

PROCEEDINGS
of the
NORTH DAKOTA
ACADEMY OF SCIENCE

Founded December, 1908

VOLUME VII

1953

PUBLICATION COMMITTEE

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

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

July, 1953

GRAND FORKS, NORTH DAKOTA

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OFFICERS

President - - - - - Carl O. Clagett, Agricultural College

Vice President - - - - G. A. Abbott, University

Secretary-Treasurer - J. Donald Henderson, University

Historian - - - - - G. A. Abbott, University

Additional Members of Executive Committee:

Gerhard O. Ovrebo, Valley City

Jerome H. Svore, Bismarck

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NORTH DAKOTA ACADEMY OF SCIENCE

ACTIVE MEMBERS

- Abbott, G. A. (Chemistry), University. Charter Member.
- Arnason, A. F. (Forestry), Commissioner, State Board of Higher Education, Bismarck. 1939.
- Banasik, Orville J. (Cereal Chemistry), Agricultural College. 1947.
- Bitzan, Edward F. (Chemistry), U. S. Bureau of Mines. 1952.
- 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.
- Brezden, William. (Chemistry), State Mill and Elevator, Grand Forks. 1945.
- Broberg, Joel W. (Chemistry), Agricultural College. 1948.
- Brown, Leonard W. (Chemistry), Armour and Company, Fargo. 1952.
- 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.
- Chernick, Sidney S. (Pharmacology), Agricultural College. 1952.
- Chetrick, M. H. (Chemical Engineering), University, 1947.
- Christoferson, Lee A. (Neurological Surgery), Fargo. 1952.
- 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.
- Corbus, Jr., Budd C. (Urological Surgery), Fargo. 1952.
- Cornatzer, William E. (Biochemistry), University. 1952.
- Davis, Mildred L. (Nutrition), University. 1951.
- Davison, John P. (Biochemistry), University. 1952.
- De Boer, Benjamin. (Pharmacology), University. 1952.
- 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.
- Downing, William L. (Biology), Jamestown College. 1952.
- 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.
- Eveleth, D. F. (Veterinary Science), Agricultural College. 1944.

- Facey, Vera. (Botany), University. 1948.
- Fischer, Robert G. (Bacteriology), University. 1948.
- Fisher, Stanley P., Jr. (Petroleum Geology), N. D. Geological Survey. 1952.
- 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), Abbott Laboratories, North Chicago, Ill. 1951.
- French, Harley E. (Anatomy), Dean Emeritus, University. 1911.
- Gault, Alta R. (Physiology), University. 1949.
- Geiszler, Gustav N. (Agronomy), Agricultural Experiment Station, Minot. 1950.
- Goldsby, Alice. (Veterinary Science), Agricultural College. 1946.
- Golob, Edward F. (Chemical Engineering), U. S. Bureau of Mines. 1952.
- 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.
- Hamre, Christopher J. (Anatomy), University. 1950.
- Hansen, Miller. (Geology), N. D. Geological Survey. 1952.
- Haraldson, Harald C. (Geology), University. 1952.
- Harris, Rae H. (Agricultural Biochemistry), Agricultural College. 1938.
- Hart, Harry B. (Chemistry), Jamestown College.
- 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.
- Henderson, J. Donald. (Physics), University. 1945.
- Henrickson, Russell M. (Chemistry), North Dakota Research Foundation. 1952.
- 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.
- Holm, Glenn C. (Veterinary Science), Agricultural College. 1950.
- Holtz, John C. (Chemical Engineering), Bureau of Mines, Morgantown, West Virginia. 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.
- Kaufman, Victor. (Physics), University. 1951.
- Kelly, Eunice. (Nutrition), Agricultural College. 1944.
- King, Richard P. (Animal Nutrition), Agricultural College. 1952.
- Kingsley, Allan F. (Agricultural Chemistry), Agricultural College. 1950.
- Kjerstad, C. L. (Philosophy and Psychology), University. 1937.
- Klosterman, Harold J. (Agricultural Chemistry), Agricultural College. 1948.
- 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.
- Kratochvil, Donald E. (Botany), Agricultural College. 1952.
- 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.
- 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.
- McMillan, William W. (Chemistry), N. D. Research Foundation, Fordville. 1947.
- MacDonald, John H. (Biology), Teachers College, Dickinson. 1951.
- Marwin, Richard M. (Bacteriology), University. 1949.
- Mason, Harry. (Physics), Jamestown College. 1951.
- 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.
- Moore, Cyril C. (Chemistry), Teachers College, Minot. 1948.
- Moran, Walter H. (Chemistry), University. 1931.
- Munro, J. A. (Entomology), c/o American Embassy, La Paz, Bolivia, S. A. 1927.
- Murphy, H. E. (Chemistry), Teachers College, Dickinson.
- Nelson, Casper I. (Bacteriology), Agricultural College. 1915.
- Norum, E. B. (Soils), Agricultural College. 1948.
- 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.
- Ovrebo, 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.
- 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.
- 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.
- Ryan, Floyd T. (Forestry), School of Forestry, Bottineau. 1950.
- Saiki, Arthur K. (Pathology), University. 1949.
- Sands, F. H. (Chemistry), Agricultural College. 1946.
- Saugstad, Stanley. (Entomology), Minot. 1939.
- Saumur, Mrs. William G. (Pathology), Grand Forks. 1951.
- Schultz, J. H. (Horticulture), Agricultural College. 1948.
- Scott, George M. (Cereal Chemistry), Agricultural College. 1952.
- Sebens, William P. (Agriculture), Greater North Dakota Association, Fargo. 1948.
- Severson, Donald E. (Chemical Engineering), University. 1949.
- Severson, Roland G. (Chemistry), University. 1951.
- Shoesmith, Lloyd. (Soils), Agricultural College. 1950.
- Sibbitt, L. D. (Cereal Technology), Agricultural College. 1946.
- Sleeper, Bayard P. (Bacteriology), Agricultural College. 1952.
- Smith, Glenn S. (Plant Breeding), Agricultural College. 1930.
- Spier, Jack J. (Pathology), St. John's Hospital, Fargo. 1952.
- Staley, Raymond C. (Mathematics), University. 1946.
- Stallings, H. Dean. (Library), Agricultural College. 1951.
- 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.
- 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.
- Towse, Donald F. (Geology), University. 1952.
- Traverse, Alfred. (Plant Paleontology), U. S. Bureau of Mines, 1952.

- 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.
Wendland, Ray T. (Chemistry), Agricultural College. 1948.
Whedon, Arthur D. (Zoology), Danbury, Connecticut. 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.

MEMBERS ELECTED IN 1953

- Anderson, Sidney B. (Geology), North Dakota Geological Survey.
1953.
Ederstrom, Helge E. (Physiology), University. 1953.
Erickson, Roland I. (Mining), University. 1953.
Holmes, Richard R. (Chemistry), University. 1953.
Hoyer, Horst W. (Chemistry), University. 1953.
Keefer, Daryle E. (Psychology), University. 1953.
Keith, Eaden F., Jr. (Pharmacology), University. 1953.
Lium, Elder L. (Civil Engineering), University. 1953.
Manz, Oscar E. (Ceramic Engineering), University. 1953.
Reid, Neil J. (Mammalogy), Theodore Roosevelt National Memorial
Park, Medora. 1953.
Willamson, Arthur E. (Sanitary Engineering), State Health Depart-
ment, Bismarck. 1953.

NORTH DAKOTA ACADEMY OF SCIENCE

Minutes of the Forty-Fifth Annual Meeting

FRIDAY, MAY 1, 1953

President Wilson M. Laird called the meeting to order at 9:10 a.m., in the Student Union Ballroom on the Campus of the University of North Dakota. After brief introductory remarks the program proceeded as scheduled and the eight papers listed on the morning program were read and discussed.

The following committees were announced. Nominating Committee: G. C. Wheeler, Chairman; C. E. Miller, D. W. Bolin, H. B. Hart, and Lawrence Summers. Resolution Committee: Wouter Bosch, Chairman, G. A. Abbott, and Cyril C. Moore.

The proposed revision of the constitution was submitted to the Academy with the announcement that a vote on its adoption would be taken the following morning.

The morning session adjourned at 11:45 a.m. and was followed immediately by luncheon in the Student Union Cafeteria. Thirty-six visiting members were guests of the University.

The Academy reconvened at 1:30 p.m. in the Student Union Ballroom. The eight papers scheduled for the afternoon were read and discussed. At 4:00 p.m. the formal session was adjourned to permit the members to visit the Open House being held by the Medical School in the New Science Building.

The Academy Dinner, a joint meeting with the Red River Valley Section of the American Chemical Society, was sponsored by the local chapter of Sigma Xi. The dinner was held in the Student Union Ballroom with seventy five members and guests present. Dr. M. H. Chetrick, President of the University Chapter of Sigma Xi, presided at the dinner. He introduced Dr. E. D. Coon, President of the Red River Valley Section of the American Chemical Society who announced the officers of the A. C. S. who had been elected for the coming year and introduced their President-elect, Dr. W. B. Treumann. Academy President Wilson M. Laird then presented the guest speaker, Dr. A. Rodger Denison, Vice President of Amerada Petroleum Corporation who spoke on "Prospecting for Petroleum—An Examination of the Application of Geology to Oil Finding."

SATURDAY, MAY 2, 1953

The meeting was called to order at 9:05 a.m. in the Student Union Ballroom with President Laird presiding. The four papers scheduled for the morning were read and discussed.

The Annual Business Session was called to order at 10:20 a.m. The minutes of the 1952 meeting were approved as printed in the 1952 Proceedings. The treasurer's report was read and approved as read. The report of the Publication Committee by its Chairman,

Dr. Rae Harris, was adopted as given. Dr. G. C. Wheeler moved that the Academy express a formal vote of thanks to the Publication Committee and secretary for the work on the Proceedings. Motion was seconded by Professor Tuneberg and carried unanimously.

Chairman Wouter Bosch speaking for the Committee on Resolutions presented the following resolutions:

1. We express our appreciation to the University of North Dakota 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. A. Rodger Denison, Vice-President of Amerada Petroleum Corporation for his interesting address on 'Prospecting for Petroleum—An Examination of the Application of Geology to Oil Finding.'
3. We thank the Red River Valley Section of the American Chemical Society for its participation in our meetings.
4. Our thanks are extended to the local Sigma Xi Chapter for sponsoring the Academy Dinner.
5. We are especially grateful to the Administrations of the University and of the Agricultural College for continuing the policy of financing the publication of the Proceedings of the Academy and to the members of the Committee on Publications for the excellent work they have done.
6. 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.

The report was adopted as read.

The secretary read the names of eleven candidates who had been nominated for membership in the Academy. These candidates were unanimously elected and their names are given immediately following the list of active members in the first section of the Proceedings.

The proposed revision of the Constitution and By-Laws as prepared by the Constitution Committee consisting of J. Donald Henderson, chairman, Glenn C. Holm, and Jerome H. Svore was presented in sections. After considerable discussion resulting in a number of modifications and amendments, the Constitution and By-Laws as printed below were adopted.

CONSTITUTION OF THE NORTH DAKOTA ACADEMY OF SCIENCE

ARTICLE I - Name and Purpose

Section I. This association shall be called the North Dakota Academy of Science.

Section II. The purposes of this association shall be to promote and conduct scientific research and to diffuse scientific knowledge.

ARTICLE II - Membership

Section I. Active members shall be elected from persons interested in scientific work or active in research in any field of science. Candidates for membership may be proposed by any member of the Academy by submitting the candidate's name to the secretary for consideration by the membership committee. Upon nomination by the membership committee and election by a two-thirds vote at a regular meeting the candidate shall become an active member.

Section II. Honorary members may be elected in the same manner as active members except that they must receive unanimous approval of the members present at a regular meeting. Honorary members are exempt from the payment of dues.

ARTICLE III - Officers

Section I. The officers of the Academy of Science shall be a President, Vice President, and Secretary-Treasurer who shall perform the duties usually pertaining to these offices. The officers shall be chosen by ballot at the Annual Meeting and shall hold office for one year, or until their successors are duly elected. They shall take office at the close of the Annual Meeting.

Section II. The Executive Committee consisting of the above named officers and two other members elected for one year shall have charge of the ordinary executive duties such as the preparation of programs, selection of meeting place, and arrangement of the details of the meeting.

ARTICLE IV - Meetings

Section I. There shall be an Annual Meeting each year held at such time and place as the Executive Committee may determine.

Section II. Special meetings shall be called by the President upon the request of ten per cent of the active members. Only matters specified in the call can be transacted at a special meeting.

Section III. Ten per cent of the active members shall constitute a quorum at the Annual Meeting. Special meetings require twenty per cent of the active members for a quorum.

ARTICLE V - Amendments

- Section I. This Constitution may be amended at any Annual Meeting of the Academy by a two-thirds vote. Proposed amendments shall be submitted in writing to the secretary who shall send them to the members at least two weeks before the meeting at which such amendments are to be considered.
- Section II. By-laws may be adopted or repealed at any regular meeting by a two-thirds vote.

**BY-LAWS OF THE NORTH DAKOTA
ACADEMY OF SCIENCE**

1. The Academy's official guide for parliamentary procedure shall be the "Standard Code of Parliamentary Procedure" by Alice F. Sturgis.
2. The annual dues shall be determined by a two-thirds vote at an Annual Meeting. These dues are payable January 1 of each year.
3. Members shall be dropped from the active list following the non-payment of dues for two consecutive years. After being dropped a member may return to the active list by paying his dues for the past two years and the current year.
4. Each member on the current list of active and honorary members shall receive a copy of the annual Proceedings of the North Dakota Academy of Science.
5. Special offices such as Historian may be created by the unanimous vote of the members at an Annual Meeting.
6. The Academy's Representative to the American Association for the Advancement of Science shall be appointed by the Executive Committee. This Representative must meet all of the requirements of the American Association for the Advancement of Science.
7. The President shall appoint the following standing committees:
 - a. Nominating Committee of five members.
 - b. Membership Committee of five members.
 - c. Publication Committee of five members to include the secretary-treasurer and historian.
 - d. Resolution Committee of three members.
 - e. Necrology Committee of five members.

Chairman G. C. Wheeler of the Nominating Committee presented the following slate of candidates:

President	- - - -	Carl O. Clagett, Agricultural College
Vice President	- - - - -	G. A. Abbott, University
Secretary-Treasurer	-	J. Donald Henderson, University
Historian	- - - - -	G. A. Abbott, University

Additional Members of the Executive Committee:

Gerhard O. Ovrebo, Valley City

Jerome H. Svore, Bismarck

There were no nominations from the floor and the above candidates were unanimously elected.

Professor Everett Tuneberg of the School of Forestry invited the Academy to hold the 1954 meeting at Bottineau. The matter was left for the Executive Committee to decide.

The Academy adjourned at 11:55 a.m. and following adjournment, luncheon was held in the Student Union Cafeteria with twenty two visitors as guests of the University.

J. Donald Henderson
Secretary-Treasurer

PARASITES OF FISH OF TURTLE RIVER, NORTH DAK.

Glenn L. Hoffman

Department of Bacteriology

University of North Dakota, Grand Forks, North Dakota

During the summers of 1951 and 1952 fish were collected from Turtle River, Arvilla, North Dakota, and examined for parasites. To my knowledge no fish parasite surveys have been done previously in North Dakota or the Red River watershed.

