prepared with these acids, glycerol and phthalic anhydride and tested for acid number, solubility and color. The varnish films, made from same were subjected to accelerated yellowing and tested for hardness, flexibility, drying and water resistance. Contrary to the commonly accepted conception it was found that the alkyds made with both the double distilled fatty acids and rosin acids yellowed less than those prepared with single distilled fatty acids.

In other experiments tall oil, containing various percentages of rosin acids, were styrenated and consequently esterfied. Since, according to Farmer's theory, styrene adds to a methylene group adjacent to a conjugated double bond, styrenations were performed

also with a tall oil, containing 3% rosin acids only and previously isomerized with alkali. Contrary to expectations, it was found that the tall oil with a large percentage of rosin acids (70%) gave fast drying, clear and hard films, that show a great deal of promise.

PHOSPHATASE DISTRIBUTION IN MATURE FLAX SEED¹

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¹ Published with permission of the Director of the North Dakota Agricultural Experiment Station as a progress report on Adams Project 35, "Biochemical Action of Herbicides on Plant Enzymes."

The phosphatases of a number of oil bearing seeds have been studied rather extensively, particularly by European workers. However, the literature apparently contains no references to studies on the phosphatases of the important oil bearing crop, flax.

Decorticated, oil free flax seed meal was extracted with water at approximately 10°C. for 24 hours, and the supernatant examined for phosphatases responsible for the hydrolysis of sodium B glycerophosphate, fructose 1,6 diphosphate, phosphoglyceric acid, sodium nucleate, glucose 1 phosphate, and phytic acid. No appreciable phosphatase activity could be detected on glucose-1-phosphate, sodium nucleate, and phytic acid, but this is not considered to preclude such activity in the untreated seed due to the possibility of denaturation in the decortication and delipidization processes and loss of activity on storage. Particularly with sodium nucleate, where the hydrolysis proceeds by several complex steps, it is impossible to state definitely that no activity is present. A fairly high degree of phosphatase activity was exhibited on sodium B glycerophosphate, phosphoglyceric acid, and fructose 1,6 diphosphate. The pH optima for these substrates at 35°C. lie near 5.2, 5.4 and 5.8, respectively.

2,4-DICHLOROPHENOXYACETIC ACID INHIBITION OF PLANT ENZYMES¹ POTATO PHOSPHORYLASE

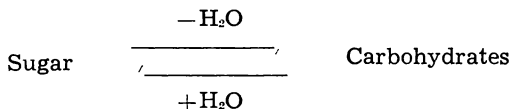
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¹ Published permission of the Director of the North Dakota Agriculture Experiment Station as a progress report on Adams Project 35, "Biochemical Action of Herbicides on Plant Enzymes."

Cori and colleagues (1) showed that glucose-1-phosphate (Coriester) is the primary product in the transformation of glycogen to glucose in the animal. Hanes (2) showed that similar reaction occurs in the reversible conversion of glucose to starch in the potato and pea. The enzyme mediating these reactions has been termed phosphorylase. Several workers have reported a mobilization of carbo-

hydrate reserves in plants treated with 2,4-Dichlorophenoxyacetic acid and similar herbicides. In some manner, the kinetics of the re-



action must be disturbed and the equilibrium shifted in the direction of less carbohydrate material and increased sugar which is metabolized, or the sugar must be metabolized more rapidly and thus affect the equilibrium. Since phosphorylase plays a part in the synthesis and breakdown of carbohydrate polymers we decided to investigate the effects of the herbicide on this enzyme system.

Preparation of a stable enzyme

Green and Stumpf (3) have investigated the preparation and some of the properties of potato phosphorylase. However, the longevity of the enzyme was not sufficient to permit studies of the kinetics of inhibition.

