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TWENTIETH ANNUAL REPORT

OF THE

International Association of Dairy and Milk Inspectors

INCLUDING PAPERS READ AT THE ANNUAL
CONVENTION IN MONTREAL, CANADA
SEPTEMBER 10, 11, AND 12,
1931 -32

"What do we live for, if it is not to make life less difficult for others?"

COMPILED BY

PAUL B. BROOKS, M.D., Secretary-Treasurer
STATE DEPARTMENT OF HEALTH
ALBANY, N. Y.

1932

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International Association of Dairy and Milk Inspectors

CONSTITUTION AND BY-LAWS

CONSTITUTION

ADOPTED OCTOBER 16, 1911

NAME

This Association shall be known as the International Association of Dairy and Milk Inspectors.

OBJECT

The object of this Association shall be to develop uniform and efficient inspection of dairy farms, milk establishments, milk and milk products, and to place the inspection of the same in the hands of men who have a thorough knowledge of dairy work.

MEMBERSHIP

The membership of this Association shall be composed of men who now are or who have been actively engaged in dairy or milk inspection. Any person who now is or who has been so engaged may make application to the Secretary-Treasurer and if application is accepted by the Membership Committee, said applicant may become a member of the Association upon payment of the annual dues of five dollars ($5.00).

OFFICERS

The officers of this Association shall be a President, three Vice-Presidents, a Secretary-Treasurer, and two Auditors, who shall be elected by a majority ballot at the Annual Meeting of the Association, and shall hold office for one year or until their successors are elected. An Executive Board, which shall direct the affairs of the Association when not in Annual Session, shall consist of the President, the three Vice-Presidents, and the Secretary-Treasurer.

AMENDMENTS

This Constitution may be amended at any Annual Meeting by a two-thirds vote of the entire membership of the Association. Any member proposing amendments must submit the same in writing to the Secretary-Treasurer at least sixty days before the date of the Annual Meeting, and the Secretary-Treasurer shall at once notify all members of such proposed amendments. All members voting on such proposed amendments shall register their vote with the Secretary-Treasurer on blanks provided by the Association before the date of the Annual Meeting.

BY-LAWS

ADOPTED OCTOBER 25, 1913

ORGANIZATION

The Constitution shall be the basis of government of this Association.

ARTICLE 1

MEMBERSHIP

SECTION 1. Any person eligible for membership under the Constitution who shall file an official application, accompanied by the first annual membership dues of five dollars, and whose application for membership shall have the approval of the Membership Committee, may become a member of the Association for one year.

SECTION 2. Any person having once become a member may continue membership in the Association so long as the annual membership dues are paid. Any member who shall fail to pay annual dues within thirty days after having been notified by the Secretary that said dues are due and payable, shall be dropped from membership. Any member so dropped may, within ninety days, be reinstated by the Membership Committee, upon application filed in due form and accompanied by the annual membership dues for that year.

SECTION 3. A member of the Association may be expelled for due cause upon recommendation of the Membership Committee, and a majority vote of the members at any annual meeting. Any member so expelled shall have refunded such *pro rata* part of his membership dues as may not be covered by his term of membership.

HONORARY MEMBERS

SECTION 4. Members of the Association may elect as honorary members, at any stated meeting, on the recommendation of the Membership Committee, those whose labors have substantially added to the scientific knowledge of milk supply betterment, or those who have been of pronounced practical influence in the improvement of the milk industry. From such members no dues shall be required. They shall have the privilege of attending the meetings of the Association, but they shall not be entitled to vote.

ARTICLE 2

OFFICERS

SECTION 1. The officers of this Association shall be a President, a First, Second, and Third Vice-President, a Secretary-Treasurer, and two Auditors, who shall be chosen by a ballot at the annual meeting of the Association, and shall hold office for one year, or until their successors are duly elected.

SECTION 2. The Executive Board shall consist of the President, the three Vice-Presidents, and the Secretary-Treasurer.

SECTION 3. The Membership Committee shall consist of the President, the three Vice-Presidents, and the Secretary-Treasurer.

ARTICLE 3

DUTIES OF OFFICERS

SECTION 1. It shall be the duty of the President to preside at all meetings of the Association. He shall examine and approve all bills previous to their payment, appoint all committees unless otherwise directed by vote of the Association, and perform such other duties as usually devolve upon a presiding officer, or are required of him by the Association.

SECTION 2. The Vice-Presidents, in the order of their selection, shall perform the duties of the President in his absence.

SECTION 3. The Secretary-Treasurer shall record the proceedings of the Association. He shall keep a list of members, and collect all moneys due the Association, giving his receipt therefor. He shall record the amount of each payment, with the name and address of the person so paying. He shall faithfully care for all moneys entrusted to his keeping, paying out the same only with the approval of the President, and taking a receipt therefor. He shall, immediately after his election to office, file with the President of the Association a bond in the sum of five hundred dollars, the expense of which shall be borne by the Association. He shall, at the annual meeting, make a detailed statement of the financial condition of the Association.

It shall also be the duty of the Secretary-Treasurer to assist in making arrangements and preparing a program for the annual meeting, and to compile and prepare for publication all papers, addresses, discussions and other matter worthy of publication, as soon as possible after the annual meeting.

SECTION 4. The full management of the affairs of the Association when the Association is not in session shall be in the hands of the Executive Board, as provided in the Constitution.

SECTION 5. It shall be the duty of the Auditors to examine and audit the accounts of the Secretary-Treasurer and all other financial accounts of the Association, and to make a full report of the condition of the same at the annual meeting.

ARTICLE 4

MEETINGS

SECTION 1. The annual meeting of the Association shall be held at such time and place during the month of October of each year or at such other time as shall be designated by the Executive Board.

SECTION 2. Special meetings of the Association may be called by the Executive Board, of which due notice shall be given to the members by the Secretary.