A total of 195 fish belonging to 9 species from the families Catostomidae, Cyprinidae, and Percidae were examined and 180 (92%) were infected with at least one species of parasite. Surveys in Ontario, Wisconsin, and Wyoming by other workers have shown similar infection rates in fish: 75%-96% (1, 2, 3, 4, 5).

The muscle and integument were examined fresh and, in some cases, after pepsin digestion or Waring blendor maceration techniques. Some species of larval trematodes were easily recovered following the latter two techniques. The fins, eyes, gills, and viscera were examined fresh. In some cases it was found advantageous to digest the viscera in pepsin solution at 39°C. to free the parasites from tissue and mucus. This method must be used with discretion because most adult helminths and all stages of cestodes are soon destroyed; ten to 15 minutes were found satisfactory for intestinal helminths, however. The trematodes and cestodes were stained with celestin blue B and mounted. Nematodes and copepods were mounted unstained in glycerin jelly. No examinations were made for motile protozoa except that *Ichthyophthirius multifiliis* was found as a pest in an aquarium.

The fish were collected by seining from accessible pools. There are some predator fish, *Esox lucius*, in the stream but none

were obtained. Assisting in the collecting at various times were Mrs. Glenn Hoffman, Messrs. John Vennes, William Kinn, Douglas Norris, Robert O'Brien, and Louis Kaplan.

A new strigeid metacercaria, **Neascus nolfi**, (7) was discovered in the chub and northern common shiner. Another strigeid metacercaria, **Ornithodiplostomum ptychocheilus** was found in 4 new hosts; the northern common shiner, central bigmouth shiner, fathead minnow, and the northern creek chub (8). This metacercaria was also found in the cranial cavity of the common shiner, which constitutes a new location record. The copepod, **Ergasilus caeruleus** was found on one new host, the northern fathead minnow. Other new host rec-

TABLE 1
PARASITES ENCOUNTERED AND HOST FREQUENCY

	Number of species of fish
PROTOZOA	
Myxosoma sp.	6
CESTODA	
* Proteocephalus sp.	3
** Proteocephalus sp.	2
Bothriocephalus formosa	1
Glaridacris confusus	1
ACANTHOCEPHALA	
Pomphorhynchus bulbocolli	1
TREMATODA	
* Uvulifer (Neascus) ambloplitis	9
Gyodactyloidea	4
* Ornithodiplostomum ptychocheilus	4
* Bucephalus sp.	3
* Neascus nolfi	3
* Posthodiplostomum m. minimum	3
Phyllodistomum etheostomae	3
Allocreadium lobatum	1
* Diplostomulum sp.	1
Phyllodistomum fausti	1
P. notropidis	1
Phyllodistomum sp.	1
Triganodistomum attenuatum	1
NEMATODA	
* Larval nematode	5
Rhabdochona cascadilla	4
Philometra sp.	1
COPEPODA	
Ergasilus caeruleus	3
* Ergasilus sp.	2
Lernaea catostomi	1

ords established are **Phyllodistomum sp.** and **Rhabdochona cascadilla** in the central bigmouth shiner and **Phyllodistomum fausti** in the northern creek chub.

Dr. J. H. Fischthal verified the identification of the **Phyllodistomum** spp.; Dr. B. G. Chitwood identified the **Philometra** sp.; and Dr. R. M. Cable gave help in identifying the one specimen of **Centrovarium lobotes**; Dr. R. M. Bailey verified the fish identification.

Table 1 lists the species of parasites found and their host frequency. Larval trematodes were encountered more frequently than others. An asterisk (*) in front of the name indicates a larval form; two asterisks (**) indicate an immature adult.

The only two parasites that were found in abundance in single fish were **Uvulifer (Neascus) ambloplitis** and **Posthodiplostomum m. minimum**. The former has been shown to cause death to fish under experimental conditions (11). Hunter (10) found that large numbers of the cercariae of **Posthodiplostomum minimum** killed fish but the author (6) was able to infect a single fish with over 400 cercariae within a period of 3 hours without deleterious effect and has found as high as 4,544 in a single fish. In the latter, although the kidneys were tremendously enlarged due to the cysts, the fish appeared normal in other respects. To my knowledge no one has shown that either of these parasites harm their hosts under normal, natural conditions. Apparently very heavy infections can be built up over a period of time if the cercariae are dispersed by natural causes.

The species of fish examined are arranged in their families according to Hubbs and Lagler (9). The first number following the species denotes the number of that fish examined for that particular parasite; the second number denotes the number infected, and the percentage infected is listed. Larval forms are indicated by a single asterisk (*) and immature forms within the digestive tract are designated by a double asterisk(**).

CATOSTOMIDAE

1. **Catostomus c. commersonii** (Lac.) Common white sucker

PROTOZOA

Myxosoma sp. (gills) 8:3 (38%)

CESTODA

Glaridacris confusus (intest.) 9:1 (11%)

ACANTHOCEPHALA

Pomphorhynchus bulbocolli (intest.) 8:1 (13%)

TREMATODA

Uvulifer (Neascus) ambloplitis

(skin and muscle) 14:9 (64%)

Gyrodactyloidea (gills) 6:2 (33%)

Unidentified metacercaria (gut wall) 8:1 (13%)

Triganodistomum attenuatum (intest.) 8:1 (13%)

Phyllodistomum etheostomae (urinary bladder) 8:1 (13%)

NEMATODA

Philometra sp. (body cav.)	8:2	(25%)
*Larval nematode	8:1	(13%)

COPEPODA

Lernaea catostomi (base of fins) on adult fish only	8:3	(38%)
Ergasilus caeruleus (gills)	8:2	(25%)

Lernaea catostomi was found only on adult fish about 12 inches in length where they were unusually numerous, about 30 per fish. Only 2 adult males of **Philometra** sp. were recovered. **Glaridacris confusus** was rather numerous in the one infected fish; there were 60 present. **Neascus ambloplitis** was never numerous in infected fish with only 5 to 34 per fish. Only 2 specimens each of **T. attenuatum** and **P. etheostomae** were recovered.

CYPRINIDAE

1. **Notropis cornutus frontalis** (Agassiz) Northern common shiner

PROTOZOA

Myxosoma sp. (muscle, kidney, spleen, gills, intestinal wall)	11:4	(36%)
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CESTODA

Proteocephalus sp. (intest.)	11:4	(36%)
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TREMATODA

* Uvulifer (Neascus) ambloplitis	28:27	(96%)
* Posthodiplostomum m. minimum (mesent.)	25:24	(96%)
* Bucephalus sp. (muscle)	12:11	(92%)
* Ornithodiplostomum ptychocheilus (mesent.)	7:6	(86%)
* Ornithodiplostomum ptychocheilus (cran. cav)	12:7	(58%)
* Diplostomulum sp. (mesent.)	11:2	(18%)
Phyllodistomum notropidus (urin. blad.)	11:2	(18%)
* Neascus nolfi (muscle)	11:1	(9%)
Centrovarium lobotes (intest.)	11:1	(9%)
*Unidentified metacercaria (stomach mucosa)	11:1	(9%)

NEMATODA

Rhabdochona cascadilla (intest.)	11:6	(55%)
*Larval nematode (small; muscle and mesent.)	11:1	(9%)
*Larval nematode (red intest.; 2.8 mm.; in mesent.)	11:1	(9%)

The two most common parasites of this fish were **Neascus ambloplitis** and **P. m. minimum**. **N. ambloplitis** was usually present in far larger numbers per infected fish with 9 to 1100 per fish. The number of **P. m. minimum** in infected fish ranged from 2 to 170. Infections with the small strigeid **O. ptychocheilus** ranged from 1 to 10. The unusual location of this metacercaria in the cranial cavity constituted a new location as well as host record (8). The new species of strigeid, **Neascus nolfi** was described elsewhere (7). Only one specimen of **C. lobotes** was found.

Notropis d. dorsalis (Agassiz) Central bigmouth shiner

PROTOZOA

Myxosoma sp. (ovary)10:1 (10%)

TREMATODA

***Ornithodiplostomum ptychocheilus** (mesent.) 17:7 (41%)

*Unidentified metacercaria (mesent.)10:1 (10%)

Phyllodistomum sp. (urin. blad.)10:2 (20%)

***Uvulifer (Neascus) ambloplitis** (skin and muscle)41:3 (7%)

NEMATODA

Rhabdochona cascadilla (intest.)10:1 (10%)

These small fish, which were very numerous, were relatively free of parasites. The small strigeid, **O. ptychocheilus** was most frequently encountered with 1 to 12 present in the infected fish. This constituted a new host record (8). **Phyllodistomum sp.** and **R. cascadilla** in this fish also constitute new host records.

3. **Pimephales p. promelas** (Raf.) Northern fathead minnow

PROTOZOA

Myxosoma sp. (gills, kidney) 6:1 (17%)

CESTODA

***Proteocephalus** sp. (mesent.) 6:2 (33%)

TREMATODA

***Uvulifer (Neascus) ambloplitis**10:9 (90%)

***Posthodiplostomum m. minimum** (mesent.)10:9 (90%)

***Neascus nolfi** (muscle) 5:2 (40%)

*Unidentified metacercaria 5:2 (40%)

***Ornithodiplostomum ptychocheilus** (mesent.) 3:1 (33%)

***Bucephalus** sp. (muscle) 3:3 (30%)

Gyrodactyloidea (gills) 5:1 (20%)

COPEPODA

Ergasilus caeruleus (gills) 7:6 (86%)

The larval strigeids, **P. m. minimum** and **Neascus ambloplitis**, were most frequently encountered and most numerous in infected fish. Greatest numbers of each found were 445 and 77 respectively.

4. **Rhinichthys atratulus meleagris** (Agassiz) Western blacknose dace

TREMATODA

***Uvulifer (Neascus) ambloplitis** (skin and muscle)10:9 (53%)

Posthodiplostomum m. minimum (mesent.) 7:3 (43%)

*Unidentified metacercaria (muscle) 7:1 (14%)

**Unidentified immature trematode (urinary bladder) 7:1 (14%)

NEMATODA

*Larval nematode (small; mesent.) 7:1 (14%)

Rhabdochona cascadilla (intest.) 7:1 (14%)

These fish were not heavily parasitized. The greatest number of

parasites in a single fish were: **Neascus ambloplitis**—102; **R. cascadilla**—3; and **P. m. minimum**—3.

5. **Rhinichthys c. cataractae** (Val.) Great Lakes longnose dace
TREMATODA

***Uvulifer (Neascus) ambloplitis** (skin and muscle) 2:1 (50%)
Only two specimens of this fish were obtained.

6. **Semotilus a. atromaculatus** (Mitchell) Northern creek chub
PROTOZOA

Ichthyophthirius multifiliis (found on fish in tank) ?

CESTODA

****Proteocephalus** sp. (intest.) 11:1 (9%)

TREMATODA

***Uvulifer (Neascus) ambloplitis** (skin and muscle) 66:65 (98%)

***Neascus nolfi** (skin and muscle) 8:8 (100%)

***Posthodiplostomum m. minimum** (mesent.) 69:67 (97%)

***Ornithodiplostomum ptychocheilus** (mesent.) 19:17 (90%)

***Bucephalus** sp. (muscle) 11:9 (82%)

Phyllodistomum fausti (urin. blad.) 11:2 (18%)

*Unidentified metacercaria (stomach mucosa) 25:2 (8%)

Gyrodactyloidea (gills) 11:3 (27%)

Allocreadium lobatum 28:2 (7%)

NEMATODA

*Larval nematode (small; mesent.) 24:24 (100%)

*Larval nematode (red intest.; 2.8 mm.; in mesent.) 7:6 (86%)

Rhabdochona cascadilla (intest.) 28:28 (100%)

COPEPODA

Ergasilus caeruleus (gills) 11:1 (9%)

Larval strigeids, larval nematodes, and **R. cascadilla** were most frequently encountered. The range of these parasites in infected fish were: **Neascus ambloplitis** 6-990, **P. m. minimum** 1-355, larval nematodes 1-22 and **R. cascadilla** 1-38. The new species **Neascus nolfi** which was described elsewhere (7), was difficult to count because of being susceptible to pepsin digest; however, it didn't appear to be as numerous as **N. ambloplitis**. The occurrence of **O. ptychocheilus** and **P. fausti** constitute new host records. The unidentified metacercaria in the stomach mucosa seemed unusual and the writer couldn't find a published record of any metacercaria in the stomach mucosa of other fish. The two specimens of **A. lobatum** differ from the type specimen in some details and possibly represent a new species. They are tentatively identified as **A. lobatum** and further study will be made.

In 1934, Krull noted that small sunfish could be infected experimentally with a tremendous number of the cercariae of **N. ambloplitis** over a period of time, but that larger sunfish (about 6") could

be infected with only a very few. It is not known whether this is acquired or age immunity. Apparently the same thing occurs in the chub, because the small fish class averaged approximately as many *N. ambloplitis* cysts as the larger fish classes. The ranges fall on a bell curve. In the following table is given the numbers of cysts per length class of fish:

TABLE II

Length class of fish in inches	No. of fish	No. of Cysts range	Average No. of Cysts	Highest No. of Cysts per gram weight of fish
2-3	15	6-820	222.7	410
3-4	25	24-990	196.8	198
4-5	12	0-457	240.2	32
5-6	9	16-700	159.3	23

PERCIDAE

1. *Boleosoma n. nigrum* (Raf.) Central Johnny darter

PROTOZOA

Myxosoma sp. (gills)21:1 (5%)

CESTODA

**Proteocephalus* sp. (mesent.)21:12 (57%)

Bothriocephalus formosus (ceca)21:1 (%)

TREMATODA

**Uvulifer (Neascus) ambloplitis* (skin and muscle)21:9 (43%)

Phyllodistomum etheostomae (urin. bladder) 21:3 (14%)

*Unidentified metacercaria (mesent.)21.2 (10%)

These small fish, which were quite numerous in the stream, were not very heavily parasitized. Larval *Proteocephalus*, *Neascus ambloplitis* and nematodes were the most common and numerous. *Proteocephalus* was most numerous with 2 to 10 per infected fish whereas there were usually one to two *Neascus* and nematodes per infected fish. The larval copepod is tentatively identified as a species of *Eragasilus*, possibly the larva of *E. caeruleus*. *P. etheostomae* and *B. formosa* were the only adult helminths found.

2. *Hadropterus maculatus* (Girard) Blackside darter

PROTOZOA

Myxosoma sp. (operc.) 6:1 (17%)

CESTODA

**Proteocephalus* sp. (mesent.) 6:2 (33%)

TREMATODA

Gyrodactyloidea (gills) 6:2 (33%)

**Uvulifer (Neascus) ambloplitis* (skin and muscle) 6:2 (33%)

Phyllodistomum etheostomae (urin. blad.) 6:1 (17%)

NEMATODA

*Larval nematode (small; mesenteries and

musculature) 6:2 (33%)

COPEPODA

***Ergasilus?** larval (gills) 6:2 (33%)

These little fish were not as numerous as **Boleosoma n. nigrum**.

The larval copepod is tentatively identified as a species of **Ergasilus**; possibly it is the larva of **E. caeruleus**. Larval **Proteocephalus** were the most numerous in infected fish with 1 to 7 per infected fish. No more than one **Neascus ambloplitis** was found in a single fish.