Lyophilization or freeze-drying method has been used in the preservation of many enzymes, proteins in general, and even units with a fairly high degree of organization such as bacteria. No commercial lyophil apparatus was available in the laboratory. An outfit was constructed from readily available parts which proved very satisfactory for simultaneously drying eight equal fractions of the enzyme solution. Regular 29/40 standard taper joints and round bottom flasks were used in the construction of the manifold and dry ice trap. Low temperature was maintained with dry ice-alcohol mixture in a Dewar flask. The L tubes containing the enzyme were constructed by attaching side arms and sealing the open ends of 10 x 180 mm pyrex test tubes. A 5 ml. portion of the $(\text{NH}_4)_2\text{SO}_4$ precipitated enzyme was frozen in a thin layer on the lower part of the tube by swirling in a dry ice bath, and connected to the evacuated system. Heat loss by evaporation was sufficient to keep the shell frozen during the drying process. After complete drying, the tube was sealed by drawing off the side arm, and stored in a refrigerator at 10° C. until used for experimental determinations. No loss of activity was evident over 132 days of storage, whereas the water suspended enzyme deteriorated completely within several weeks.

TABLE I
Retention of Enzyme Activity

Days of lyophilization	Units of enzyme/tube
0	48
13	50
24	52
28	48
33	50
132	51

Shortly after this work was completed, Barker, Bourne, Wilkinson and Peat (4) published studies giving similar results. The glucose-1-phosphate used in these experiments was prepared enzymatically by the action of potato phosphorylase on starch in the presence of phosphate buffer as outlined by Hanes (2). Free phosphorus was determined by the method of Fiske and Subbarow (5).

The activity of the enzyme was determined as follows: The tip of the lyophil tube was broken and 20 ml. of water was added. The tube was shaken to insure dispersion, and transferred to a beaker. A 1 ml. aliquot of the enzyme solution was added to a centrifuge tube followed by 0.5 ml. of 0.5 M citrate buffer of pH 6, and 0.5 ml. of 2% starch solution. The starch solution is added to catalyze the reaction. This tube was placed in a constant temperature bath at 38° C., 1 ml. of substrate added, and the mixture stirred. After the desired period of time, the reaction was arrested by the addition of 5 ml. of 5% trichloroacetic acid, the precipitated proteins removed by centrifugation and the liberated phosphorus determined from an aliquot of the supernatant.

The variation of activity with concentration of enzymes was determined by preparing five serial dilutions of the lyophilized enzyme. Within experimental error the activity is directly proportional to enzyme concentration, and agrees with results reported by Green and Stumpf (3).

The effect of substrate concentration was determined by using a dilution of 1/100 of the lyophilized enzyme. Seven substrate concentrations ranging from .0016M to 0.0333M, final concentrations were run from 5, 10, and 15 minute periods.

2,4-D Inhibition Studies

In determining the effect of 2,4-D on the rate of reaction, four substrate concentrations (final) ranging from 0.0016M. to 0.0133M. and four concentrations of 2,4-D ranging from 0.005 M. to 0.040 M. The method of determination was the same as used previously except that 1 ml. of 2,4-D solution of proper concentration was added in place of 1 ml. of water in the reaction mixture. The reaction time was held constant at 10 minutes. Results are shown in Table II.

TABLE II

The Effect of the Sodium Salt of 2, 4-D on Potato Phosphorylase

Molarity of Substrate	Molarity of 2, 4-D	% Inhibition
0.0016	0.005	8
0.0033	0.005	8
0.0066	0.005	6
0.0133	0.005	7
0.0016	0.010	19
0.0033	0.010	23
0.0066	0.010	12
0.0133	0.010	26

0.0016	0.020	50
0.0033	0.020	53
0.0066	0.020	47
0.0133	0.020	56
0.0016	0.040	96
0.0033	0.040	94
0.0066	0.040	98
0.0133	0.040	100

The type of inhibition was determined by the method of Lineweaver and Burk (6), that is, the reciprocal of velocity plotted against reciprocal substrate concentration. Statistical methods were used to obtain regression lines. The regression line for the zero inhibition concentration permits the calculation of the Michaelis constant, K_s . This was found to be $1.3 \times 10^{-3} M$. We have been unable to find literature reports of this value so no comparisons are possible. The K_i values for the different inhibitor concentrations are shown in Table III.