SECTION 3. Quorum.—Twenty-five per cent of the membership shall constitute a quorum for transaction of business at any annual meeting. Voting by proxy shall not be permitted.

ARTICLE 5

These By-Laws may be altered or amended at any annual meeting of the Association. Any member proposing amendments must seasonably submit the same in writing to the Secretary-Treasurer, who shall then give notice of the proposed amendments by mail to each member of the Association at least thirty days previous to the date of the annual meeting.

International Association of Dairy and Milk Inspectors

OFFICERS 1930—1931

President, A. R. B. RICHMOND........Toronto, Ontario
First Vice-President, WM. B. PALMER........Orange, N. J.
Second Vice-President, HORATIO N. PARKER
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Third Vice-President, PAUL F. KRUEGER........Chicago, Ill.
Secretary-Treasurer, PAUL B. BROOKS........Albany, N. Y.
Auditors: W. J. WARNER........Hartford, Conn.
F. D. HOLFORD........New York City

COMMITTEES

COMMUNICABLE DISEASES AFFECTING MAN—Their Relation to Public Milk Supplies.

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Leslie C. Frank........Washington, D. C.
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METHODS OF IMPROVING MILK SUPPLIES IN SMALL COMMUNITIES

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James A. Tobey	New York City
F. H. Downs, Jr.	Montgomery, Ala.
Horatio N. Parker	Jacksonville, Fla.
Russell I. Prentiss	Lexington, Mass.

REVISION OF CONSTITUTION AND BY-LAWS

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I. V. Hiscock	New Haven, Conn.
George W. Grim	Ardmore, Pa.
W. D. Dotterer	Chicago, Ill.

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J. B. Hollingsworth	Ottawa, Canada
Ralph E. Irwin	Harrisburg, Pa.
I. V. Hiscock	New Haven, Conn.
W. H. Price	Detroit, Mich.
Ernest Kelly	Washington, D. C.
W. A. Shoults	Winnipeg, Manitoba
Howard R. Estes	Lakewood, Ohio
T. J. Strauch	Richmond, Va.

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Miller, Dr. John F., Inspector of Milk Pasteurizing Plants, State Department of Health, Albany, N. Y.

Mitchell, Dr. H. B., Milk Supervisor, City Hall, Lancaster, Pa.

Moak, Dr. Harris, Bacteriologist, Kings County Medical Milk Commission, 360 Park Place, Brooklyn, N. Y.

Moore, Mrs. Edith L., 1721 Park St., Houston, Texas.

Morris, Geo. C., Bureau of Milk Control, Dept. of Health, 211 N. 17th St., Camp Hill, Pa.

Morrow, Dr. A. C., District Veterinarian, Butte District, Dillon, Montana.

Mott, Frank E., Chemist, Health Department, and Inspector of Milk, 1104 City Hall Annex, Boston, Mass.

Mumford, Dr. J. E., Veterinary Dairy Farm Inspector, 62 Gothic Ave., Toronto, Ontario.

Munro, Harold R., Milk Inspector, City of Malden, 8 Lovell Road, Watertown, Mass.

Neer, Lester C., Meat and Dairy Inspector, 328 Edgar Ave., Dayton, O.

Oakley, Roger, Dairy Inspector, City Hall, Brockton, Mass.

Ocker, Harry A., Meat and Dairy Inspector, Department of Health, Cleveland, O.

Oldfield, H. G., Associate Sanitarian, Div. of Sanitation, University Campus, Minneapolis, Minn.

Oliver, John, Meat and Milk Inspector, Columbus, Miss.

Osborne, W. J. Earl, Dairy Inspector, Essex Border Municipalities, Windsor, Ontario.

Osgood, Clayton P., Assistant State Dairy Inspector, Augusta, Maine.

Palmer, Russell R., Chief Milk Inspector, City of Detroit, 1300 Beaubien St., Detroit, Mich.

Palmer, Wm. B., Executive Officer, Milk Association of the Oranges, City Hall, Orange, N. J.

Parker, Horatio N., City Bacteriologist, Engineer Building, Jacksonville, Fla.

Parker, N. M., Chief Inspector Milk Supervision, State Board of Health, Jackson, Miss.

Pearce, Dr. C. D., Chief Veterinarian, The Borden Company, 350 Madison Ave., New York, N. Y.

Pease, Dr. Herbert D., Director of Pease Laboratories, 39 W. 38th St., New York City.

Pierson, John, Health Inspector, 629 N. Parramara St., Orlando, Fla.

Pilgrim, Dr. S. L., Chief, Division of Food, Health Department, Milwaukee, Wis.

Plimpton, Geo. E., Chemist, United Farmers, 98 Cambridge St., Charlestown, Mass.

Possien, S. G., Chief Milk and Dairy Inspector, Board of Health, Mobile, Ala.

Posson, R. J., Sec'y-Mgr., Wash. Dairy Council, 502 Hill Bldg., Washington, D. C.

Pratte, Dr. Antonio, Supervisor of Milk Inspection Section, Health Department, City Hall, Montreal, Can.

Prentiss, Russell I., Milk Inspector, Town of Lexington, Lexington, Mass.

Price, Dr. Wm. H., Athletic Club, Detroit, Mich.

Putnam, Geo. W., Director of Research, The Creamery Package Mfg. Co., 1243 W. Washington Blvd., Chicago, Ill.

Quigley, J. V., President, Country Club Dairy Co., 5633 Troost Ave., Kansas City, Mo.

Rath, Dr. Floyd C., Assistant Health Officer, Dairy and Food Inspector, Madison, Wis.

Redfield, Dr. H. W., Mendham, N. J., R. F. D. 1.

Regan, Dr. J. J., Chief Veterinarian and Director of Labs., Dairymen's League, 11 W. 42d St., New York City.