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THE KINETICS OF THE DIELS-ALDER REACTION BETWEEN DIPHENYLBUTADIENE AND MALEIC ANHYDRIDE

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INTRODUCTION

The Diels-Alder reaction, also known as the "diene synthesis," is an addition reaction which occurs between the members of two large

classes of organic compounds. Although the Diels-Alder reaction has become extremely important in organic synthesis (6) its kinetic aspects have received remarkably little quantitative investigation.

The reactants employed in the present kinetic study of a typical Diels-Alder reaction were chosen because of their ease of purification and the freedom of their adduct from isomerism.

EXPERIMENTAL

The diene, *trans, trans*-1,4-diphenyl-1,3-butadiene, was prepared and purified by the method described by Corson (1). The dienophile, maleic anhydride, was twice recrystallized from chloroform. The corresponding adduct, 3,6-diphenyl-1,2,3,6-tetrahydrophthalic anhydride, was prepared and purified according to the procedure of Kuhn and Wagner-Jauregg (5).

Both the forward and reverse reactions were conducted in anisole solutions, of measured initial concentrations, contained in sealed Pyrex ampoules. Solutions for the forward reactions, equimolar with respect to diene and dienophile, were prepared by mixing solutions of the reactants immediately before their introduction into the vials.

Constant reaction temperatures were maintained by introducing the ampoules into flasks containing water, toluene, *n*-butyl alcohol or xylene refluxing at 100, 111, 117 and 141°C., respectively. The temperature 117°C. was used for the reverse reaction only.

At appropriate intervals, pairs of ampoules were removed, cooled and opened. A portion of the contents of each vessel was promptly diluted by a known factor with 95 *per cent* ethyl alcohol and the optical densities of the resulting solutions were measured at wave lengths of 3290, 3405 and 3460 Angstrom units, using a Model DU Beckman spectrophotometer. At these wave lengths the diene exhibits characteristic absorption maxima and a minimum. The corresponding extinction coefficients are 57200, 35600 and 37000 liter/mol-cm., respectively. The other components of the solutions exhibit negligible extinction coefficients, hence the concentration of the diene in each ampoule at the time of removal was directly available through application of Beer's law.

RESULTS AND CONCLUSIONS

For the forward reaction the reciprocal of the diene concentration is initially a linear function of the reaction time, hence the reaction is of the second order.

The reverse reaction proceeds to such a slight extent at the temperatures and concentrations employed that, within the limits of experimental error, all functions of the concentration of the adduct which correspond to reasonable orders would be linear functions of the reaction time. Therefore it is not possible to determine the order of the reverse reaction from the data obtained. However, Kistiakowsky and Lacher (3), Khambata and Wassermann (2), and Krzyzaniak (4) have shown that certain reverse Diels-Alder reactions

are of the first order. Reports of other orders have not been found in the literature. The reverse reaction of the present study is presumably also of the first order because all reverse Diels-Alder reactions probably proceed by the same mechanism. The reverse reaction rate constants and most of the thermodynamic quantities reported here have been computed on the assumption of a first order reverse reaction.

The rate constants were evaluated at each temperature from the slopes of the linear curves of the appropriate functions of concentration plotted against reaction time. The corresponding equilibrium constants (K) for the formation of one mol of adduct were computed from the ratio of the forward reaction rate constant (k_f) to the reverse reaction rate constant (k_r), employing the approximation that the reactants and product are ideal solutes. The standard state molal free energy increases were computed from the corresponding equilibrium constants. These temperature-dependent quantities appear in Table I.

TABLE I
REACTION RATE AND EQUILIBRIUM CONSTANTS

Temp.	k_f	$10^4 k_r$	$10^{-3} K$	Free Energy Increase
°C	l./mol-hr.	hr. ⁻¹		kcal./mol
100	0.738	1.9	4.0	-6.15
111	1.34	3.5	3.8	-6.29
117		5.1		
141	5.69	18	3.2	-6.63

Certain kinetic and thermodynamic characteristics of the reaction which are independent of temperature within experimental error over the range investigated may be obtained from the results presented above. Application of the Arrhenius equation yields activation energies of 15.4 and 17 kcal./mol for the forward and the reverse reactions, respectively, and frequency factors of 8×10^8 l./mol-hr. and 3×10^6 hr.⁻¹, respectively. For the formation of one mol of adduct the internal energy of the system is decreased by 1.8 kcal. and the entropy is increased by 11.7 cal./deg.

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PHOSPHOLIPIDE AND NUCLEOPROTEIN SYNTHESIS IN ISOLATED RAT LIVER SLICES

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ABSTRACT

Slices prepared from the livers of rats maintained on stock diet were incubated four hours at 37°C. The incubation medium consisted of freshly prepared Krebs-Ringer-phosphate buffer (pH 7.4) containing added glucose and approximately 2 millicuries of P32. At the termination of the incubation period, enzymatic activity was stopped by trichloroacetic acid and the lipide, nucleoprotein and inorganic phosphorus components of the tissue isolated. The phosphorus content, radioactivity and specific activity of the fractions were determined, as well as the nitrogen content of the nucleoprotein. The gamma of inorganic phosphorus incorporated into the phospholipides and nucleoproteins have been calculated.

Results indicate that the uptake of phosphorus in the phospholipide and nucleoprotein fractions of the isolated tissues was increased when the flasks were aerated with air. A greater increase in uptake was observed when the atmosphere used consisted of 95% oxygen and 5% carbon dioxide.

Livers from rats subjected to 700 r. of X-irradiation showed no change in phosphorus incorporation in the phospholipide and nucleoprotein molecules 20 hours post-irradiation, but a marked decrease was evident in both fractions 120 hours after the irradiation dose. (Work performed under contract AT-(11-1)-204 with the U. S. Atomic Energy Commission).

REACTION OF BENZYL MAGNESIUM CHLORIDE WITH CERTAIN alpha-HALOALKYL ETHERS

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Many of the reactions of benzylmagnesium halides yield products in which the entering group becomes attached to the ortho or para carbon atom of the aromatic ring¹. For example, the reactions of these Grignard reagents with alpha-haloalkyl ethers lead to such rearrangement. In this as in most other cases, the rearrangement does not proceed to the exclusion of the "normal" reaction; instead, there is obtained a mixture of the ortho-rearranged, para-rearranged, and "normal" products. In a previous study², it was concluded that with

ethers of the type ROCHXR' (where R is alkyl, R' is hydrogen or alkyl, and X is halogen), variations in the structure of either R or R' which cause a relative electron release toward the reaction center will facilitate the "normal" reaction.

If this conclusion is correct, it should be possible to predict the probable occurrence of rearrangement in cases not previously studied. The present paper reports the results of an investigation of two such cases.

The reaction of 1, 2-dichloro-1-ethoxyethane with benzylmagnesium chloride is recorded in the literature³, and the product is described as 1-benzyl-2-chloro-1-ethoxyethane. In this case the group R' of the haloalkyl ether contains the strongly electronegative Cl atom, and must exert an inductive effect of electron withdrawal from the reaction center. It seemed that rearrangement should occur in this case, and that the ether obtained could scarcely be a pure normal product. This reaction was therefore re-investigated.

Benzylmagnesium chloride, prepared from 38.0 g. (0.30 mole) of benzyl chloride and 7.3 g. (0.30 mole) of magnesium in 180 ml. of diethyl ether, was filtered through glass wool into a 500-ml. three-neck flask equipped with stirrer, reflux condenser, and dropping funnel. A solution of 34.3 g. (0.24 mole) of 1,2-dichloro-1-ethoxyethane (Eastman, redistilled) in 40 ml. of diethyl ether was added dropwise over a period of one hour, while the mixture was stirred and cooled in an ice bath. Stirring was then continued for ten minutes longer at the same temperature. All these operations were conducted under nitrogen. The mixture was poured into ice water containing 20 ml. of 12 N hydrochloric acid, and was then worked up as usual. Final distillation gave 20.2 g. (42% yield) of liquid product, b.p. 109-130° (9.5 mm.), n_D^{20} 1.5077. The wide b.p. range was for the purpose of including all isomers which might be present. (The b.p. previously reported³ for the product was 125-126° at 9.5 mm.) Of this material, a sample of 4.0 g. was oxidized by refluxing it for 4.5 hours with a solution containing 31.4 g. of potassium permanganate and 3.1 g. of sodium hydroxide in 380 ml. of water. The resulting carboxylic acids were separated by a method described by Gilman and Kirby¹. There was obtained 0.28 g. of terephthalic acid and 0.80 g. of benzoic acid. Phthalic acid was also present, but its isolation was complicated by the presence of, apparently, incompletely oxidized material. This material, like phthalic acid, was soluble in water and not very soluble in organic solvents. The terephthalic acid isolated corresponds to 8% of para-rearranged product. The benzoic acid represents at least 32% of normal product; but the actual amount of this product may have been more, because benzoate ion is readily oxidized by alkaline permanganate under the conditions employed⁵. In any case, the product of the reaction is obviously a mixture, containing perhaps 15 or 20% of rearranged material.

A duplicate experiment was carried out in almost identical

fashion, and yielded 36.9 g. (62%) of product, b. p. 110-130° (9.5 mm.), n_D^{20} 1.5089. In this case, however, the sample was redistilled to give 28.9 g. of material, b.p. 112-114° (9.5 mm.), n_D^{20} 1.5073. Anal: Calc'd for $C_{11}H_{10}OC_1$, C 17.85. Found, C 17.86, 17.54. This sample, in spite of its narrow boiling range, was not a pure substance. Oxidation as above gave, from 4.0 g. of sample, 0.32 g. of terephthalic acid (neutral equivalent calc'd 83.0, found 84.9), which represents 10% of para-rearranged product, and 0.75 g. of benzoic acid, representing at least 30% of normal product. The same difficulty as above was encountered with the phthalic acid fraction.

Another case of interest is that of alpha-chloroanisole. In this compound the group R is aromatic, and presumably its electronic effect (a mesomeric effect in this case, rather than an inductive one) can only be electron withdrawal. Rearrangement would again be predicted. This compound had been prepared once before⁶, but its chemistry had not been investigated. After preliminary studies⁷ in this laboratory had shown that it would react smoothly with Grignard reagents, its behavior with benzylmagnesium halides was investigated.

The reactions were carried out, on approximately a 0.2-mole scale, by a procedure essentially similar to that described above. Duplicate reactions were performed, including the use of different batches of benzyl chloride and of different preparations of alpha-chloroanisole. These duplicate reactions gave results as follows: Yields of ether product, 41%, b.p. 153-166° (14 mm.), n_D^{20} 1.5693; and 44%, b.p. 154-169° (14 mm.), n_D^{20} 1.5660. Yields of oxidation products from 4.0 g. of the ether product, 0.49 and 0.28 g. of terephthalic acid, 1.08 and 0.89 g. of phthalic anhydride, and 0.36 and 0.51 g. of benzoic acid. Oxidation was by refluxing for 8.5 hours with a solution of 42.5 g. of potassium permanganate and 1.0 g. of sodium hydroxide in 350 ml. of water. These amounts of terephthalic acid represent respectively 15% and 8% of para rearrangement; of phthalic anhydride, 35% and 30% of ortho rearrangement; and of benzoic acid, at least 15% and 21% of normal product. The total amount of rearrangement was therefore 50% and 38% in the two experiments. Comparatively, these are rather large percentages of rearrangement.

SUMMARY

Reactions of benzylmagnesium chloride with alpha-chloroanisole and with 1,2-dichloro-1-ethoxyethane were studied. Conclusions arrived at as a result of previous studies² would indicate that both these reactions should lead to products containing a considerable amount of rearranged material. This was found to be the case. The present work therefore serves to substantiate the previous conclusions, and to demonstrate that an empirical prediction as to the occurrence of rearrangement in such compounds can be made with some certainty.

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SUNFLOWER SEED OIL IN PAINTS AND VARNISHES

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ABSTRACT

Because corn and soybeans do not grow well in the northern part of North Dakota the sunflower plant, *Helianthus annus* L., has been considered as a row crop for this region. The price of sunflower seeds has not been consistently high enough to promise the farmer a good cash return and the harvesting presents difficulties when present methods are employed. However, should the oil from sunflower seeds find sufficient use in industry, the price could well become more stable and favorable.

The drying speed as a paint or varnish oil depends mainly upon the degree of unsaturation of the fatty acid radicals in the triglycerides within a plant species and is known to vary with the region in which it is grown. Higher temperatures favor the formation of saturated acids while lower temperatures are conducive to the formation of unsaturated acids. This makes the oil from northern grown varieties somewhat more desirable than that from seeds grown in southern states. Comparing the chemical compositions of linseed oil and sunflower oil, it has been proven that the latter does not contain linolenic acid which is commonly accepted as the cause of yellowing of varnishes and paints. During our investigations it was found that the iodine number of North Dakota and Canadian degummed sunflower oils is only slightly higher than that of degummed soybean oil and much lower than that of linseed oil. Yet the drying speed of sunflower oil was the same as that of linseed oil and much greater than that of soybean oil with or without the addition of driers.

With regard to the rate of heat bodying it was found that sunflower oil polymerizes slower than linseed oil at the same temperature. However, when cooking varnishes of an oil length of twenty five gallons, using a pentaerythritol esterified rosin, it was experienced that the time of cook for the sunflower oil varnish, the linseed oil varnish, and the soybean oil varnish was two hours, one hour and twenty minutes, and two hours and thirty minutes, respec-

tively. Interior white enamels were formulated with the above varnishes and a comparison of the various properties of the paints did not reveal important differences. The figures for dry-time, dry-hard time, flexibility, gas check, gloss, brushability and flow for the three different paints showed minor differences only.

In comparing the dry times of white outside house paints, formulated with linseed oil, sunflower oil, and soybean oil, it was found again that there was no appreciable deviation between sunflower and linseed oil paints. The soybean oil paint on the other hand dried slower and it took also longer for the latter paint to harden. This is easily explained because no varnishes are employed in the formulation of this type of paints and raw oils make up the major portion of the vehicle.

Summarizing it can be concluded from our investigations that in most cases North Dakota Sunflower Oil can take the place of linseed oil in the preparation of paints and varnishes. Due to an absence of linolenic acid, sunflower oil has the advantage that white interior enamels and clear varnishes should yellow to a much lesser extent.

THE EFFECT OF ENVIRONMENTAL CONDITIONS UPON THE STIMULATION OF GROWTH WITH ANTIBIOTICS IN A CHICK RATION

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ABSTRACT

One week old chicks from the same hatch were divided into eight lots of 20 chicks each. Four lots of chicks were housed in new quarters previously not used for rearing chicks. Two lots of chicks were fed the basal, and two lots were fed the basal plus aureomycin. The other four lots were fed and reared in old quarters under similar conditions in a laboratory previously used for chick growth studies. All chicks received the same basal ration, they were weighed weekly, and their feed consumption recorded.

The results were as follows:

Quarters	Ration	Grams Gained
Old	Basal	377
Old	Basal + aureomycin	452
New	Basal	406
New	Basal + aureomycin	460

These results show that the antibiotic increased the rate of growth in the old and new quarters. The food consumption was practically the same for all lots.