TABLE III
Effect of Sodium Salt of 2, 4-D of the Dissociation Constant

Molarity of 2, 4-D	$K_i \times 10^{-3}$
0.000	1.32
0.005	1.35
0.010	0.95
0.020	1.05

Inhibition appears to be noncompetitive, however, the many inherent errors in this type of determination make it difficult to rule out uncompetitive inhibition with certainty. In noncompetitive inhibition the slope and intercept are increased by the same factor whereas in uncompetitive inhibition the slope may change by a smaller factor than the intercept, Ebersole, Guttentag and Wilson (7). Kvamme (8) working with wheat germ lipase, and Hagen (9) working with malt diastase indicated noncompetitive inhibition.

From the standpoint of the quantity of 2, 4-D required for inhibition of the enzyme system, phosphorylase is intermediate in sensitivity, as shown in Table IV.

TABLE IV
Molarity of 2,4-D Necessary For 50 Per Cent Inhibition

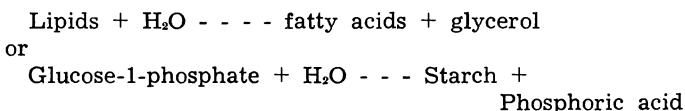
Enzyme	Molarity of 2, 4-D
Wheat germ lipase (11)	5.6×10^{-2}
Malt diastase (12)	5.0×10^{-2}
Potato Phosphorylase	2.0×10^{-2}
Caster bean lipase (12)	1.5×10^{-3}

In all cases thus far studied there is an indication of 2, 4-D-enzyme complex formation independent of substrate concentration. The mechanism of this complex formation can not be determined from the

limited information available at this time. A number of theories have been advanced, suggesting involvement of sulfhydryl and other reactive groups of proteins, however, no experimental evidence is available to support such theories.

The enzymes thus far studied show no definite clues as to the mechanisms by which the synthetic hormone 2,4-D exerts its powerful physiological action on plants.

All of the systems thus far studied have been investigated from the hydrolytic point of view, that is



This approach has been dictated by the available analytical methods. It is possible that examination of the reverse reaction might have shown differing degrees of inhibition.

Summary

A successful method for the preparation of potato phosphorylase in a form which was completely stable for at least 132 days was developed.

The activity of phosphorylase was found to be directly proportional to enzyme concentrations.

The effect of substrate concentration on the kinetics of the phosphorylase-catalyzed reaction was studied.

The inhibition of phosphorylase by the sodium salt of 2,4-D was studied.

Among the enzymes thus far studied, phosphorylase is intermediate in sensitivity to 2,4-D inhibition.

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REPORT OF THE NORTH DAKOTA STATE DIABETES DETECTION PROGRAM

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Diabetes is a major public health problem in the United States today. 1,000,000 known cases are at present under treatment. Another 1,000,000 cases known to exist are being searched for by the American Diabetes Association, its affiliated societies, and various state and district medical societies. According to the American Diabetes Association, "One out of every 25 women under 50 years of age is now, or will become, diabetic".

Grand Forks pioneered in diabetes detection in 1948 when the Grand Forks District Medical Society sponsored free tests for 1,810 people. Fourteen new diabetics were discovered. Results of this drive stimulated state-wide participation in 1949 with endorsement of the North Dakota State Medical Association, and 12,000 people were tested. Sixty five new cases were discovered.

By 1950 "Diabetes Week" had become an important event in North Dakota and a new high of 24,374 tests was reached. Under the local chairmanship of Dr. Charles M. Graham, Grand Forks led the state in testing 8,137 people. It is anticipated that well over 90 new cases of diabetes will have been discovered when the final reports are available from physicians throughout the state.

Diabetes cannot be diagnosed merely by finding sugar in the urine. It can only be suspected until detailed evaluation of the patient is made by the physician, including blood sugar tests. Only one case of diabetes is discovered among every 6 to 10 cases of glycosuria (sugar in the urine). Unfortunately, this necessitates temporary anxiety for many persons having "positive tests" until they are proven not to have the disease. Nevertheless this is a very worthwhile sacrifice for these individuals in view of the fact that it may actually save the lives of others.