Rempe, William, Chief, Milk Food Division, City Hall, Scranton, Pa.

Richmond, Dr. A. R. B., Chief of Division of Food Control, Department of Public Health, City Hall, Toronto, Ontario.

Roberts, H. P., Dairy and Food Inspector, City Health Department, Fargo, N. D.

Robertson, Dr. T. R., Sanitary Inspector, Dyersburg, Tenn.

Romberger, Dr. E. E., Milk and Meat Inspector, 340 N. 6th St., Reading, Pa.

Rosenberger, Dr. M., Superintendent, Adohr Stock Farm, R. 2, Box 105, Van Nuys, Cal.

Ruffner, Dr. F. J., City Dairy and Food Inspector, Beloit, Kansas.

Russell, C. C., Dairy Inspector, City Health Department, Birmingham, Ala.

Schlegel, John M., Dairy Inspector, Chicago Health Department, Daleville, Ind.

Schmeing, J. B., Sanitary Inspector of Dairies, Covington, Ky.

Schofield, Dr. Earle F., Milk and Food Inspector, Department of Health, Greenwich, Conn.

Scott, John M., Chief Milk Inspector, 230 E. Main St., So. Gainesville, Fla.

Secoy, Chas. W., Meat and Dairy Inspector, Bellevue, O.

Shain, Dr. Chas., Chief Food Inspector, Health Department, Hamilton, Ontario.

Shere, Lewis, c/o Diversey Mfg. Co., 53 W. Jackson Blvd., Chicago, Ill.

Shields, Fred M., Milk Specialist, State Board of Health, Jefferson City, Mo.

Shoults, Dr. W. A., Director Division of Food Control, Department of Health and Public Welfare, Winnipeg, Canada.

Shrader, Dr. J. H., Director, Research Laboratories, National Dairy Products Corporation, Baltimore, Md.

Shroat, H. E., Assistant, Division of Milk Control, State Department of Health, 28 Evergreen St., Harrisburg, Pa.

Shull, Dr. Hubert, Food and Dairy Inspector, 414 W. Third St., Texarkana, Ark.

Shutt, Donald B., Dept. of Bacteriology, Ontario Agr. College, Guelph, Ont.

Sibbald, A. D., Assistant Dairy and Food Commissioner, Old Capitol, St. Paul, Minn.

Slater, J. P., Sanitary Inspector, Union County Health Unit, Eldorado, Ark.

Smith, D. R., Dairy Supervisor, Southern Dairies Inc., 60 M St., N.E., Washington, D. C.

Smith, E. J., Ira Wilson Dairy, Tillman Ave., Detroit, Mich.

Steiger, L. T., Dairy Inspector, City Health Department, Memphis, Tenn.

Stevenson, A. F., The Borden Company, 350 Madison Ave., New York City.

Stovall, Roy S., Sanitary and Milk Inspector, New Albany, Miss.

Strauch, Thos. J., Chief Dairy Inspector, Bureau of Health, Richmond, Va.

Stricklen, Owen E., Plant Superintendent, Ann Arbor Dairy Co., 1132 Berk St., Ann Arbor, Mich.

Supplee, Dr. G. C., Director of Research Laboratory, The Dry Milk Company, Bainbridge, N. Y.

Swanner, R. O., Asst. Sanitarian, Milk Control Work, State Health Dept., Albany, N. Y.

Switzer, H. B., Chief, Rouses Point Import Milk Station, Rouses Point, N. Y.

Testerman, H. L., Inspector of Milk and Foods, Colorado Springs, Colo.

Thomas, R. C., Asst. Milk Specialist, U. S. Public Health Service, Washington, D. C.

Thomson, James E., Manager Department of Milk Supply, Borden's Farm Products Company, 110 Hudson St., New York City.

Thrasher, H. J., Assistant Director of Inspection, Alabama State Board of Health, Huntsville, Ala.

Tiedeman, Walter D., Chief, Bureau of Milk Sanitation, State Department of Health, Albany, N. Y.

Tobey, Dr. James A., Director, Health Service, The Borden Company, 350 Madison Ave., New York City.

Tobias, James H., Dairy Inspector, Chicago Health Department, 307 Bent St., Elgin, Ill.

Tobin, Michael F., Inspector of Pasteurization, 245 Canal St., Providence, R. I.

Tolland, A. R., Dairy Inspector, Health Department, Room 1102, City Hall Annex, Boston, Mass.

Trish, Dr. Karl A., Food and Dairy Inspector, Health Department, City Hall, Kenosha, Wis.

Trotter, Dr. A. M., Chief Veterinary Inspector, Corporation of Glasgow, 60 Melbourne St., Glasgow, Scotland.

Vener, Benj., 2738 E. 19th St., Brooklyn, N. Y.

Voorhees, Dr. L. A., City Chemist, Department of Health, P. O. Box 114, New Brunswick, N. J.

Walker, Dr. W. F., Director, Committee on Administrative Practice, American Public Health Association, 450 Seventh Ave., New York City.

Walmsley, Dr. F. D., Borden's Farm Products Company of Illinois, 326 W. Madison St., Chicago, Ill.

Ward, Dr. Archibald R., Assistant Chief, Dairy Research Bureau, The Mathews Co., P. O. Box 834, Detroit, Mich.

Ward, Willard E., Agent, Board of Health, for Milk and Food Inspection, 14 Town Hall, Brookline, Mass.

Warner, W. J., State Dairy and Food Commissioner, Hartford, Conn.

Washburn, A. M., Director, Miss. County Health Unit, Blytheville, Ark.

Washburn, Prof. R. M., Director, Dairy Products Institute, Olsen Publishing Co., 505 W. Cherry St., Milwaukee, Wis.

Way, H. O., Director, H. O. Way Laboratory Service, 308 Western Reserve Bldg., Cleveland, O.