JURASSIC SYSTEM IN THE WILLISTON BASIN

*Donald Towse**Department of Geology**University of North Dakota, Grand Forks, North Dakota***ABSTRACT**

The Jurassic system in the Williston Basin is divided into the thin non-marine Morrison formation at the top and the thick marine Ellis group below. The Ellis group includes the Upper Jurassic Sundance formation and the Middle Jurassic Piper formation. No lower Jurassic rocks are known. Over most of the basin the Piper overlies Triassic Spearfish rocks, except in the north, where it overlies Mississippian or Devonian.

Center of Jurassic deposition was in western North Dakota, and a less important Jurassic basin was in southern Saskatchewan.

Grain size and relative amount of clastic material decreases in an easterly direction, and limestones and limy shales are more abundant in the areas of thickest accumulation.

The lower part of the Piper formation contains red shales and gypsum, and it is often difficult to separate it from underlying Triassic strata.

Members of the Sundance formation defined in the Black Hills cannot now be recognized within the basin, and the Rierdon formation of the Ellis group in Montana is not a readily mappable unit in North Dakota.

Oil has been produced in Wyoming, Montana, and Saskatchewan from rocks equivalent to the Sundance and Piper. Sundance sandstones and Piper limestones have suitable porosity and may be found to be productive on structure elsewhere in the basin.

EFFECT OF FLUORIDE ON TOOTH DECAY*Arthur E. Williamson and Jerome H. Svore**North Dakota State Department of Health, Bismarck, North Dakota***Introduction**

With the increased interest in the fluoridation of municipal water supplies, the North Dakota State Department of Health was faced with the problem of answering a number of questions in regard to fluoridation and its prevention of dental caries. Several of these questions were strictly local in nature, or pertaining definitely to North Dakota. A review of the literature was of no help in answering the questions and, in fact, showed that research on fluorides and dental decay had not progressed much beyond the initial stage of

definitely proving that fluorides were beneficial in preventing dental caries. The basic relationship of how, where, why, and when had not been determined, and very little information pertaining to geographical differences was available. Also, the criteria used for comparative purposes did not appear to be ideal and suggested that other comparative analyses should be derived.

In an attempt to answer our questions, it was decided to analyze the data that were available on North Dakota. The only material that was available consisted of dental surveys that had been made by the Oral Hygiene Division and, at the best, could be considered very rough data. The analysis of these data was sufficient to answer our immediate questions and the conclusions indicated by the study were sufficient to indicate that further study along these lines was necessary. Because of these new ideas, the material was published in 1951 with the hope of stirring up interest and promoting further research along the suggested lines. In an effort to prove, or disprove, our initial conclusions, it was felt that a precise, controlled dental survey should be made of school children in North Dakota. This survey was carried out through the help of the U. S. Public Health Service, and the data which will be discussed in this paper are the result of that survey.

Survey Methods

In this survey, ten of our larger North Dakota cities were selected for study. The basis of selection was on population, fluoride content of municipal water supply, and continuity of the water source over the past fifteen years. In these cities, the children selected for the survey were only those who had been born and raised in that city and who had used the municipal water supply throughout their life. All school children between the ages of 6 and 14 who could fill these qualifications were included in the study.

On the basis of selection described, the cities fall into three fluoride groups: the low or absent fluoride group, the medium or .5 part per million group, and the high or 2.3 parts per million group. Due to the small population of our state, it was impossible to carry out the study at closer fluoride intervals. Because of the method used in selecting the children for study, not more than 20 per cent of any school group is apt to qualify. Therefore, unless a large population is available it is difficult to get a representative sample.

The actual dental inspections were made by two dental officers from the U. S. Public Health Service. These men were utilized so that a uniform inspection technique would be followed and the data would be comparable to that obtained from other states at a later date.

Data Obtained

In this survey, 3,200 school children were examined. The distribution, according to fluoride content of the water supply and by age

groups, is shown in Table I. It would have been desirable to have a large number of children in the high fluoride category, however they could not be obtained due to our small population.

TABLE I

DISTRIBUTION OF SCHOOL CHILDREN BY AGE GROUP AND FLUORIDE CONTENT OF WATER

Age	Total	Ave.	Total	Ave.	Total	Ave.
	Children	DMF	Children	DMF	Children	DMF
	0.0 P.P.M. F ⁻		0.5 P.P.M. F ⁻		2.3 P.P.M. F ⁻	
6	248	.71	297	.44	48	.04
7	194	1.75	211	1.12	43	.37
8	200	2.80	215	1.90	36	.47
9	160	3.45	195	2.37	42	1.31
10	140	4.37	166	2.73	34	1.33
11	112	5.61	128	3.59	29	1.48
12	137	6.30	147	4.37	22	1.95
13	115	8.37	120	5.35	18	2.06
14	74	10.45	67	6.27	13	2.77

When the data in Table I are plotted, using simple arithmetic scales, three distinct curves are formed which show a definite relationship between the fluoride content and the average DMF values per child. The general shape of the curves is of interest in that they are compound curves, with the inflection point at approximately 9 years of age. The two segments of the curve appear to be logarithmic in nature.

Since the arithmetic curves appeared to be of a logarithmic nature, the data were plotted on semilog paper for further study. This produced straightline functions made up of two intersecting segments with the intercepting point of the curves ranging from 9 to 13-year-old age groups. The slope of the straight lines on the semilog plotting are indicative of the rate of decay. For purposes of discussions, this slope or rate, in units of years per DMF, has been defined as a rate of protection. A true rate of decay would be in the units DMF per year, and the one which will be discussed is a reciprocal of this rate. The curves show that the rate of protection increases with the fluoride content, and in all cases there is a change in the rate of protection above a given age. In all cases, this is a decrease in the rate of protection, indicating that decay has become more active. This observation poses two unanswered questions: No. 1) Why should there be a change in the rate of protection above a given age? and No. 2) Why should the age at which this change occurs increase with the fluoride content?

For further study, the North Dakota curves were compared with data obtained in other portions of the United States. Information was available in the literature on dental surveys that had been made at

Grand Rapids, Michigan; Newburgh, New York; and Aurora, Illinois. The fluoride content of these water supplies was known and the method of making the surveys was very comparable to those used in North Dakota. These data, shown in Table II, when plotted on semilog scales, produced curves identical with those obtained by the North Dakota data and they also fall into the proper places according to the fluoride content. This would indicate that the general shape of the curve is as shown and not something peculiar to North Dakota conditions.

TABLE II

Age	Out of State Data (1), (2)					
	Grand Rapids, Mich.		Newburgh, N. Y.		Aurora, Ill.	
	Total Children	Ave. DMF F ⁻	Total Children	Ave. DMF F ⁻	Total Children	Ave. DMF F ⁻
	0.0 P.P.M.		0.1 P.P.M.		1.2 P.P.M.	
6	1,789	0.78		0.48	473	0.28
7	1,806	1.89		1.05	516	0.70
8	1,647	2.94		1.95	469	1.04
9	1,639	3.90		3.11	368	1.52
10	1,626	4.92		4.01	397	2.02
11	1,556	6.41		4.84	383	2.67
12	1,685	8.07		6.36	401	2.95
13	1,668	9.73		7.43	401	3.09
14	1,690	10.94		8.50	433	3.64
15	1,511	12.48			467	4.54
16	1,107	13.50			371	5.19

- (1) Data from Article, "Water Fluoridation," by C. R. Cox and D. B. Ast, Journal of the American Water Works Association, Vol. 43, No. 8, August, 1951.
- (2) Data from Article, "Effect of Fluoridated Public Water Supplies on Dental Caries Prevalence", by F. A. Arnold, Jr., H. T. Dean, and J. W. Knutson, Vol. 68, No. 2, February, 1953, issue of Public Health Reports.

The natural rate for North Dakota (0 ppm fluoride curve) is somewhat greater than the corresponding rate for Grand Rapids, Michigan. This could possibly be due to a climatic factor, such as sunshine. The rate of protection for Newburgh, New York (.1 ppm fluoride curve) is greater than the natural rate for North Dakota. Since we would expect similar climatic conditions between Grand Rapids, Michigan, and Newburgh, New York, insofar as sunshine is concerned, the increase in the rate of protection must be accredited to the small amount of fluoride present in the water supply.

For convenient comparison, the rates of protection, or K values of the various curves, are given in Table III with the corresponding fluoride content. The rates both above and below the break point

of the curve are given. When these data are plotted on arithmetic scales, the curve of best fit is a straight line and indicates that the relationship of fluoride to tooth protection is a straight-line function. Above the break point of the curves, the linear relationship of rate of protection to fluoride content appears to hold up to concentrations of approximately 1.2 ppm. The data in the present survey are not extensive enough beyond the range of 1.2 ppm fluoride to determine the shape of the curve beyond this point. However, if the data available were considered an indication of the trend, it appears that the curve would level off and approach some asymptotic value in the vicinity of .055.

TABLE III
RATES OF PROTECTION

Group	Fluoride Content	Rates of Protection	
		(1)	(2)
Grand Rapids, Mich.	0.0	.057	.023
North Dakota, Low	0.0	.062	.023
Newburgh, N. Y.	0.1	.063	.03
North Dakota, Med.	0.5	.088	.036
Aurora, Ill.	1.2	.120	.046
North Dakota, High	2.3	.176	.051*

*Indicated value.

(1) Below break point of curve.

(2) Above break point of curve.

The observation that tooth protection is a directly proportional function of the fluoride content is of considerable interest. It has been the general opinion of previous authors and people active in the field of fluoridation that any fluoride content below .5 ppm was of little or no value in the protection of teeth. As the rate of protection appears to be directly proportional to the fluoride content, we then must concede that .1 ppm of fluoride does as much good, proportionately, as 1 ppm and, economically speaking, would bring equal returns for the investment.

To further investigate the inflection point of the curves, various methods of plotting the data were tried. None of the methods tried helped in interpreting the material in any way, however one study involving a correlation with the average number of teeth present at a given age did bring forth additional points of interest. When the average DMF values are expressed as a percentage of the possible maximum for that age, Table IV, and plotted against the corresponding age, another family of curves is produced but the general shape is quite different from previous curves. The general observation is that for the period of 8 to 11 years, the percentage of decay remains constant with sharply rising percentages of decay both below and above these age limits. When the manner in which permanent teeth

erupt between the ages of 6 and 13 years is considered, the conclusion is that it is approximately a straight-line function. The general shape of the percentage of decay curves, when considered with the manner in which the teeth erupt, would indicate that some strong anti-decay factor is operating through the period of 8 to 11 years of age. That it is some factor other than fluorides is borne out by the fact that the flat portion of the curve is very prominent in the 0 ppm fluoride group. This same flattened portion of the curve is present for the other fluoride groups, however, the presence or effect of fluorides tends to mask this portion of the curve and, in fact, tends to straighten the curve into one horizontal line as the fluoride concentrations increase. At present, no explanation can be given for this apparent decay-resistant period and this certainly presents a point for further research and study.

TABLE IV

DECAY AS A PERCENTAGE OF POSSIBLE AT A GIVEN AGE

Age	Ave. No. Perm. Teeth (1)	Ave. Percent DMF		Ave. Percent DMF		Ave. Percent DMF		Ave. Percent DMF	
		Grand Rapids, Mich.		N. D. Low		N. D. Med.		N. D. High	
6	4.92	.78	15.8	.71	14.4	.44	8.95	.04	.81
7	8.95	1.89	21.1	1.73	19.3	1.12	12.5	.37	4.1
8	11.6	2.94	25.4	2.85	24.6	1.90	16.4	.47	4.0
9	14.3	3.90	27.3	3.40	23.8	2.37	16.5	1.31	9.2
10	19.1	4.92	27.1	4.37	24.1	2.73	15.1	1.33	7.3
11	22.3	6.41	28.7	5.61	25.1	3.59	16.1	1.48	6.6
12	25.1	8.07	32.1	6.18	24.6	4.37	17.4	1.95	7.8
13	28.0	9.73	34.7	8.50	30.3	5.37	19.1	2.06	7.4
14	28.0	10.94	39.1	10.45	37.3	6.27	22.4	2.77	9.9

- (1) Newburgh-Kingston Caries Fluorine Study III, D. B. Ast., S. B. Finn, H. C. Chase, Journal of American Dental Association, Vol. 42, P. 188-195, February, 1951.

Conclusions

1. There is a definite relationship between fluoride content and tooth decay in North Dakota. In different school groups having water supplies of different fluoride content, the relationship between age and DMF per child follows the same general type of curve. This curve is compound in nature, with definite inflection points, and appears to be logarithmic.

2. Rate of protection values can be determined for any group using a common water supply, however, there will be a change or lessening of the rate of protection above the ages of 10 to 13 years, depending upon the original fluoride content.

3. Data from dental surveys outside of North Dakota show the same general change in rates of protection. There is some difference between the natural rates of protection for North Dakota and other portions of the country which may be due to climatic differences.

4. The rate of protection for the teeth is a straight-line function of the fluoride content. Therefore, very low fluoride concentrations do as much good proportionately as the optimum amounts.

5. For comparative purposes, protection rate values should be a much better criteria than specific DMF per age group data.

6. Some factor other than the presence of fluoride retards decay between the ages of 8 and 11 years.

7. The two unexplained observations in the present survey should be further investigated; namely, No. 1) Why does the rate of protection change above a certain age limit? and No. 2) What is the apparent anti-decay factor operating between the ages of 8 and 11 years?

THE EFFECT OF VARIOUS TREATMENTS ON BRABENDER EXTENSOGRAMS

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ABSTRACT

The Brabender Extensograph is used as an instrument for supplying quantitative information to the miller and baker with regard to the dough handling characteristics of flours. It is a supplementary test to the baking test and in special cases may replace the baking test.

Flour-water-salt doughs are mixed, scaled to a constant weight, rounded and moulded into a "sausage shape" approximately 1½ inches in diameter and 7 inches long. These doughs are then placed in holders and permitted to rest for various periods of time in controlled temperature cabinets. After the rest periods the dough and holders are transferred to the stretching mechanism. A movable hook travelling at a constant velocity stretches the dough until it breaks. At the same time a recording pen is tracing a curve on kymograph paper, indicating the extension properties of the dough. The dough properties quantitatively measured are extensibility, which is curve length, and resistance to extension, which is curve height.

To develop a constant procedure using North Dakota wheats, studies were made using 0-4% sodium chloride based on flour at 13.5% moisture level. The time interval between moulding and stretching the dough was 45 minutes. It was found that both the resistance to extension and the extensibility increased with increas-

ing salt concentration and that the curve for weak doughs approached that for strong doughs as the concentration was increased.

Another study showed the effects of the addition of potassium bromate in increments from 0 to 4 mg %. In this case the initial curves were obtained after 45 minutes rest and were comparable to the curves of unbromated doughs. But a second curve taken after 180 minutes from mixing and 45 minutes from reworking the dough showed an increase in resistance to extension and a decrease in extensibility. These changes may be explained by oxidation of sulfhydryl groups in the flour proteins, or the formation of cross-linkages between the protein molecules.

Mixing time was found to affect the shape of the curves. Using the Hobart and Swanson mixers it was found that in the 180 minute curves for markedly overmixed doughs (6 minutes in the Swanson or 12 minutes in the Hobart) the resistance to extension increased while the extensibility decreased. Probably the reducing groups are oxidized by atmospheric oxygen when mixing is prolonged.