The momentous import of the entire diabetes detection program is that undiscovered cases may undergo rapid progressive deterioration with innumerable complications, while discovered cases can virtually be assured a normal, healthful life span, thanks to medical science. Roughly 50% of diabetics require insulin, and prior to the discovery of insulin by Drs. Banting and Best in 1922, about 80% of insulin-requiring diabetics were doomed to certain death within two years.

Diabetes is not a temporary problem; it is on the increase. The U.S. Public health service has shown that by 1985 the number of diabetics will have increased 74% while the general population will have increased only 22%. Simply because cases are not discovered early enough, diabetes unnecessarily ranks as the eighth most important cause of death in the United States.

Public alarm or "mass hysteria" over diabetes is inexcusable because, in the words of the American Diabetes Association, "No other chronic disease can be so easily and inexpensively detected and, once detected, be so successfully managed by the patient's physician, and by the patient himself.

Any person with diabetic relatives should be regularly tested for the presence of urine sugar because of the strong hereditary influence characteristic of this disease.

ESTIMATION OF MILK LIPASE

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Introduction

The presence of lipase in milk, as a normal constituent, was demonstrated in 1922. Since then it has been shown that under certain conditions, lipolysis proceeds so rapidly that the products of hydrolysis can be detected by taste and smell in a matter of minutes after the milk is drawn from the cow. Undoubtedly, the rancid flavor of old cream is the result of enzymic activity of bacterial origin but the rancidity occasionally observed in fresh milk is probably the result of the action of natural milk lipases.

A number of undesirable flavors commonly encountered in milk may be traced to lipolytic activity. Milk flavors described as barny, cowey, and butyric may be due to such lipolytic activity. Milk may be perfectly fresh and yet be discriminated against because of these defects, thus resulting in a loss to the producer.

Some form of activation is generally required before lipolysis will proceed at a measurable rate. Methods used in activating the lipase system consist of rendering the substrate more vulnerable to lipolytic activity. This may be accomplished by temperature changes, shaking or by homogenization of the milk. It makes little difference how it is accomplished, all methods of activating the lipase system consist of (a) disruption (b) partial replacement or (c) distortion of the natural adsorption layer of the fat globule. Disruption of the adsorption layer by homogenization of raw milk apparently is the most effective means of activating the system. Possibly the increase in fat globule surface resulting from homogenization renders the hydrolyzable linkages more vulnerable to enzymic action.

Several methods have been used in studying lipase. Incubation of milk at low temperature for several days has been used. Bacterial activity has not been adequately prevented in some methods. Some have used substances to inhibit bacteria which also inhibited the lipase. Methods of study which used glycerol in the reaction mixture defeated their purpose. Glycerol, an end product of fat hydrolysis serves to retard or inhibit the reaction.

The purpose of the present study of lipase was (a) to reduce the

incubation time and (b) to develop if possible a completely soluble substrate. Any means of lipase estimation requiring an incubation time of two hours or more is open to criticism on the grounds that bacterial fermentation may have been great enough to cause inaccuracies. A water soluble substrate would be more intimately in contact with the enzyme and thus be more readily hydrolyzed.

Experimental

Peterson et al* in 1943 developed a method of lipase estimation basically similar to that used in the present investigation. A reaction mixture consisting of a measured amount of skim milk, buffer solution, substrate, bacteria inhibitor and water was incubated under controlled conditions. It was necessary to adjust the pH of the reaction mixture after the reaction mixture was assembled. Determination of liberated fatty acid was made at regular intervals by titrating an aliquot portion of the reaction mixture.

In the present study the effect of shaking on the rate of lipolysis was investigated first because of the controversial nature of literature published on the subject. A reaction mixture of the following general composition was used:

Water	10.0 ml.	Buffer	10.0 ml.
Substrate	0.8 ml.	Toluene	0.1 ml.
Skim milk	20.0 ml.	Total volume	40.9 ml.