Weaver, B. F., County Sanitary Inspector, Moulton, Ala.

Webb, K. C., Dairy and Milk Inspector, 318 E. 28th St., Erie, Pa.

Weber, Clarence W., Sanitarian, State Health Dept., 65 Court St., Buffalo, N. Y.

Wheeler, Ralph J., Milk Inspector, City of Pasadena, 547 Padilla St., San Gabriel, Cal.

White, G. T., Milk Inspector, 1130 Seward Ave., Detroit, Mich.

Wickham, Dr. J. C., Div. of Meat and Dairy Inspection, Cleveland Board of Health, Wooster, Ohio.

Wilcox, Dr. F. P., Chief, Division of Dairy Products, Los Angeles County Health Department, Hall of Justice, Los Angeles, Cal.

Williams, Dr. R. W., Milk and Food Inspector, P. O. Box 923, Eldorado, Ark.

Wilson, Frank C., in charge Milk Laboratory, Food and Drug Department, State Board of Health, Indianapolis, Ind.

Yale, Dr. Maurice W., Associate in Research, Division of Bacteriology, New York State Agricultural Experiment Station, Geneva, N. Y.

Yates, J. W., General Laboratories, Inc., 124 S. Dickenson St., Madison, Wis.

HONORARY MEMBERS

Evans, Dr. Wm. A., Health Editor, Chicago *Tribune*, Chicago, Ill.

Pearson, Dr. R. A., President, University of Maryland, College Park, Md.

Van Norman, Dr. H. E., The Borden Co., 350 Madison Ave., New York City.

Woodward, Dr. W. C., American Medical Association, Bureau of Legal Medicine and Legislation, 535 N. Dearborn St., Chicago, Ill.

TWENTIETH ANNUAL CONVENTION

HOTEL WINDSOR

MONTREAL, CANADA

THURSDAY, FRIDAY, SATURDAY, SEPT. 10, 11, AND 12, 1931

Thursday, Sept. 10

8.30 P.M.

BUSINESS SESSION

The business session was called to order at approximately 8:30 P.M. Thursday, September 10, 1931, Dr. Richmond presiding.

On motion of Mr. Kelly, the reading of the minutes of the last annual meeting was dispensed with, inasmuch as they were published in the annual report.

Dr. Holford reported that the auditors had examined the books and accounts of the Secretary-Treasurer and found them correct. Upon appropriate motion the report of the auditors was accepted and approved.

Dr. Brooks presented the report of the Secretary-Treasurer, a resumé of which follows:

> Cash on hand amounts to $723.37, which exceeds the amount on hand at the same time last year $291.06. The difference is accounted for by an increase in receipts from advertising over last year of $242.57 and by payment of dues by members in arrears.
>
> The Executive Committee met at Buffalo on January 6, selecting Montreal as the place for this meeting. By meeting in conjunction with the American Public Health Association we were able to take advantage of the reduced fare privilege. Tentative plans were made for the program, it being agreed to so limit the number of papers and reports to be presented as to avoid overcrowding the program.
>
> The Executive Committee, acting under authority imposed upon it at the last annual meeting, by appropriate motion reached the following decision regarding payment of annual dues: That the Association year be deemed to begin on

October 1 in each year; that all dues be payable on that date or, if the annual meeting is held at a later date, not later than the date of such meeting; that members whose membership year, under the old system, expired before October 1, be carried to that date in 1931 without extra charge or assessment; that all members in arrears be again notified and if they failed to remit promptly that they be dropped from the mailing list for the annual report; that all members in arrears at the close of each annual meeting, including this one, be notified immediately and, if they fail to remit within 30 days, that the Secretary-Treasurer shall delete their names from the list of members and so notify them. All members in arrears were notified and a majority have paid up to the present year. Twelve members have paid no dues since 1928. If they have not paid at the close of this meeting or within 30 days of the next notice, their names will be deleted, in accordance with the instructions of the Executive Committee.

The Executive Committee authorized a moderate increase in advertising rates in the annual report, agreeing that advertisements be distributed through the report, insofar as practicable in proximity to papers or reports on related subjects and that the words "When writing, mention this report" should appear at the bottom of each advertising page. Through an oversight the latter understanding was not carried out. However, a list of advertisers and their products, under the caption "One good turn deserves another" was sent to each member. Several advertisers indicated appreciation of this little innovation.

The Executive Committee considered a suggestion as to publication of a periodical bulletin and concluded that this was not at present feasible. It was, however, agreed that at this meeting the First Vice-President would present a proposition involving publication of the annual report in installments.

The suggestion of the Committee on Public Relations in regard to forming affiliated regional sections was considered. It was agreed that closer relationship with local organizations having similar objectives was desirable. The matter was referred back to the Committee with the request that it secure a list of local organizations, consider possible plans and report its recommendations at this meeting. In this connection it was agreed that the First Vice-President would also present for consideration at this meeting a proposal as to the formation of an inter-organization council or co-ordinating committee made up of representatives of national and international organizations having objectives similar to our own.

After considering a suggestion of the Public Relations Committee in regard to publicity, it was decided to discontinue the separate committee on publicity and turn its functions over to the Committee on Public Relations, with the understanding that $50.00, or such reasonable additional amount as might be required, would be made available for this purpose.

The further suggestion of the Committee that the Association issue news releases and magazine articles in the intervals between meetings was discussed and referred back to the Committee with the request that it consider the matter further and report at this meeting what, if any, such activities it believes to be feasible and how and by whom they should be carried on.

It is interesting to compare our present membership of 271 with that in 1920—97. Twenty-two new members have been accepted since the last meeting, as compared with 60 last year.