On the basis of this information a standard mixing time of three minutes using the Hobart mixer and a salt level of 1% was selected for variety testing. To determine response to oxidation of the flour a second dough is mixed which contains 3 mg. % of potassium bromate. This procedure is employed to ascertain the physical properties of doughs from varieties grown in Experiment Station plots. This work is particularly pertinent at this time when new wheats resistant to 15 B stem rust are in the process of development.

ANALYSIS OF WILLISTON BASIN CRUDE OIL

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An earlier report on the analytical characteristics of gasoline derived from Tioga petroleum (1), was based on data obtained from one crude. The contribution of this paper is to extend the analysis to several crudes and thereby evolve a general basis for determining the types of hydrocarbons present, percentage of gasoline, octane numbers, residues, etc.

The crude oil was obtained directly from the wells of the Amerada Petroleum Company. From this point, the analysis included: 1st removal of the gasoline and light oils by distillation under reduced pressure; 2nd redistillation of the gasoline into thirteen fractions by means of a helix packed column equipped for reflux and containing the equivalent of fifteen theoretical plates; 3rd evaluation of the fractions through use of refractive index, density, specific dispersion and specific refraction. The values obtained were correlated

with constitution by reference to the system of identifying hydrocarbon types developed earlier by Wendland (2). The complex mixture of alkanes, cyclanes and aromatics present in gasoline does not lend itself to complete separation. Thus, it was necessary to make a "profile" type of analysis in which the values obtained from the individual fractions were plotted against known properties of hydrocarbon types occurring in natural gasolines. The types include the alkanes, cyclopentanes, cyclohexanes and alkyl benzenes. In Figure I, the boiling points of these hydrocarbons are plotted versus refractive indices. Properties of the fractions derived from a typical Williston Basin Crude, the H. O. Bakken, are given in Table I and are superimposed on Figure I as shown by the heavy line.

From Figure I and Table I it can be seen that the average refractive index values obtained lie uniformly above those that would be expected for a mixture of straight alkanes. This implies the presence of naphthenes in the lower boiling fractions and substituted benzenes in the higher fractions. Specific dispersion values remain near 100 in the lower fractions except for a slight elevation near 80°C. This shows the presence of mostly alkanes and cyclanes and a trace of benzene. The increased refractive index reading in the 79 to 82°C fraction shows the presence of a significant amount of cyclohexane rather than benzene. In this same range, the specific dispersion value of cyclohexane (96.2) and that of benzene (189.8), in comparison to the experimental value of (101.9), shows that the majority of this fraction is composed of cyclohexane. Again, in this same range, the only alkanes that could be present are: 2,2-Dimethylpentane and 2,2,3-Trimethylbutane, but their lower refractive index shows them to be present in lesser quantity than cyclohexane. Between 82 and 100°C the drop in refractive index along with a specific dispersion value of 98.9 show the presence of a majority of C₇ alkanes. This, of course, is to be expected since no substituted benzenes or cyclohexanes boil in this range. From 100 to 107°C the high refractive index indicates that methyl cyclohexane is present in considerable amount along with some C₈ branched alkanes. At this point the specific dispersion also increases significantly showing that some toluene was carried over. The high refractive index and specific dispersion values of the next fraction prove that toluene is present as probably the major component. From 112 to 132°C the refractive index drops again indicating the presence of mainly alkanes in the range of C₈ to C₉. In the xylene range (132 to 145°C), the increased refractive index and specific dispersion prove the presence of xylenes probably mixed with ethyl benzene and some alkanes. Trimethyl benzenes and alkanes constitute the major portion of the 145 to 150° fraction. From 150 to 176° C. the refractive index and specific dispersion drop and indicate a large amount of the C₁₀ alkanes. Above 176°C the composition of gasoline becomes too complex to attempt separation in the type of apparatus used. Thus, it is only possible to predict that substituted benzenes

are present and that the major portion of this fraction would be composed of alkanes in the C₁₀ to C₁₂ range. For further separation of these higher boiling fractions, it is suggested that the method of Van Nes and Van Westen (3) be used.

It was found that the other samples of crude oil examined had properties that compared very closely with those of Figure I. For this reason, only a summary of their individual properties is given in Table II.

TABLE I

ANALYTICAL PROPERTIES OF THE H. O. BAKKEN CRUDE OIL

Crude oil Analysis

Date **Jan. 17, 1953**

A Name of Crude, H. O. Bakken Run No. 2. Wt. 2405.0 g. Vol. 3000 cc. at 25°C. Density 0.813²⁰ N²⁰D 1.4575 Z 19.75 Sp. D. 121.0 r .336.

B First Fractionation—up to 150°C. and 1 mm. Hg. pressure, or less. Distillate—containing Gasoline, Kerosene and Light Oils. For use in part C. Wt. 1445.6 g. Vol. 1868cc. at 20°C. Density 0.779²⁰ N²⁰D 1.4375 Z 19.5 Sp. D. 118.5 r .336.

Residue—For use in catalytic cracking. See separate report Wt. 859.0 g. Vol. 972 cc. at 60°C. Density 0.885 Total Wt. 2304.5 g. Loss of Wt. 100.4 g. (Presumed to be low boiling fractions)

C Rectification and Analysis of Gasoline

Date **Jan. 23, 1953**

Start. Wt. (- of above dist. minus -g. Transf. Loss) = **Wt. 722.8g. Vol. 929cc. at 20°C** See part **B** for physical constants of starting material. Reflux Ratio **15/1.**

Fraction	Boiling Range	Wt.	Vol.	Density	N ²⁰ D	Z	Sp. D	r	Wt. % of Mixture
1	20-40°C.	19.4g.	30.9cc.	0.627	1.3581	17.75	96.7	.350	4.6
2	40-55	7.0	10.6	0.657	1.3720	18.0	98.7	.346	1.7
3	55-70	37.5	55.3	0.679	1.3835	18.25	102.1	.344	8.9
4	70-79	16.7	22.9	0.731	1.4062	18.75	107.0	.336	4.0
5	79-82	6.3	8.4	0.747	1.4126	18.5	101.9	.334	1.5
6	82-100	46.7	64.5	0.725	1.4040	18.25	98.9	.337	11.1
7	100-107	31.6	41.4	0.763	1.4265	19.5	118.9	.336	7.5
8	107-112	15.4	20.3	0.760	1.4255	19.5	119.2	.337	3.7
9	112-132	50.6	67.3	0.752	1.4208	19.5	119.6	.337	12.1
10	132-145	42.3	54.8	0.774	1.4342	19.75	122.6	.337	10.1
11	145-150	17.0	22.0	0.774	1.4333	19.75	122.5	.336	4.1
12	150-176	82.8	105.7	0.783	1.4385	19.25	113.7	.336	19.8
13	176-200	45.6	57.6	0.792	1.4431	19.0	109.3	.335	10.9
									100%

Gasoline Wt. $418.9 \times 2 = 837.8g$	57.9
Keros.+Oil $283.2 \times 2 = 566.4$	39.2
Rectif. Loss $20.7 \times 2 = 41.4$ (presumed to be light frac.)	2.9

100.0%

TABLE II

PROPERTIES OF THREE WILLISTON BASIN CRUDE OILS

CRUDE	Math Iverson	H. O. Bakken	Benhommer Risser
Density	0.808	0.813	0.812
N ²⁰ D	1.4530	1.4575	1.4558
Sp. D.	120.9	121.0	120.8
r	.335	.336	.335
GASOLINE			
Density	0.765	0.779	0.778
N ²⁰ D	1.4360	1.4375	1.4374
Sp. D	116.2	118.5	118.6
r	.342	.336	.337
Wt. % of Crude	37.0	34.8	37.8
KEROSENE & OIL			
Wt. % of Crude	20.9	23.6	22.5
RESIDUE			
Wt. % of Crude	33.7	35.7	35.1
LOSS			
Wt. % of Crude	7.5	5.9	4.6
OCTANE NUMBER	54.0	54.3	53.7

SUMMARY

By characterization of several samples of Williston Basin crude oil using the method outlined, it is possible to draw the following general conclusions:

1. Natural gasoline comprises about 36 weight % of the original crude.
2. The kerosenes and light fuel oils contain significant amounts of aromatics and comprise about 22 weight % of the original crude.
3. The residue of higher boiling fractions comprises about 35 weight % of the original crude.
4. Octane number of the natural gasoline is about 54. This requires upgrading to meet the requirements of present day engines.
5. Sulfur content and corrosive action are well within the required limits.
6. Benzene is nearly absent, but cyclohexane or methyl cyclopentane are present in significant quantity.
7. Toluene, xylenes and mesitylenes are present in the higher fractions.

- Detailed analysis of the Iverson and Risser crudes shows them to have essentially the same composition as the Bakken.

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THE "BROWNING REACTION" IN MACARONI DISCS

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ABSTRACT

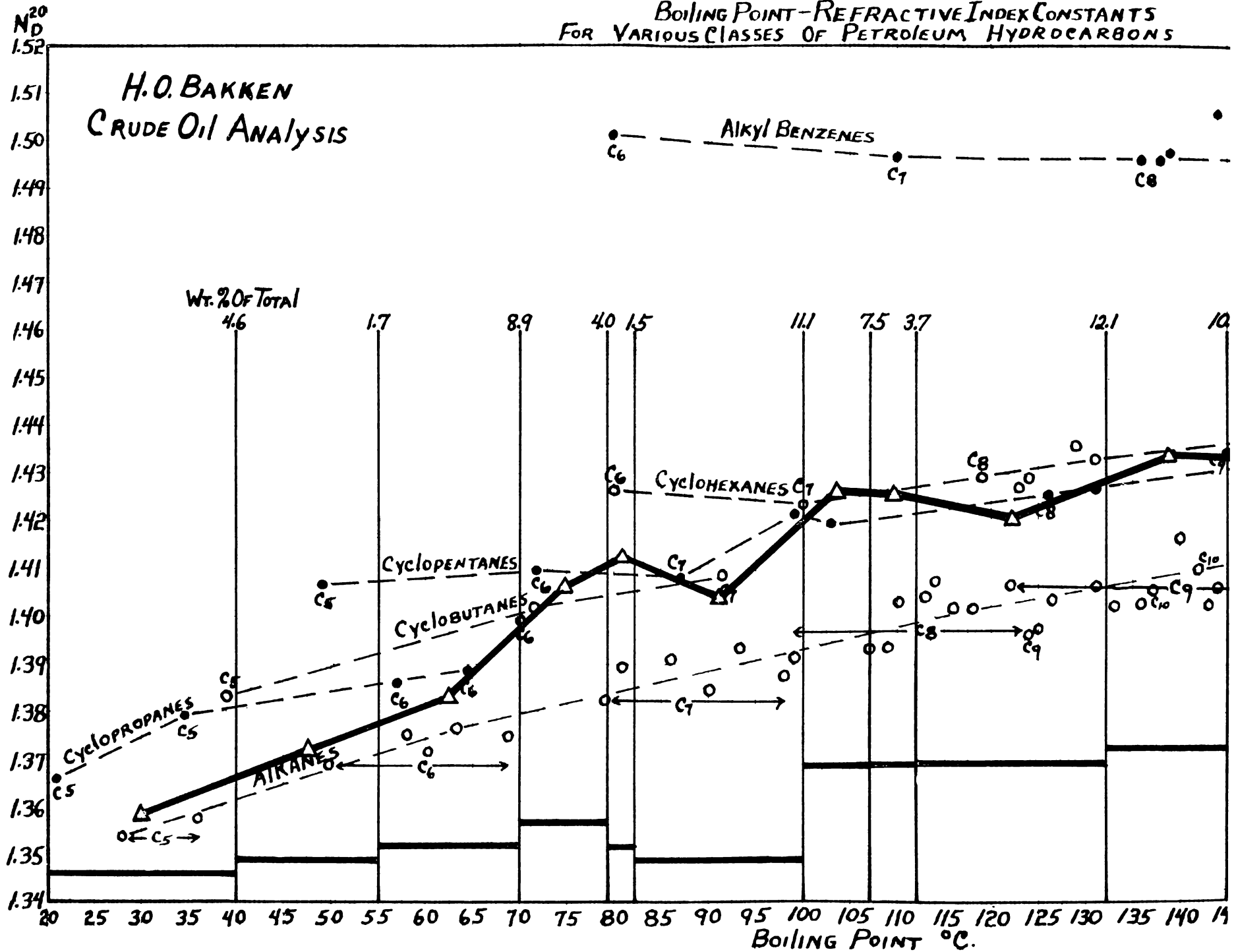
Pressed macaroni discs developed a dark brown color when dried for one hour at 130°C. Pressure and heat were necessary for this effect since unpressed as well as air-dried discs remained unchanged. The reaction involved was similar to the characteristic browning reaction occurring in many food products where a protein-carbohydrate complex is formed. The reducing capacity of the complex was determined as a method of observing the reaction. By adding various amounts of sucrose, glucose, dextrin and maltose to the mix, it was shown that glucose was the principle carbohydrate involved. The reactive group (s) of the protein was studied to determine how the complex is formed. A carboxyamino (or sulfhydryl) linkage had been suspected since compounds of this nature have been prepared. Semolina, premixed with a 3% formaldehyde solution, air dried and ground, then remixed and pressed, showed no browning. Therefore, it was concluded that NH_2 -and-SH are probably involved. Since a positive nitroprusside test was not obtained, it is probable that the amino group was combined with the carbohydrate.