Some reaction mixtures were buffered with sodium tetra borate and others with sodium diethylbarbiturate. Tributyrin was used as substrate in all reaction mixtures unless otherwise stated. Reaction mixtures were made up in pairs one of which was shaken during the incubation period and the other one simply placed in the water bath. All components of the mixture were placed in the water bath at least 20 minutes before they were brought together. At regular intervals duplicate portions of the reaction mixtures were withdrawn, titrated with alcoholic NaOH and a pH determination made. Alcoholic thymolphthalein indicator was used.

Results of eight trials to determine the effect of buffer used and the effect of shaking are summarized in Table I. Shaking the borate buffered mixture resulted in a 45.5 per cent increase in butyric acid liberation whereas under identical conditions, 14.3 per cent increase was observed with the barbital buffer.

TABLE I
The Effect of Shaking On the Rate of Lipolysis**

Sodium tetra borate buffer		Increase in acid liberation due to shaking	Sodium barbital buffer		Increase in acid liberation due to shaking
Shaken	Unshaken		Shaken	Unshaken	8.24
106.025	57.75	48.275	57.65	49.41	

* Peterson, M. H., Johnson, M. J., and Price, W. V. Determination of Milk Lipase, *J. Dairy Sci.*, 26:233, 1943.

** Values shown are micromoles of butyric acid.

Results of experiments made to determine the effect of pH on the rate of lipolysis very closely paralleled the results of Peterson et al. The pH optimum was observed to be about 8.6.

Butyric acid liberation as observed by Peterson et al., was greatest where the substrate concentration was 2 per cent. In the present study greatest butyric acid liberation was obtained when the substrate concentration was 1.5 per cent. This difference may have been due to use of partially hydrolyzed tributyrin. Butyric acid, an end product of the reaction, would have an inhibiting action.

Studies were made to determine the effect of time on the rate of hydrolysis of tributyrin by milk lipase. Results of five trials are summarized in Table II. Data obtained indicates slightly over three times as much hydrolysis occurs in the first hour of incubation as compared to the second hour. From these data a standard curve was

TABLE II
Rate of Butyric Acid Liberation by Milk Lipase*

Incubation time in minutes	15	30	45	60	75	90	105	120
Micromoles acid liberated	44.4	32.30	22.10	18.65	14.05	11.95	5.90	4.55
Accumulated per cent of total liberation	28.9	49.8	64.2	76.3	85.4	93.1	96.9	100.0

* Values shown are the average of five trials.

set up whereby the units of lipase in any lot of milk could be estimated.

A completely soluble substrate was made jointly by Dr. Forster of the Dairy Department and Dr. Wendland of the Chemistry Department. This compound, a sulfonated phenolic ester of butyric acid, was tested under exactly the same conditions as reaction mixtures having tributyrin substrate. Results of one trial with the synthetic substrate are shown in Table III.

TABLE III
Comparison of Substrates

	Tributyrin		Sodium sulfophenyl butyrate	
	Shaken	Unshaken	Shaken	Unshaken
Micromoles of acid liberated	66.75	19.75	64.50	65.00

According to these results it makes little difference whether reaction mixtures having the synthetic substrate are shaken or unshaken.

Discussion

The data indicate that shaking the reaction mixture during incubation markedly increases the rate of lipolysis when tributyrin serves as substrate. An increase in the rate of lipolysis would increase the sensitivity of the test. Probably shaking served to more evenly dis-

perse this substrate throughout the mixture. Thus, the substrate was brought more intimately in contact with the enzyme. It is also probable that shaking served to remove the reaction end products from the site of reaction.

The synthetic substrate apparently is hydrolyzed as rapidly by milk lipase as is tributyrin. It may be possible to develop a colorimetric method of lipase estimation based on measurement of the phenol compound liberated by the hydrolysis.

Thus far the phenolic ester of butyric acid is the only member of this series tested. It may be possible to determine the specificity of milk lipase by preparation of other fatty acid esters. Before the synthetic substrate can reliably be used in lipase estimation, more research work is necessary.