The Secretary-Treasurer expressed the opinion that the section of the Association's constitution relating to method of amending constitution and by-laws was not clear and urged that it be amended. He felt that before vote was taken on any amendment, the proposed amendment should be presented for discussion at a meeting. Pointing out that only about 55 percent of the members of the Association are inspectors "under that or some other title," the Secretary-Treasurer advocated that the name of the organization be changed to one more accurately descriptive of the character of the membership and "suggesting supervision and service" rather than "police control." (end of resumé)

Mr. Strauch moved that the report of the Secretary-Treasurer be accepted and placed on file. Motion seconded and carried.

Mr. Bowman presented the following report of the Committee on Resolutions:

WHEREAS, The International Association of Dairy and Milk Inspectors is closing a most instructive and successful annual convention in the city of Montreal, Canada; and

WHEREAS, The success of this meeting was so materially contributed to by outside agencies; therefore be it

RESOLVED, That the Association express its thanks and appreciation to the following officials of the Federal and Provincial Governments of Canada, and the officials of the city of Montreal, and Quebec, for their contributions and hospitality:

Dr. S. Boucher, Director of Health
Dr. A. J. G. Hood

RESOLVED, That the Association convey to the Windsor Hotel management and staff its appreciation of courtesies extended; and be it further

RESOLVED, That the secretary of the Association spread upon the records and transmit a copy to each of the individuals concerned.

Dr. J. B. Hollingsworth moved that the report be accepted and resolutions adopted. Motion seconded and carried.

Mr. Kelly moved that a resolution on the death of Dr. Hassler be incorporated in the report of the Resolutions Committee. Motion seconded and carried. The following resolution was incorporated in the report:

WHEREAS, In the death at the age of sixty-three of William Charles Hassler, City Health Officer of San Francisco, the International Association of Dairy and Milk Inspectors loses an active member who has done much toward the improvement of milk supplies and the raising of standards of milk inspection; and

WHEREAS, Dr. Hassler being a practical and persistent public health official of a kind disposition, was able to bring his public health plans to a full realization thereby contributing so much of a constructive character to milk inspection; therefore be it

RESOLVED, That this International Association of Dairy and Milk Inspectors spread upon its records a copy of this resolution and transmit a copy to the family.

Dr. Holford, Chairman of the Committee on Securing Advertising for the annual report, stated that the essential facts regarding the work of his committee had been included in the report of the Secretary-Treasurer and that his committee had prepared no report.

Dr. Grim, Chairman of the Committee on Public Relations, gave a brief verbal report covering the work done by his committee in handling publicity. Mr. Irwin moved that the report be accepted and approved. Motion seconded and carried.

Mr. Kelly presented the report of the Committee on Revision of the Constitution and By-Laws. Prof. Hiscock moved that the report be accepted and placed on file. Motion seconded by Mr. Bowman and carried. There followed a general discussion concerning details, after which Mr. Estes moved that the report be returned to the committee to be amended in accordance with the ideas brought out in the discussion and that the report as amended be returned for consideration at the session on Friday. Motion seconded by Mr. Irwin and carried.

Under the head of new business Mr. William B. Palmer presented a proposition to issue the annual report in installments instead of in a single issue as at present. After a discussion in which probable increased cost of publication was emphasized, Mr. Kelly moved that the Association continue for the present to publish its annual report in a single issue. Motion seconded and carried.

Mr. Palmer made a further suggestion that the Association endeavor to arrange with the several national organizations having interests in common for the organization of a conference committee made up of representatives of the various organizations to consider matters of common interest as they arise from time to time. Mr. Irwin moved that the Executive Committee extend an invitation to such organizations to appoint representatives to serve on such committee and that the president of this Association be authorized to appoint one or more such representatives. Motion seconded and carried.

Mr. Irwin made the suggestion that the Executive Committee in selecting the place at which the annual meeting is to be held from year to year arrange to have the meetings held alternately in conjunction with the American Public Health Association and the National Dairy Industries Exposition. The president requested an expression of opinion, and a majority of those present indicated approval of this suggestion.

Proceeding to election of Officers, Dr. Hollingsworth moved the nomination of William B. Palmer for President. Nomination seconded. Prof. Hiscock moved that the nominations be closed and that the Secretary be instructed to cast one ballot for Mr. Palmer. Seconded and carried. The Secretary reported the ballot cast and Mr. Palmer elected.

Mr. Kelly moved the nomination of Horatio N. Parker for First Vice-President. Seconded. Dr Mitchell moved that the nominations be closed and that the Secretary cast one ballot for Mr. Parker. Seconded and carried. The Secretary reported the ballot cast and Mr. Parker elected.

Mr. Irwin moved the nomination of Paul F. Krueger for Second Vice-President. Seconded. Mr. Bowman moved that the nominations be closed and that the Secretary cast one ballot for Mr. Krueger. Seconded and carried. The Secretary reported the ballot cast and Mr. Krueger elected.

Mr. Strauch moved the nomination of Mr. C. K. Johns for Third Vice-President. Seconded. Prof. Hiscock moved that the nominations be closed and that the Secretary cast one ballot for Mr. Johns. Seconded and carried. The Secretary reported the ballot cast and Mr. Johns elected.

Mr. Bowman moved the nomination of Paul B. Brooks for Secretary-Treasurer. Seconded. Mr. Palmer moved that the nominations be closed and that one ballot be cast for Dr. Brooks by the President. Seconded and carried. The President reported that the ballot had been cast and Dr. Brooks was elected.

Mr. Estes moved the nomination of W. J. Warner and F. D. Holford as auditors. Seconded. Mr. Palmer moved that the nominations be closed and the the Secretary cast one ballot for Mr. Warner and Dr. Holford. Seconded and carried. The Secretary reported the ballot cast and Mr. Warner and Dr. Holford elected.

There being no further business, the meeting adjourned until Friday afternoon.