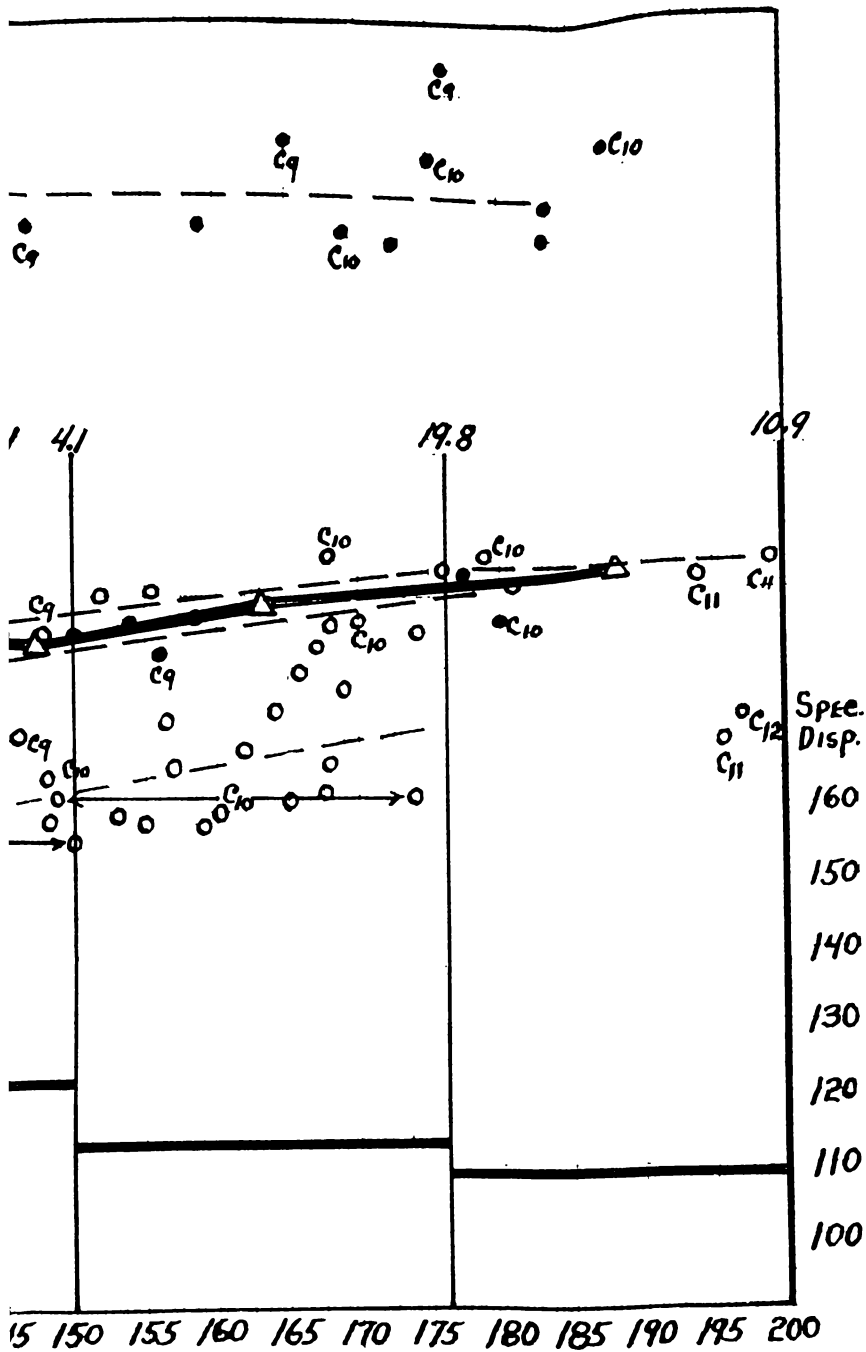
Sodium bisulfite and cysteine hydrochloride are used as anti-browning agents. However, they appeared to increase browning in the discs. Their usual action may have been reversed due to the interfering effects of pressure and heat.

Color production in pressed macaroni discs during oven drying is apparently related to the formation of reducing compounds. The changes in reflected light of the ground disc was measured with a Beckman spectrophotometer fitted with a reflection attachment. A highly significant correlation coefficient (+0.926) was obtained between absorbed light and reducing groups.

FIGURE I

BOILING POINT-REFRACTIVE INDEX CONSTANTS
FOR VARIOUS CLASSES OF PETROLEUM HYDROCARBONS





HOW GOOD ARE pH- INDICATOR PAPERS?

*Richard E. Frank**Department of Chemistry**University of North Dakota, Grand Forks, North Dakota***ABSTRACT**

Startled by an instance of spectacularly misindicated pH, the author has checked the validity of pH-tests with indicator papers in general. The solutions into which the test papers were dipped, were at the same time tested with dissolved indicators and with the glass-electrode pH-meter. Uniformity was assured by continuous stirring. No major deviations of the "paper values" were found while dealing with well buffered solutions. In poorly buffered systems, however, misreadings of several pH-units were apparent over a large and important part of the pH-scale.

A simple demonstration was given and an explanation for the observed facts was offered.

The author does not think his observations are strikingly new. Rather, former knowledge seems to have been forgotten because of the great convenience and speed of the paper test. Knowledge of its limitations is bound to avoid embarrassment and enhance the usefulness of the "quickie" test within its proper field.

ANTIPYRINE HYDROCHLORIDE*A. Knevel and C. E. Miller**School of Pharmacy**North Dakota Agricultural College, Fargo, North Dakota*

In the study of the condensation reaction between active hydrogen compounds and ethyl chloroformate our attention was called to the published record of Ludwig and Piech (1) who reported the use of antipyrine as a hydrogen chloride acceptor. According to their report antipyrine hydrochloride formed at relatively low temperature and a contact time of reactants of at least twelve hours. The authors did not mention any data concerning this compound.

We have already established the efficacy of such compounds as dimethylaniline, pyridine, morpholine, piperidine and aqueous solutions of sodium hydroxide as catalysts for condensation reactions involving ethyl chloroformate (2). Because of the relative neutral reaction of antipyrine the reported formation of its hydrochloride was of more than casual interest to us.

The purpose of this paper is to describe our method of preparation and to record our observations relative to the properties of antipyrine

hydrochloride. A typical run describing the laboratory procedure for isolating the antipyrene hydrochloride is given herewith.

EXPERIMENTAL

Antipyrene Hydrochloride. In a 500 cc. three-necked flask fitted with a dropping funnel, stirrer, thermometer and a condenser was placed 0.1 mole of the active hydrogen compound, 0.1 mole of antipyrene and 150 cc. of 1,4-dioxane. The contents of the flask were stirred to facilitate the dissolving of the antipyrene. Then 0.1 mole of ethyl chloroformate was added dropwise and the flask and its contents heated to the refluxing point of 1,4-dioxane. After about 45 minutes the formation of a white crystalline precipitate was observed. The refluxing was continued for an additional three hours, after which the contents were allowed to cool and the solid crystalline material collected by filtering. After washing with ether and air drying there was obtained a yield of 0.05 mole (50 per cent) of antipyrene hydrochloride.

The following observations and comparisons of the antipyrene hydrochloride isolated with that of antipyrene were made.

TABLE I

	Antipyrene	Antipyrene Hydrochloride
Water Soluble	Yes	Yes
Ether Soluble	Yes	No
Presence of Cl ⁻	No	Yes
pH of 1% w/v Soln. 30°	7.03	1.82
Volatility	Neg.	21.5% in 12 hours
Identity Tests (3)		
a) Tannic Acid	Positive	Positive
b) Vanillin	Positive	Positive
c) Sodium Nitrite	Positive	Positive

Treatment of the antipyrene hydrochloride with sodium hydroxide solution and extraction with ether followed by evaporation of the solvent yielded free antipyrene. This material gave positive tests with Tannic Acid, Vanillin and Sodium Nitrite.

Conclusions

1. A water soluble hydrochloride was isolated from the antipyrene catalyzed reaction involving ethyl chloroformate and an active hydrogen compound.
2. Certain physical and chemical properties of this compound have been determined.
3. What is considered final proof of the identity of this compound are the positive reactions observed when the isolated antipyrene from the alkaline hydrolysis of the hydrochloride is treated with vanillin, tannic acid, and sodium nitrite.

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THE REACTION OF ZIRCONYL CHLORIDE WITH CERTAIN SUGARS

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This reaction was encountered, in 1946, during an investigation conducted with Mr. Milton M. Wachtel, then a graduate student in Chemistry at the University. A brief announcement was made to the Academy of Science at its 38th annual meeting, at Fargo. Since then the reaction has been subjected to further investigation.

Production of the Reaction

The reaction between the sugar and the zirconyl salt solution takes place very slowly on standing at room temperature, requiring days to become noticeable. But hexoses react rapidly at temperatures above 65 degrees C. Disaccharides require longer heating on the waterbath in order first to undergo hydrolysis into hexoses. The colorless solution gradually acquires a yellow to brown color, depending upon the concentration, and if the zirconyl salt is the **chloride**, the solution also acquires a brilliant green fluorescence. With zirconyl nitrate the yellow to brown color is obtained; but, except in extremely dilute solution, no fluorescence is observed, for nitrate ion and many other ions are known to quench fluorescence.

Review of Previous Work

Very meager information having a possible bearing on this reaction was found in the literature. In 1926, Britton (1) titrated a solution of zirconyl chloride with NaOH, noting the volumes of base required 1st to produce visible turbidity, and 2nd to cause the re-dissolving of the precipitate. When glucose was added to the solution, he found that it caused notable changes in these volumes. He concluded that a reaction had occurred between the "zirconia" and the hydroxy groups of the glucose; but he did not heat the solutions and he makes no mention of any color production, much less of any fluorescence. Thus he could hardly have produced the reaction now under consideration.

In a book entitled "Fluorescence Analysis in Ultraviolet Light" (2), by Hadley and Grant, reference is made to the "Rimbach-Weber" reaction. (3) This was found to deal only with the effect of zirconyl

salts on the optical rotation of sugars. No mention is made of color or fluorescence as presumably the solutions were not heated.

Brief Outline of Facts Observed

In the time available, it is possible to give only the briefest outline and summary of work done. It was essentially a chemical reconnaissance, covering a wide territory and involving many detailed observations. The most significant observations may be summarized as follows:

1. The **fluorescent** substance was obtained only with zirconyl **chloride**, as nitrate ion and many other ions are known to quench fluorescence.

2. The **fluorescent reaction** was observed **only with sugars possessing the cyclic structure containing an "oxygen bridge."**

3. Only aldoses and ketoses containing **more than four carbons** were found to give the reaction. Erythrose, a four carbon sugar containing the aldehyde group failed to give the reaction; but Arabinose, a pentose, or five carbon sugar, reacts like the hexoses.

4. Tests with other related metals showed that tin, lead, and thorium failed to give the sugar reaction. Titanium was uncertain, germanium was not available; but hafnium, as might be expected, was found to give both the color and the fluorescence, hardly distinguishable from zirconium. The purity of the hafnium was such as to preclude a zirconium reaction.

5. It was natural to assume that the aldehyde and ketone groups in the sugars were primarily involved in this reaction; but butyric aldehyde, and other aliphatic aldehydes and ketones corresponding to the aldose and ketose sugars failed to give the reaction.

6. That the reaction was not involving hydroxy groups alone, was strikingly shown by the fact that the polyhydric alcohols closely related to the aldoses failed to give the reaction. This was observed for example with d-sorbitol from d-glucose, and with d-mannitol from d-mannose. Glycerol, a trihydric alcohol likewise failed to give the reaction.

7. Since the ring or cyclic sugars give the reaction, it seemed well to examine the behavior of typical aromatic ring compounds containing phenolic (OH) groups. The following were tried with uniformly negative results:—hydroquinone, resorcinol, catechol, and phloroglucinol. Likewise aromatic aldehydes, such as benzaldehyde failed to give the reaction.

8. Many aldehydes and ketones were studied, including formaldehyde, acetaldehyde, butyric aldehyde, and such ketones as acetone, methyl-ethyl-ketone, and cyclohexanone. None of them gave the sugar reaction, although under other conditions, especially in alkaline solution, zirconium is known to form complexes with acetylacetonate and other related compounds (4).

9. Attempts to isolate the fluorescent material were unsuccessful.

ful. Evaporation of the fluorescent solutions, either on the waterbath or at room temperature in the desiccator gave only brown amorphous residues containing considerable amounts of zirconium hydroxide due to hydrolysis. Extraction with a variety of solvents failed to isolate the material. When glucose was melted at the lowest possible temperature and solid zirconyl chloride was added, upon cooling a highly fluorescent glassy mass was obtained which retained its fluorescence for many weeks. Perhaps oxygen could not easily penetrate the glazed mass to quench the fluorescence.

10. Electrical transference experiments show that the fluorescent material migrates toward the cathode at a rate comparable to that of many large complex ions.

11. Dialysis of the fluorescent colored solutions showed that no color diffused through the membranes; but the diffusate contained both zirconium and glucose. This was true for solutions containing excess of either zirconium or glucose. In one experiment the dialysis was continued for a month with frequent changes of distilled water. The diffusates continued to give tests for both zirconium and glucose; but at the end of the experiment the bag was found to contain a firm gel of zirconium hydroxide, nearly white, showing only a slight yellow tinge. Whatever the substance may be, it is obvious that it is dissociated into its components which passed through the membrane independently.

Interpretations and Conclusions

As stated, the fluorescent reaction appears to be associated with a definite type of structure in the reacting sugar. We have seen that the mere presence of aldehyde or ketone groups in the molecule is not sufficient; for the corresponding aliphatic aldehydes and ketones fail to give the reaction. Nor is the presence of hydroxy groups in itself enough to account for the reaction; for the polyhydric alcohols corresponding to the sugars likewise fail to react. The ability to undergo this reaction seems definitely associated with the cyclic structure in which there is an "oxygen bridge" or linkage of an oxygen atom between two carbon atoms. Other conditions in the molecule must exert their influences; for we have noted that only those sugars containing more than four carbon atoms give the reaction, that is, the pentoses and hexoses.

Electrical migration experiments indicate that the fluorescent substance is associated with zirconium in a complex ion that moves toward the cathode. The simplest assumption is that it is associated with the positive, oxygen containing, zirconyl ion.

We have also noted that zirconium is known to form complex compounds with certain organic substances, particularly with acetylacetone and related compounds, and that its coordination number is 8.

In order to determine if possible the number of sugar molecules

in the fluorescent complex, dilute solutions were prepared in which the ratio of sugar molecules to zirconium atoms ranged from 1 to 5 or more. Colorimetric comparison showed a regular increase in color depth up to and including 4 moles of sugar per atom of zirconium. Further increases in the sugar ratio failed to increase the color.

Cryoscopic measurements of the mole numbers roughly agreed with the colorimetric measurements, although many factors tend to lessen their reliability. More concentrated solutions must be used to give satisfactory lowerings of freezing points, and ionization and hydrolytic equilibria may be subjected to greater disturbance by the additions of relatively large amounts of solute.

From the information so far obtained, it seems highly probable that this reaction of sugars with zirconyl salts results in the formation of a chelate or other addition complex, involving 4 sugar molecules per atom of zirconium, thus conforming to the coordinate number 8. That it is an ion and not merely a highly polymerized colloidal substance is indicated by its ready solubility and the relatively high velocity of ionic migration. Such an associated ion might be expected to exhibit resonance which might well cause fluorescence in the visible spectral range.

Spectrometric studies of the color and fluorescence are planned, as well as measurements of reaction velocities at different temperatures. It is also desirable to carry the correlation of the reaction with molecular structure much farther in the effort to determine more fully the mechanism of this interesting reaction.

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COBALT CONTENT OF SOME NORTH DAKOTA FEEDS

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ABSTRACT

A chromatographic method for the determination of cobalt in feeds has been developed which consists of passing a perchloric acid

solution of the plant ash containing a cobalt nitroso R salt complex through a perchloric acid-washed alumina adsorption column, concentrating the cobalt complex on the column, eluting the cobalt complex, and determine the amount of cobalt present colorimetrically. In this method, the nitroso R salt is a specific reagent for cobalt. Iron and copper does not interfere. However, the cobalt nitroso R salt complex could not be retained on the alumina column because of the eluting effect of excess sulfates, phosphates, and pyrophosphates. Hence, the sulfates are precipitated by barium chloride, the pyrophosphates hydrolized to orthophosphates by perchloric acid, and the eluting effect of the orthophosphates inhibited by increasing the perchloric acid concentration of the cobalt nitroso R salt complex solution.

The forages analyzed to-date by the above method indicate that sufficient cobalt is present to meet the nutritive requirements of sheep and cattle. However, forages from different areas of that state may differ appreciably in their cobalt content. The number of analysis made so far are insufficient to show whether or not any cobalt deficient forages exist.