Summary

1. A definite increase in the rate of lipolysis is obtained by shaking reaction mixtures containing tributyrin during the incubation period.
2. The rate of lipolysis diminishes rapidly after the first hour of incubation.
3. A synthetic substrate has been described and tested which appears to be as suitable as tributyrin for milk lipase estimation. It was not necessary to shake the reaction mixture during incubation.

THE FOUNDING OF THE NORTH DAKOTA ACADEMY OF SCIENCE

(A brief historical sketch by G. A. Abbott, Historian of the Academy.)

In a real sense, the North Dakota Academy of Science is an off-shoot of the famous Indiana Academy of Science, which for more than three quarters of a century has numbered among its members many of the most distinguished scientists of America. Such men as David Starr Jordan, Harvey W. Wiley, of pure food fame, John and Stanley Coulter, Arthur, Barnes, Stone, Nef, Alexander Smith, Evermann, Eigenman, Underwood, Baker, Moore, McDougal, Goss, and a host of others who in their day contributed so conspicuously to the advancement of American science. It was a small group of former members of the Indiana organization who established the North Dakota Academy of Science. The idea originated with the late Dr. Melvin A. Brannon, then Dean of the School of Medicine, at the University of North Dakota, who later served as the Chancellor of Higher Institutions of Learning in Montana.

Dr. Brannon often remarked that this inspiration came from his former association with the Indiana Academy. His suggestion was received with great enthusiasm by other members of the Indiana organization, particularly by Lynn B. McMullen, then instructor of Physics at the State Normal School, at Valley City, who had served

as Press Secretary of the Indiana Academy. Others were Dean H. L. Bolley, and Dr. C. B. Waldron of the Agricultural College, at Fargo.

At the meeting of the State Educational Association, held at Valley City, December 31, 1908, a small group met informally to consider the plan of organizing a North Dakota Academy of Science.

Unfortunately very meager records of this meeting were kept, and they do not include the names of all those present at this meeting. These brief minutes read as follows: "Moved and carried that Professor Brannon be elected chairman of the organization. Morris Johnson appointed Secretary. Moved that those present organize as the North Dakota Academy of Science. Moved, seconded and carried that a proposed Constitution be read. Moved that the instrument as read be adopted for the coming year. Seconded and carried. Moved, seconded and carried that officers be elected. Moved that the chairman of the meeting (Dr. M. A. Brannon) be empowered to appoint officers for the year, and that he act as President of the Executive Committee of five. Motion to adjourn, carried. (Signed) Morris Johnson, Secretary-Pro-tem."

The next record we have is that of the minutes of a meeting of the Executive Committee held in Professor Daniel E. Willard's office, at the Agricultural College, February 1, 1909. These very brief minutes read as follows:

"Those present, C. B. Waldron, M. A. Brannon, D. E. Willard, L. B. McMullen, and G. A. Abbott. Secretary was instructed to write to School Science and Mathematics, Science, and Popular Science Monthly. Decided to hold first regular meeting of the Academy at Grand Forks, May 21, 1909. Moved by McMullen, seconded by Waldron, to have President Brannon prepare a program on the general topic 'What can Biology do for North Dakota', Willard to prepare a similar program for Geology, Stewart for Physics, and Babcock for Chemistry. Voted to pay railroad expenses of members of the Committee for this meeting, Brannon, \$3.90, McMullen, \$2.90."

On May 3, 1909, Secretary Lynn B. McMullen sent a notice of the meeting with invitations to prospective members to attend. The list included 75 names and was accepted by the Executive Committee. All who joined the Academy at this first general meeting at Grand Forks, were officially declared to be the charter members of the North Dakota Academy of Science. Of these only the following now appear on the active membership roster:- G. A. Abbott, H. L. Bolley, and W. F. Sudro.