At the opening of the afternoon session on Friday, President Richmond called the meeting to order for the purpose of considering the amended report of the Committee on Constitution and By-Laws. Mr. Kelly submitted the following report; and moved its adoption: Motion seconded.

In accordance with a motion passed at last year's meeting, Dr. Paul B. Brooks, the Secretary, sent to each member of the Association a copy of last year's committee report. This letter was sent out about November 1, 1930 and up to the present time only 31 replies have been received from members. This apparently shows a very small amount of interest on the part of the membership at large. Among those answering there is a decided tendency toward an amendment of the constitution allowing associate memberships under certain conditions. Nearly 85 per cent of the replies indicated such a preference. A great majority of those expressing their opinions wished present members of the Association to retain their present status as active members under the proposed amendment.

Nearly 90 per cent wished to retain the present provision for amendment; that is, two-thirds vote of the entire membership. A large proportion of these stated that they thought voting on amendments by mail should be allowed. The present constitution indicates to your committee that this is the approved procedure. The constitution states that "members shall register their votes on blanks provided by the Association before the date of the annual meeting." It is clear then that a vote on an amendment must be in writing and that it must be registered *before* the meeting.

There seems to be little sentiment for a board of directors other than the executive committee, for a nominating committee, or for a new name for the Association.

In accordance with these sentiments, your committee has drawn up two proposed amendments which it wishes to submit to the membership through the Secretary as provided in the constitution.

Amendment No. 1

The present section of the constitution entitled "Membership" shall be deleted and the following wording substituted:

"There shall be two classes of membership in this Association: Active and associate.

"The active membership shall be composed of persons who are officially engaged in dairy or milk inspection, or the laboratory control of, or the administration of such function for any country or any subdivision thereof, and of persons who are officially engaged in research or educational work related to dairy or milk inspection for any country or subdivision thereof; provided, however, that all persons who at the time of the adoption of this amendment are members of the Association shall be active members.

"The associate membership shall be composed of any persons not eligible for active membership, who are interested in the promotion of dairy sanitation. Associate members shall not be eligible to vote, serve as officers, hold the chairmanship of any committee, serve on the Resolutions Committee, or serve as majority members of any committee of this Association.

"Any properly qualified person may make application for active or associate membership to the Secretary-Treasurer and if application is accepted by the Membership Committee, said applicant may become an active or associate member, as the case may be, upon payment of the annual dues of $5."

Amendment No. 2.

The present section of the constitution entitled "Amendments" shall be deleted and the following wording substituted:

"The Constitution may be amended by a two-thirds affirmative vote of those active members of the Association who register their votes with the Secretary. Any member proposing amendments must submit the same in writing to the Secretary-Treasurer at least sixty days before the date of the Annual Meeting, and the Secretary-Treasurer shall at once notify all members that the proposed amendments will be open for discussion at the Annual Meeting immediately succeeding such notification. After discussion at the Annual Meeting such amendments, upon a majority affirmative vote of the members in attendance, shall be, within 90 days, submitted to the entire membership of the Association by the Secretary-Treasurer. All members voting on such amendments shall, within 60 days after receipt of such notification, register their vote in writing with the Secretary-Treasurer on blanks furnished by the Association. These ballots shall be opened and recorded by the Executive Committee, and the results shall be reported by the Secretary-Treasurer at the next annual meeting; and if the amendments are passed they shall become a part of the Constitution from the date of such report by the Secretary-Treasurer at the Annual Meeting."

In the discussion a question was raised by Dr. Holford as to whether in order to carry this motion a vote of two-thirds of the members of the Association or two-thirds of those present and voting would be required. The chair ruled that it would require two-thirds of those present and voting. There being no objection to this ruling, the question was submitted and the motion carried.

Mr. Kelly requested the secretary-treasurer to submit the proposed amendments to the constitution and by-laws to the membership for vote following final adjournment of the annual meeting.

There being nothing further to come before the meeting, the business session was declared adjourned and the president-elect, William B. Palmer, was invited to take the chair for the scientific session of the afternoon.

Program

THURSDAY, SEPTEMBER 10

9.30 A.M.

Address of Welcome
DR. S. BOUCHER
Director of Health, Montreal, Canada

Remarks by the President
A. R. B. RICHMOND, V. M. D.

Municipal Milk Control in Montreal
DR. A. J. G. HOOD
Department of Public Health, Montreal, Canada.

The Florida Milk Law
JOHN M. SCOTT
State Department of Agriculture, Jacksonville, Fla.

Measuring Efficiency of Municipal Milk Control
PROF. IRA V. HISCOCK
Yale University Medical School, New Haven, Conn.

Report of Committee on Dairy and Milk Plant Equipment
GEORGE W. PUTNAM, *Chairman*

THURSDAY, SEPTEMBER 10

2.00 P.M.

High Temperature "Short-Time" Pasteurization
C. A. HOLMQUIST
State Department of Health, Albany, N. Y.

The Relations of High Temperature Short Time Pasteurization to the Number of Thermophiles in Milk
M. W. YALE & R. S. BREED
State Agricultural Experiment Station, Geneva, N. Y.

Temperature Behavior of Milk Pasteurizers of the Thirty Minutes Holding Type
LESLIE C. FRANK
United States Public Health Service, Washington, D. C.

Effects of Cattle Feeding and Pasteurization on Food Value of Milk
ERNEST SCOTT
Ohio State University, Columbus, Ohio

To What Extent Should We Encourage Pasteurization?
HENRY VAUGHAN
Commissioner of Health, Detroit, Mich.