TABLE I. Cobalt Content of Some North Dakota Feeds

Feed	Sample no.	Avg. cobalt content p.p.m.
Alfalfa	1	0.344
Barley, grain	2	0.027
	3	0.042
	4	0.044
	5	0.062
Barley hay, early	5	0.062
Beet pulp	6	0.322
Brome grass	7	0.108
	8	0.100
	9	0.064
Corn, yellow No. 2	10	0.019
	11	0.014
	12	0.027
Corn silage	13	0.348
Crested wheat	14	0.143
	15	0.224
	16	0.250
	17	0.051
Oats, grain	18	0.040
	19	0.191
Prairie hay	20	0.130
	21	0.128
	22	0.097
	23	0.077
Wheat, grain	23	0.077

THE HEAT OF VAPORIZATION AND OF DISSOCIATION OF NITROGEN TETROXIDE

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The object of this investigation was to measure directly the heat of vaporization and of dissociation of Nitrogen Tetroxide. Under any conditions, there exists in this compound the equilibrium $N_2O_4 = 2NO_2$. The solid form is colorless indicating the equilibrium is entirely to the left or 100% N_2O_4 . As the temperature rises above the melting point ($-11.20^\circ C$) the color becomes increasingly darker brown as the above equilibrium shifts to the right. This shift continues into the vapor state (boiling point $21.15^\circ C$) until at about $150^\circ C$ the equilibrium has shifted completely to 100% NO_2 and the brown color has reached a maximum. At about this temperature another dissociation begins thus: $2NO_2 = 2NO + O_2$ and as temperatures go still higher the brown color due to NO_2 fades until at about $600^\circ C$ the gaseous products are entirely colorless.

The degree of dissociation at near room temperature has been carefully studied by Farrington Daniels and his students and is well known. But no reliable information is available for the percent of dissociation in the liquid state. Thus it is seen that as the liquid evaporates, it, at the same time, undergoes a certain degree of dissociation, unless, as seems quite unlikely, the liquid is dissociated to the same degree as the vapor. The measurement of the heat evolved during evaporation may be represented $mH_v + m(a-B)H_d = \text{measured calories}$ where m is moles evaporated, H_v is Heat of vaporization per mole, H_d is Heat of dissociation per mole and a and B are the degree of dissociation in the vapor and liquid states respectively.

The measurements were made in an isothermal calorimeter previously described before this Academy and in the Jour. Physical Chem. 37, 1, 1933. A weighed quantity of liquid N_2O_4 in a sealed capsule is brought to the temperature of the calorimeter, 25° , and as the capsule is broken the N_2O_4 evaporates into a closed vessel of known and constant volume. The endothermic heats of vaporization and dissociation are compensated for by electrical heating of known input.

Smoothing the Data. The data was plotted on log-log scale and found to lie on a straight line. The slope and intercept of this line were calculated by the Method of Least Squares. No point on the curve was used which deviated more than about two percent. The average deviation was only 0.22%. The values of calories given in the table below are taken from the smoothed curve.

Each experiment's data were written as an equation of the form $mH_v + maH_d - mBH_d = \text{calories}$ and by summing made into two equations to be solved simultaneously. (Since there are three unknowns,

Hv, Hd and B, three equations were first tried but in their solutions, mHv and mBHd yielded only their difference and thus cancelled out.) The results of the two equations were Hd=10,204 calories per mole and Hv—BHd=6740 calories.

			Data*		
moles x 10 ⁴	input calories	a. in %	moles x 10 ⁴	input calories	a. in %
42.261	34.904	15.05	17.431	16.029	24.07
37.407	31.352	16.09	16.874	15.578	24.42
33.380	28.366	17.19	15.121	14.146	25.71
32.495	27.704	17.44	14.459	13.600	26.42
31.469	26.934	17.75	10.942	10.645	29.78
31.762	27.155	17.68	6.552	6.784	37.00
28.133	24.410	18.86	3.259	3.673	46.07
27.016	23.555	19.29	*Data taken from smoothed curve		

No value for B is to be found in the literature. If we assume B to be negligibly small at the temperature of 25° then Hv equals 6740 calories per mole. If B is as large as, for examples, 15.05%, thus equal to the vapor at 25° under its own vapor pressure at that temperature, Hv equals 8279 calories. The true value no doubt lies between these two, probably close to the former.

Calculations of Troutons constant where $Hv/T = \text{Constant}$ about 23 gives $6740/298 = 22.6$ for the vaporization of undissociated N₂O. This is close to the theoretical value.

Giauque and Kemp reported in the Journal of Chemical Physics of January 1938 a value for the Heat of Vaporization at 294.25°K of 9110 calories per mole. Their measurements were made at constant pressure and assumes a degree of dissociation of 16.1%. Our value of 6740 calories and theirs are in excellent agreement as will be seen below. Our measurements were made at constant volume and at 298.1°K. No heat of dissociation is included in our value.

	cal/mole
Heat of vaporization at constant volume	6740
Difference for constant pressures, assuming ideal gas laws equal $RT = 1.987 \times 298.1$	595
Heat of dissociation, 16.1% of 10204 (our value)	1643
Specific heat, by extrapolation of values of Giauque and Kemp, 34 cal/deg/mole from 294.25° to 298.1° is 34×3.85	131
	9109

The good agreement of these two values gives credence to our value of 10204 calories per mole for the Heat of dissociation and for our assumption of a low degree of dissociation in the liquid state. We hope to repeat the calorimetric measurements at 35 degrees at some time in the near future.

In order to arrive at a value for B, the dissociation in the liquid state, we propose to compare the light transmittancy of the vapor and of the liquid for various wave lengths. A little work along this line has been done with some interesting results. i.e. that a comparison of colors of the two states with white light is of doubtful value. Columns of liquid and vapor of equal length show a difference of about 30: 1 at wave length 6350A while at a wave length of 7750A each transmits equally well.

A GEOMAGNETIC SURVEY OF PART OF THE EAST EDGE OF THE WILLISTON BASIN

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Introduction

The area included in this paper consists of 2,592 square miles, located within the forty-seventh and forty-ninth degrees north latitude and between ninety-nine and one hundred-one degrees west longitude. The survey includes the area within Townships 145 through 156 north and Ranges 69 through 74 west. Portions of Pierce, Benson, Sheridan and Wells counties are included in this discussion.

Instrumentation

Fundamental Principles.

The magnetic method of prospecting involves the search for anomalies caused by changes in the physical properties of rocks. (1). The magnetic method is complicated in principle and practice mainly because the property of a rock which determines the intensity of magnetization, has both magnitude and direction. Magnetic effects from the basement rocks may be greatly affected by the sedimentary section and from surface deposits. This is especially misleading because the magnetic intensity varies with the distance from the rock that is measured.

The polarization is the intensity of magnetization. (2). In geophysical work moderately magnetic materials and weak fields are important. The induced magnetization is in the direction of the applied field with a strength proportional to the strength of that field. The intensity of magnetization I , is the induced pole strength per unit area along an area normal to the inducing field.

A homogeneous external field H which makes an angle e with the normal to the surface of a magnetic material, has an induced pole strength per unit area. (3).

$$I = kH \cos e$$

For a field normal to the surface.

$$I = kH$$

The proportionality constant k is called the susceptibility. Magnetic materials are paramagnetic if they have a positive susceptibility. These bodies line up with their long dimension in the direction of the external field. The materials having a negative susceptibility are diamagnetic. Diamagnetic materials include rock salt and anhydrite. These nonmagnetic substances line up with their long dimension across the applied field.

Instruments.

The Schmidt-type vertical field balance is used mainly for reconnaissance surveys to locate basement features which can favorably affect the overlying sedimentary section. The system consists of a nearly horizontal magnet oriented perpendicular to the magnetic meridian so that the horizontal component of the earth's magnetic field exerts no effect. The magnet is balanced on a knife-edge displaced from the center of gravity both horizontally and vertically. The vertical magnetic field of the earth, acting on the poles, tends to cause counter-clockwise rotation, and the gravitational force, clockwise rotation. The equilibrium position is indicated on a graduated scale by a light beam reflected from a mirror attached to the magnet. As the vertical magnetic field changes, at different locations, the position of equilibrium shifts and the difference in scale readings indicates the difference in the vertical fields.

The instrument is mounted on a tripod with a moving head which has a graduated meridian circle. Three leveling screws attach the head to the base. A compass that fits the head is used to orient the head before placement of the instrument.

The sensitivity of the magnet can be adjusted by moving a weight which protrudes through the bottom of the frame. The change of position of this weight moves the center of gravity with respect to the support and varies the distance, which governs the sensitivity. There is automatic temperature compensation at a given magnetic latitude. As the temperature rises, the magnet loses some of its moment, the apparent vertical intensity decreases, and the north seeking pole rotates upward. As the temperature goes up, meanwhile, the compensating bar on the north side of the frame, expands and the increased gravitational torque tends to cause downward rotation of the north pole. Selection of proper material for the bar and magnet makes it possible to compensate to less than one gamma. A change in absolute vertical field intensity (latitude) may make it necessary to bring the deflection back to the center of the scale by an adjustable weight on the invar bar.

Instruments Used.

During the course of the survey, two Schmidt type vertical intensity magnetometers were used. The first half of the survey (Townships 156 through 151 north, Ranges 69 through 74 west) was done with a Sprengnether instrument, serial number 1063. The re-

maining area (Townships 150 through 145 north, Ranges 69 through 74 west) was surveyed with an Askania instrument, serial number 92956.

Field Procedure and Corrections.

Rugby was chosen as the base station. The magnetic intensity of this station was determined from a station of known magnetic intensity near Leeds.

The latitude adjustment of the Sprengnether instrument was set for the latitude of Rugby and the sensitivity screw adjusted. The sensitivity was found to be 321.4 gammas per scale division. After considerable use the instrument was taken apart and cleaned and the sensitivity again determined. This time it was found to be 326.4 gammas per scale division.

After half the area was surveyed an Askania instrument was made available, and this was set for the latitude of Maddock. The sensitivity was found to be 35.6 gammas per scale division. The temperature coefficient of this instrument was 0.055 scale division per degree Centigrade.

Corrections were made for latitude and longitude in order to offset the 10 gamma increase per mile north and the 3 gamma increase per mile east that occurs in this part of North Dakota.

The form used for calculating field notes was of the type in which plus and minus values of corrections for diurnal variations and latitude and longitude changes are entered directly. (4) The temperature readings were adjusted to 20° Centigrade. The diurnal variation was determined for each station by plotting a straight line curve for each township traversed.

Two instrument checks were made during the summer over known magnetic highs. The first of these was made near Ramsey, and both the Sprengnether and Askania instruments agreed with the anomaly. Later in the summer a second magnetic high near Fort Totten was used as an instrument check. This time only the Askania was checked, and the results were satisfactory.

Readings were taken at each mile around a township with two stations taken one mile apart near the center of the township. After the traverse was completed the instrument was returned to the first station and checked. The diurnal variation was distributed to every station. North Dakota State Highway maps were used as base maps.

Geologic Interpretation

There are several geologic conditions which can alter the regional magnetic gradient. The conditions that may cause magnetic intensity variance in the area mapped for this report are as follows:

1. Glacial deposits which vary in type and thickness.
2. Magnetic iron derived from the iron-bearing positive area in Minnesota or adjacent areas.
3. Structure manifested in the sedimentary section.

4. Relief on homogeneous basement rock surface.
5. Basic intrusions in a less basic basement with structure associated.
6. Granitic intrusions in a more basic basement with structure associated.

The known glacial features already discussed do not seem to affect the mapping to any noticeable extent. This is probably due to the coarse setting of the sensitivity of both instruments and the large magnetic contour interval used. A trial contouring at smaller magnetic intervals showed many small anomalies a few of which may be caused by variations of the type and thickness of glacial drift.

There is a possibility that the sedimentary rocks in certain areas are contaminated by iron derived from Pre-Cambrian deposits in Minnesota or adjacent areas. Pre-Cambrian rocks in North Dakota perhaps contain iron deposits similar to those of Minnesota, but, as yet none have been found.

If a sedimentary bed such as shale has a high magnetic susceptibility, then it would be possible to map structure contained in the sedimentary section. Because of the coarse setting of the magnetometers used in the field for this report it is not thought that sedimentary structure alone was mapped, even if highly susceptible sedimentary beds exist. The influence of the sedimentary section alone is not considered in the interpretation of this magnetometer map.

Relief on a surface of homogeneous basement rocks can be mapped by vertical intensity magnetometers, because the magnetic intensity varies with the depth of the basement. In this case magnetic highs would correspond to ancient hills over which younger sediments were deposited.

In the area covered by this investigation there does not seem to be any relationship between basement depth and magnetic intensities. Vertical magnetic intensity ranges from a minimum of 4964 gammas in the northeast corner of the area to a maximum of 5662 gammas on the magnetic high in the southeast part of the map area south of Sykeston. According to the basement contour map constructed during this investigation, the magnetic low area in the northeastern part of the area should not have the greatest depth to the basement. There is considerable magnetic relief over the area which suggests that the basement rocks are heterogeneous.

Where little basement information is available, the highs of large magnetic intensity can be interpreted as intrusions into, or changes within, the basement rock, whereas the smaller magnetic highs most probably reflect areas of relief on the basement surface. (5) Further, the large magnetic contour interval used together with the coarse instrument setting would make it unlikely that basement relief on homogeneous rocks are shown on the map.

The magnetic susceptibilities of North Dakota basement rocks were not measured in laboratory experiments for this investigation.

Published literature on the subject states that basic rocks have higher magnetic susceptibilities than acidic rocks. (6) Upon this assumption rests much of the interpretation of the magnetometer map prepared for this report.

The known basement rocks in North Dakota vary considerably as to lithology and presumably as to magnetic susceptibility. Basic intrusive bodies are much less common over the world than are acidic intrusives. After considering the many factors mentioned, it seems likely that the North Dakota basement complex, with the exception of a narrow area of granite adjoining the state of Minnesota, consists of various metamorphic greenstones intruded by acidic rocks as indicated by the table of basement rocks found in North Dakota deep tests.

More basic intrusions into the metamorphic greenstones would result in a large intensity magnetic anomaly. Some structural relief may be associated with these basic intrusions.

There are two strong magnetic highs mapped. One is in Ranges 68, 69W, Township 145N, and the other is located in Ranges 74, 75W. Townships 147, 148N. Both of these magnetic highs are on the edge of the map area so that closure was not accurately determined, but they both appear to have at least 250 gammas closure. These two strong magnetic highs are suggestive more of lithologic changes than basement relief. These two magnetic anomalies quite possibly are intrusives of a more basic type of rock. There is also a possibility of basement relief due to the effects of differential erosion upon the two lithologies.

The string of magnetic highs with a few associated lows in the southern part of the map may reflect a greenstone ridge intruded by granitic rocks. Over these structures the map would show magnetic highs except where the granitic intrusions from the Pre-Cambrian surface. Because of differential erosion the granitic areas should be structurally higher than the adjoining greenstone areas. This is perhaps the situation which exists beneath the Continental Lueth test which is located in the center of a small intensity low, and where an acidic granitic basement was encountered. The overlying sedimentary rocks could be affected by these basement structures. Therefore, the previously mentioned northeasterly-trending line of magnetic highs and lows could conceivably indicate a Pre-Cambrian ridge. As has been suggested by Laird, there is a possibility of such basement structures existing.

The 5400 gamma contour line which points eastward from the west edge of the map is the largest magnetic area. This area of high magnetic susceptibility may indicate a regional change in lithology.