Prominent charter members who later moved from the State were:- Dr. M. A. Brannon, who served a short time as President of the University of Idaho, and later ten years as Chancellor of Higher Institutions in Montana, George W. Stewart, who served until his retirement, as Professor of Physics at the University of Iowa, A. Hoyt Taylor, at the Naval Research Laboratory, at Washington, D. C. Taylor, famous for his pioneering work in the field of radio and often called the "father of radar," was cited by President Roosevelt for

his outstanding war service in the development of radar, Frank L. McVey, President of the University of Kentucky, Louis Van Es, of the University of Nebraska, H. F. Bergman, of the U. S. Department of Agriculture, at Amherst, Mass., Robert T. Young, University of Southern California, Roe E. Remington, Director of the State Medical Research Laboratory, Raleigh, North Carolina, J. W. Ince of Rhode Island State College, Adolph Ziefle, of Oregon State College, and the late U. S. Senator E. F. Ladd distinguished for his outstanding services in securing pure food legislation.

At the charter meeting at Grand Forks, Dr. G. A. Abbott was elected Secretary succeeding Lynn B. McMullen, who had left the State to become President of the Eastern Montana State Teachers College. Like his predecessor, Abbott had also served as Press Secretary of the Indiana Academy. He has attended every meeting of the North Dakota Academy of Science, except the called meeting for organization, at Valley City, and has been annually re-elected from 1909 to 1950. Upon his retirement from the Secretary's office, he was unanimously elected to the newly created office of Historian of the Academy.

SUGGESTIONS TO AUTHORS

General. Authors should submit to the secretary of the Academy at the time of the annual meeting following presentation of the paper a copy of the manuscript typed double space with wide margins on 8½" by 11" white paper.

At present it is impossible to include colored drawings, photographs, or elaborate figures.

Titles and Footnotes. Titles should be specific but should be kept short by deleting unnecessary words. The title should also show the name and address of the author's institution. Additional footnotes showing other pertinent information are desirable although not obligatory.

Abstract. A concise abstract of about 200 words must be supplied to the secretary of the Academy before the annual program is arranged. In case the complete manuscript is not published in the Proceedings the abstract as submitted will be used. This abstract should state the principal result and conclusions and should contain largely by inference, adequate information on the scope and design of the investigation. The abstract in general should conform to the suggestions outlined for complete manuscripts.

Literature. In general only recent papers need be listed and these can often be cited more advantageously throughout the text than in the introduction. Long introductory reviews should be avoided especially when a recent review in another paper or in a monograph can be cited instead. References are arranged and numbered in alphabetical order of author's names and show author, title, journal, volume, first and last pages, and year. The list is given at the end of the paper. Reference numbers must invariably be cited in the text, but author's names and year may be cited also. Abbreviations for names of journals follow the list given in Chemical Abstracts 40, Pt. 4:1-CCIX. 1946.

Organization. The standard organization involves main sections for introduction, materials, methods, results, discussion, summary, and acknowledgements and literature cited. Alternately a group of related studies each made with different materials or methods may require a separate section for each study with sub-sections for materials and methods and for results under each section. Center headings are used for main sections and italicized, run-in headings for subsections. Headings should be restricted to these two types only.

Tables. Data should be arranged to facilitate the comparisons readers must make. Tables should be kept small by breaking up large ones if this is feasible. Only about eight columns of tabular matter can be printed across the page. Authors should omit all unessential data such as laboratory numbers, columns of data that show no significant variation, and any data not discussed in the text. A text reference can frequently be substituted for columns containing only a few data. The number of significant figures should be minimized. Box and side headings should be kept short by abbreviating freely; unorthodox abbreviations may be explained in footnotes, but unnecessary footnotes should be avoided. Leader tables without a number, main heading, or ruled lines are often useful for small groups of data.

Tables should be typed on separate pages at the end of the manuscript, and their position should be indicated to the printer by typing "(TABLE I)" in the appropriate place between lines of the text.

Text. Clarity and conciseness are the prime essentials of a good scientific style. Proper grouping of related information and thoughts within paragraphs, selection of logical sequences for paragraphs and for sentences within paragraphs, and a skilful use of headings and topic sentences are the greatest aids to clarity.