Report of Committee on Food Value of Milk and Milk Products
PROF. IRA V. HISCOCK, *Chairman*

THURSDAY, SEPTEMBER 10

8.00 P.M.

Report of Committee on Milk Plant Practice
H. A. HARDING, PH. D., *Chairman*

Business Session

Reading of Minutes

Report of Auditors

Reports of Standing and Special Committees
Resolutions
Securing Advertising for Annual Report
Public Relations
Revision of Constitution and By-Laws

Unfinished Business

New Business
Possible Change in Form of Annual Report
Desirability of Establishing a Conference Committee
WILLIAM B. PALMER

Election of Officers

FRIDAY, SEPTEMBER 11

9.00 A.M.

Certified Milk and Its Relation to Market Milk
H. M. HEFFERNAN
State Board of Health, New Orleans, La.

Factors Affecting Accuracy of Bacterial Counts
A. H. ROBERTSON
State Department of Agriculture and Markets, Albany, N. Y.

The Creaming of Milk
A. C. DAHLBERG
State Agricultural Experiment Station, Geneva, N. Y.

The Influence of Alkalinity Upon the Efficiency of Hypochlorite
C. K. JOHNS
Central Experimental Farm, Ottawa, Canada

Report of Committee on Laboratory Methods
GEORGE E. BOLLING, *Chairman*

FRIDAY, SEPTEMBER 11

2.00 P.M.

Use of a Photographic Standard in the Microscopic Examination of Raw Milk
KENNETH M. ROYER
Pure Milk Association, Chicago, Ill.

Bang's Disease in Relation to Milk
RONALD GWATKIN
Ontario Research Foundation, Toronto, Canada

Brucella Abortus Infection of the Udder
CHARLES A. MITCHELL
Department of Agriculture, Hull, Quebec

Excretion of Tubercle Bacilli From the Udder
E. A. WATSON
Department of Agriculture, Hull, Quebec

A Milkborne Epidemic of Septic Sore Throat
A. L. McNABB
Ontario Department of Health, Toronto, Canada

SATURDAY, SEPTEMBER 12

9.00 A.M.

Relation of the Streptococcus to Milkborne Infection
J. HOWARD BROWN
Johns Hopkins University, Baltimore, Md.

Diagnosis and Control of Mastitis
D. H. UDALL
College of Veterinary Medicine, Ithaca, N. Y.

Observations on Bovine Mastitis
H. B. SWITZER
Milk Import Station, Rouses Point, N. Y.

Some Results of Three Years of Mastitis Studies in the Province of Quebec
J. M. ROSELL
College of Veterinary Medicine, Quebec, Canada

Discussion of Papers on Mastitis
R. S. CRAIG
Department of Health, Baltimore, Md.

PAPERS IN RESERVE

To be published in annual report; read if time available.

Statewide Milk Survey in New York
W. T. D. TIEDEMAN
State Department of Health, Albany, N. Y.

Running Down the Causes of High Bacteria Counts in Milk
J. D. BREW
State Department of Health, Albany, N. Y.

With consent of the chairman, reports of the following committees will not be read but will be published in the annual report:

Report of Committee on Dairy Farm Methods
T. J. STRAUCH, *Chairman*

Report of Committee on Communicable Diseases Affecting Man
HORATIO NEWTON PARKER, *Chairman*

Committee on Sanitary Control of Ice Cream *
RALPH E. IRWIN, *Chairman*

Committee on Ordinances *
WILLIAM B. PALMER, *Chairman*

* No reports submitted.

Thursday, September 10

9.30 P.M.

ADDRESS OF WELCOME

DR. S. BOUCHER

Director of Health, Montreal, Canada

MR. CHAIRMAN, LADIES, GENTLEMEN:

I have the very pleasant duty this morning to wish you a hearty welcome; this, on my own behalf as Director of the Department of Health of the City of Montreal, and in the name of all the members of the staff of this Department.

In the first place, may I express to you my gratitude for having chosen our City as the meeting place for your convention this year; it is an honor which is highly appreciated, and in return you may rest assured that we will do our utmost to make your stay among us as pleasant as useful.

Your convention will assist us greatly in our efforts to improve the sanitary condition of the milk supplied to the population of Montreal; this question has been the object of our constant efforts for the last twenty years or so, and we were successful in not only improving this food, but, we may say without fear of being contradicted, that the milk supply of this City can be compared very favorably with the milk sold to the population of the most up-to-date centers.

But we are aware that our efforts should be continued and that our attention should never slacken, owing to the many factors which may influence the sanitary condition of milk.

Doctor A. J. G. Hood, the Superintendent of the Division of Food Inspection, who will present a paper on our organization and its working will, with pleasure, take you through the dairies and show you anything which may interest you relating to the milk production and the milk trade in this City.

The control of milk sanitation is one of the most important functions a Department of Health has to accomplish, in view of the protection of public health, because milk is the only food used during early infancy, when babies are not breast-fed; besides, it is the principal and sometimes the only food many patients can take; it is generally consumed at all ages, as it will be conceded that everybody drinks a certain quantity of milk, with the exception of very few cases.

On the other hand, it is the most perishable food existing, the one which may become polluted most easily with foreign and dangerous elements; its preservation requires great care, and the various alterations it may undergo are difficult to prevent, owing to its many unavoidable manipulations from the moment it is collected until it is delivered to the consumer.

Your task is a difficult one, but you work at it eagerly, and this congress is part of the ensemble of your activities; deep scientific knowledge is required to make this work a success, as well as long, thorough, practical training, and an exact understanding of the groups and of the individuals you are to meet; for you are educators who, besides knowing their subject well, have to present it in an attractive and comprehensive way, in order to raise no objection and to win their confidence.

This meeting will be a profitable one for spreading new knowledge, for the exchange of opinions on problems hard to solve, helping you at the same time to become better acquainted with one another and to increase the already existing cordiality.

In concluding, may I express the hope that this convention will meet with all the success you expect, and I wish to thank you for the honor you conferred upon me by asking me to inaugurate it.