Conclusions

A magnetometer survey in respect to oil exploration is a regional reconnaissance tool and, therefore, it is customary to check an in-

teresting magnetic anomaly with a seismograph or gravimeter. An exception to this is found in micromagnetic surveys which, because of their detailed nature, may serve as a check on the other types of geophysical surveying. (8)

The two large magnetic highs may be more basic areas in the basement rocks, and they may indicate structure. However, the large eastward-trending magnetic high area on the west side of the map area is quite possibly due to a regional increase in magnetic susceptibility caused by changes in lithology. The lower magnetic intensity highs and lows are more likely to reflect basement and possibly overlying sedimentary structure. These highs and lows form at least one northeasterly trend which may be an irregular basement ridge. A promising place to look for oil accumulation might then be on these lower intensity magnetic highs and lows, which may reflect both basement and the overlying sedimentary structures.

Because of the coarse sensitivity setting of the instruments used and the large magnetic interval used in contouring the map, the writer does not think that structural relief of a homogeneous body is generally indicated. Rather it is believed that changes in magnetic susceptibility were mapped. As has previously been discussed, these changes in lithology could affect the structure of the basement and possibly the sedimentary section. The writer thinks that magnetometer surveys in North Dakota made with a sensitive instrument setting can serve a definite purpose in outlining a structural prospect if the previously discussed geological and geophysical elements are kept in mind when interpreting the work.

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ACETONE TOLERANCE OF CATALYTICALLY BODIED AND BLOWN OILS¹

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The techniques used in evaluating acetone tolerances of bodied and blown oils are the outgrowth of an attempt to segregate the polymeric from the nonpolymeric portions of such oils. Limited information is available by which acetone tolerance data may be interpreted in terms of common practices and properties which the polymerized oils possess. With these facts in mind, an attempt has been made through this study to follow the path of the polymer and to find some of the relationships, where possible, between performance characteristics and physical constants.

The acetone tolerance, formerly designated as the acetone number (4, 6, 2), is defined as the quantity of acetone expressed in grams per 100 grams of oil, which is required to produce a permanent cloudiness or turbidity in the oil at 25° C. Other low molecular weight alcohols, acids and ketones have been similarly employed to isolate polymerized material from such bodied and blown oils. Several attempts have been made to correlate certain physical (3) and chemical factors (5) of blown and bodied oils with such solubility behavior or acetone tolerance.

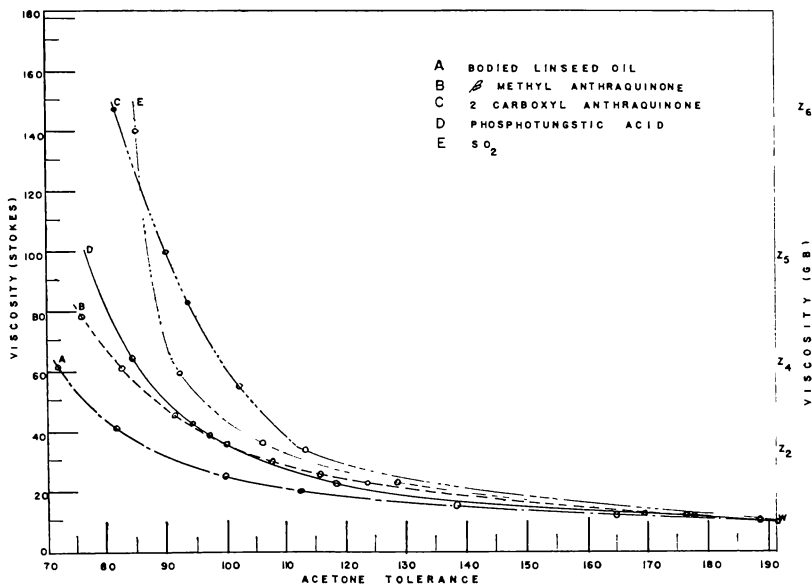


FIG. 1 ACETONE TOLERANCE OF BODIED LINSEED OILS

Stand oil is defined as a heat-bodied or polymerized vegetable oil or combination of various bodied vegetable oils. It is a drying oil which has been heated, with or without catalyst, until a desired viscosity has been obtained under conditions of minimum oxidation and optimum polymerization. Such polymerizations probably proceed in two steps (7). The first is an induction period when non-conjugated double bonds isomerize to conjugated systems, and the second is an increase in viscosity, which then takes place owing to the polymerization of the new compounds, perhaps through a modified Diels'-Alder mechanism.

Progress toward a clear interpretation of the chemical processes involved in oil oxidation has been equally slow and uncertain. Most oil research workers are now in general agreement that the oxidative polymerization in the early stages of the reaction consists of three fundamental steps: first, hydroperoxide formation, peroxide consumption, followed principally by an intramolecular arrangement to an intermediate, and then association of these intermediates to form higher molecular weight products.

The method employed for acetone tolerance in this study was standard procedure (8). A 30 g. \pm 0.01 g. oil sample was weighed into a glass-stoppered Erlenmeyer flask, brought to $25^\circ \pm 0.1^\circ\text{C}$., and titrated with anhydrous acetone, held at the same temperature, until a permanent turbidity developed.

Linseed, tung and castor (D. C. O.) were the types of oils used

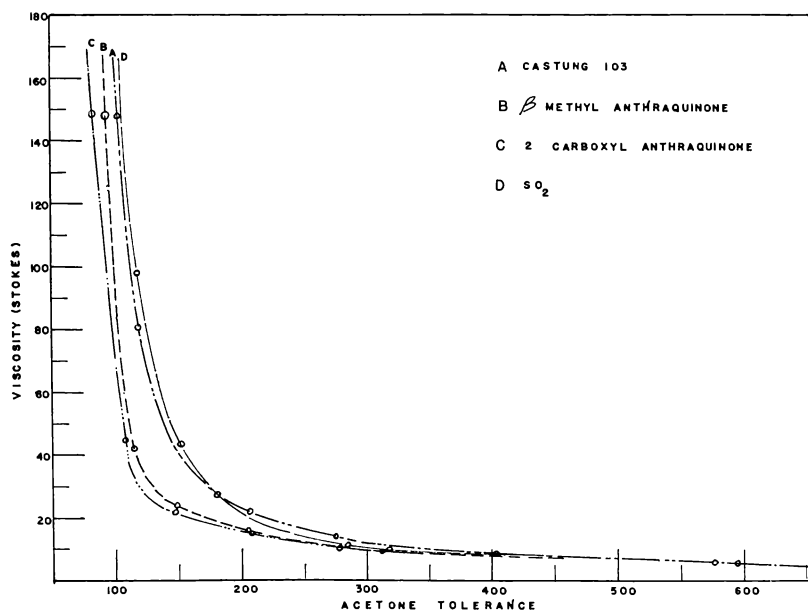


FIG. 2 ACETONE TOLERANCE OF BODIED CASTUNG 103 OIL

in the heat-bodding process by a closed kettle technique. Approximately 500 g. portions of the raw oils were heated under vacuum in an atmosphere of carbon dioxide, samples were removed at frequent intervals, and viscosity, color, acid value, and acetone tolerance were then determined for each sample so removed. During the heat-bodding process a small quantity of sulfur dioxide, beta-methylantraquinone, 2-carboxyl-anthraquinone, or phosphotungstic acid respectively were employed to increase the bodding rate. Temperatures of 204°, 285°, 290° and 295° C. were used with various oils. The activity of boron trifluoride in ether was so great that comparative studies were impractical with the catalyst.

Linseed was the only oil used in the blowing process. The blown oils were prepared at four different temperatures ranging from 50° to 200° C. Samples were again removed at frequent intervals and the same constants determined as in the heat bodied oils.

Some attention was also given to spectroscopic absorption, zinc oxide reactivity and flow characteristics. These together with acid values, color and viscosity were determined by standard methods.

Acetone tolerance results indicate that the presence of the various catalysts used greatly influenced the rate, degree and uniformity of the polymerization under comparable conditions. Thus, linseed oil, bodied without the use of a catalyst, showed a much lower acetone tolerance value than any of the catalytically bodied oils, indicating that the polymerization was more uniform with the catalytically bodied oils than with the non-catalytically bodied oils.

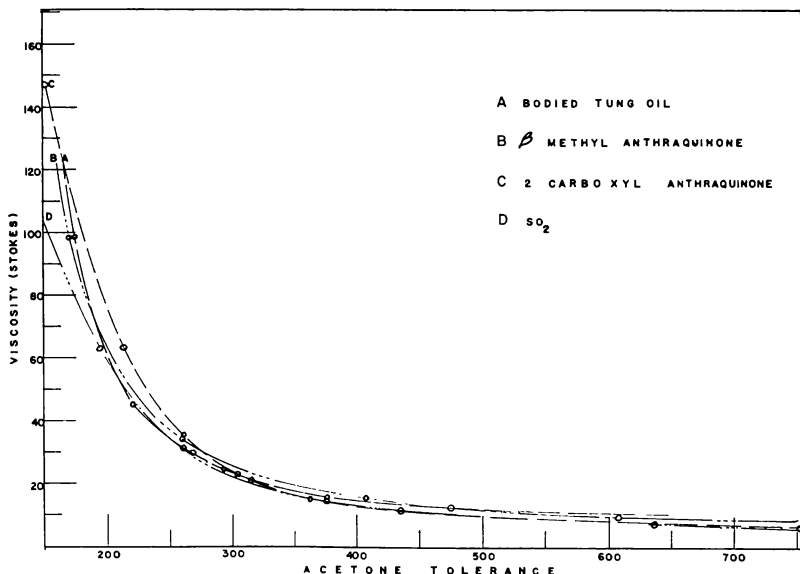


FIG. 3 ACETONE TOLERANCE OF BODIED TUNG OIL

However, acid value corrections should be made before this conclusion can be completely justified (5).

Another factor which had an appreciable effect upon the acetone tolerance was the time required for the oil to body to a given viscosity. In all cases the acetone tolerance seemed to progressively decrease as the time progressively increased. This, however, may be a coincidence, and probably can be best ascribed to the different catalysts used, including either the amount of activity of the several catalysts. Sulfur dioxide was found to be the most rapid heat-bodying catalyst.

In determining the acetone tolerance of Castung 103, it was found that the acetone tolerance values were greater than those of the linseed oil. This probably was due to the conjugation of the original oil. This oil, or dehydrated castor oil, has a considerable amount of 9, 11 linoleic acid ester, and would thus eliminate a large portion of the initial isomeric change to a conjugated system.

The results obtained from heat-bodied tung oil followed still more closely the conjugation explanation, since the acetone tolerances were higher than either the linseed or Castung 103 oils. Tung oil has far more initial conjugation than either of the other two oils, since about 72% of tung oil is eleosteric acid with a conjugated system of three double bonds. Likewise tung oil, when heated to 295° C., sets to a gel in six minutes, and, therefore, the several catalysts probably play a relatively less significant role in the heat-bodying process.

The results obtained for the acetone tolerances of blown oils could not be so easily interpreted. The presence of oxygen or air had a definite effect on the blowing of linseed to a given viscosity. The oil blown at 198° C. showed some tolerance for acetone. This was probably due to the relatively low temperature, but even here definite polymerization within the oil occurred. Another verification that polymerization was taking place at this temperature was the color change of the oil (9).

n-Butanol, as a solvent for tolerance determinations, seemed to offer advantages within the 100 to 500 acetone and A to U Gardner-Holdt viscosity range, because of lower polymer solubility. Isopropanol as a solvent offered no advantages over acetone with most oils, except possibly with blown oils where the acetone tolerance values are infinite. Methyl ethyl ketone showed a tolerance range well above that of acetone and, therefore, offered no advantages except possibly with extremely viscous or plastic materials.

The zinc oxide reactivity with linseed oils with various acetone tolerances revealed that as the acetone tolerance decreased the reactivity with zinc oxide increased. Likewise the insoluble portions of the oil were slightly more reactive than the soluble portions to acetone.

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FREE AMINO ACIDS IN POTATO PLANT STEMS AS
CORRELATED TO PLANT VARIETY AND
SUSCEPTIBILITY TO RING-ROT

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ABSTRACT

A disease of potatoes known as ring-rot is caused by a bacterium, **Corynebacterium sepedonicum**. The causal organism localizes in the xylem elements of the vascular system. Most varieties of potatoes are susceptible, some more so than others. A highly resistant seedling has been developed by the United States Department of Agriculture. The differences in susceptibilities between varieties as well as the fact that some plants may harbor the ring-rot organism without apparent symptoms of disease has raised the question as to the nature of this resistance.

Bacterial canker of tomatoes is caused by a closely related organism, **Corynebacterium michiganense**, which by comparison does not invade the xylem, but is found primarily in the phloem. The presence of these closely related organisms in different tissues suggests the possibility that varietal resistance to the causal agent may be a function of the nutritional conditions found in the host.

The overall objective of this research has been to determine differences in chemical composition of the resistant as compared to susceptible plants and as related to the suitability of these materials for the growth of **C. sepedonicum**. In this study, the main hypothesis is that resistance and susceptibility are functions of the nutritional

environment provided by the host. If such be the case, breeding for these factors of resistance may provide ready means of obtaining resistant varieties.

The first phase of this study is the determination of the amino acid composition of the susceptible Triumph potato and a resistant seedling. The method employed for the amino acid determination was that of paper partition chromatography using plant juices from macerated tissues.

The results have shown that both the Triumph and the seedling are very similar in the types of free amino acids present, but differ decidedly in relative amounts and especially in the amount of two of these acids. The following amino acids were found: aspartic, serine, asparagine, arginine, glutamine, gamma amino butyric acid, proline, and either part or all of each of the leucines and valines.

The resistant seedling has greater concentrations of some of the amino acids and is decidedly rich in asparagine. It has a low level of proline. By comparison, the Triumph stem juice has lower concentrations of these amino acids except for proline in which it is quite rich.

This amino acid spectrum has not, as yet, been used in nutritional studies with *C. sepedonicum*.

Amino Acids in Stem Juices

	Triumph	Resistant Seedling
aspartic	++	+++
serine	++	+++
asparagine	+	++++
arginine	++	+++
glutamine	++	+++
gamma amino butyric acid	++	+++
valines	++	++
leucines	++	++
proline	+++	+
++ indicates comparative values		

THE EPINEPHRINE-LIKE EFFECT OF ACETYLCHOLINE ON BLOOD SUGAR LEVELS

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ABSTRACT

The hyperglycemic effect of adrenalin is generally known, therefore the present study was undertaken to determine what effect, if any, on the blood sugar levels would result from injection of acetylcholine, a parasympathomimetic drug. Cats were starved from 18 to

24 hours in an attempt to secure more regular blood sugar values. The animals were anesthetized with Dial plus urethane (.6cc/kg) and after two hours the left femoral artery and the trachea were cannulated. For number 1 sample, .5cc of blood were taken, after which the abdomen was opened and the viscera arranged for accessibility to the portal vein for injection; number 2 sample was taken. The animals were left for one hour on a table with lights underneath to keep the table warm; after this interval, number 3 sample was taken immediately prior to injection of 1cc of acetylcholine, of mg/cc concentration into the portal vein; within four minutes number 4 sample was taken, after which subsequent samples 5, 6, 7, 8 and 9 were taken at ten minute intervals; numbers 10, 11 and 12 were drawn at hourly intervals. Repeated experimental results showed a marked hyperglycemia, which remained steady for three to four hours after injection of acetylcholine.