REMARKS BY THE PRESIDENT

A. R. B. RICHMOND

LADIES AND GENTLEMEN:

I know I am expressing the feelings of everyone present, when I say that we appreciate very fully the extreme cordiality of the welcome just extended to us by Dr. Boucher, his pleasing references to us and his very kind invitation to us to investigate and become acquainted with the activities of his Department in the control of the milk supply of Montreal. I can assure Dr. Boucher that we now accept his invitation and will be pleased to arrange with Dr. Hood and members of his staff for visits to plants and farms.

In my official capacity, my first duty this morning must be to express my high appreciation of the honor conferred upon me in being privileged to occupy the Presidential Chair at this the 20th annual convention of the International Association of Dairy and Milk Inspectors, the 2nd to be held in the Dominion of Canada.

To preside worthily over the deliberations of our Association, would, I am afraid, demand qualifications of a different order from any I am able to discover in myself, but I will do my best and my first words must be those of welcome to you who have so cordially responded to our invitation to be here. We are honored that such a large number should find it possible to assist and encourage us by their presence in making a success of what we all hope and believe will be a memorable convention.

As a Canadian, I would extend, on behalf of our Canadian members to those from other countries, a most sincere welcome to Canadian soil, with the hope that the greetings they have already received, along with the hospitality which I know is to come, will leave such an impression as will lead to our all meeting again in Canada very soon.

There is to be no President's Address, for which fact I am sure you are just as truly thankful as I am.

The program before us is a remarkably fine one and no one interested in the control of milk and milk products can afford to miss hearing a single paper or discussion.

Outstanding authorities in the various fields of this work are with us to add to our knowledge the latest information, based on the part of some upon practical experience, on the part of others upon the result of scientific research, and we are indebted to them for their kind consideration in being here, bringing with them their contributions for the good of our cause.

It might not be out of place for me to mention at this time for the benefit of those who are with us as visitors, that we welcome applications for membership in our Association from any who are interested in our objects and possessed of the necessary qualifications.

Our annual report which is distributed to all members just as soon as compiled will include a full account of our convention, with all papers and reports of committees submitted and the discussions engaged in. This report combined with the contact with men and women in the practical and technical milk control field, which membership in our Association presents, is invaluable to all health authorities.

Now, Ladies and Gentlemen, we have before us this morning a program of marked interest and we are looking forward to it.

I should just like again before calling upon the first speaker to emphasize our particular pleasure at being in Montreal, at having such a splendid gathering for our first session and to say how much we appreciate the extreme warmth of the welcome extended to us.

MUNICIPAL MILK CONTROL IN MONTREAL

A. J. G. Hood

Dept. of Public Health, Montreal, Canada

Mr. President, Ladies and Gentlemen:

Your program committee has invited me to present a paper to you today on the subject of Municipal Milk Control. As there has been so much written and distributed on this, during the last few years, I hesitate to approach the subject, knowing that there is very little new to tell you, and also that there are many in this room more capable of doing so.

I will therefore give you as briefly as possible the history of milk inspection in our City of Montreal, which illustrates fairly well what has taken place in most large cities and towns up to the present day.

Milk inspection is in my estimation one of the most important divisions of Public Health work. One has only to consider the statistics on milk-borne diseases to realize the danger of the unsupervised or improperly supervised milk supply. Milk as you all know is one of the fundamental necessities of human life. It is the substance upon which the infant, the sick and the aged depend most; it is also a substance which is becoming increasingly popular as a beverage for general use. And what is the reason, you ask, for this increased popularity. The only answer to this question is the better quality of the product sold.

When we look up the records of the beginning of milk inspection, we find that it did not, like meat inspection begin in the dim and distant past, but only about two hundred years ago in the City of Paris, where in 1743 an ordinance was adopted which regulated the keeping of cows and goats.

The first real milk ordinance, of which we have a record, was adopted in England in 1860. Shortly after this, in 1864 the City of Boston, Mass. passed a law forbidding the sale of milk from diseased cows, but not until 1879 did they follow up this law by appointing an inspector who had authority to collect samples of milk for analysis.

During the year 1881 the Montreal Medical Society discussed the advisability of appointing a veterinarian as a milk and dairy inspector, but it was not until 1889 that the first milk inspector was appointed, from this date to 1900 I have been able to find very little information about the progress made, but in 1900 we find that two veterinarians have been appointed and that the quality of the milk sold has improved very much as a result of their supervision.

During the next ten years considerable progress was made, several more inspectors were appointed, regular dairy inspection of the producers was commenced with three lay inspectors doing this work.

In 1912 shortly after I was appointed superintendent of the Food Inspection Division, I had the good fortune of attending your convention in Chicago, there I obtained a lot of valuable information about how milk and dairy inspection in other cities was being improved. Upon my return to Montreal I tried to have most of these improvements applied to our milk and dairy inspection division, but owing to lack of funds we were obliged to be satisfied with the appointment of some additional inspectors.

As the existing by-laws were entirely inadequate a new by-law was drafted covering the production, pasteurization and sale of milk, cream, butter-milk, ice cream, etc.

In January, 1914, our present Director, Dr. S. Boucher was appointed and as he had always been very much interested in the improvement of the milk supply for the

City of Montreal, he had our draft of the Milk by-law revised and submitted it to the City Council for adoption. After a great deal of controversy, both for and against, it was voted down by the council, and shelved for the time being.

In 1925 Dr. Boucher submitted our milk by-law to the Executive Committee after having brought it up-to-date once more and having added upon request of the Milk Dealers Association a clause requiring an official Tuberculin Test of all herds supplying milk or cream to the City of Montreal. After considerable controversy this oft delayed by-law was passed by the City Council on July 20th, 1925. Up to this time we had succeeded in obtaining five dairy inspectors in the country and five milk inspectors in the city with one veterinary supervisor, and one inspector in charge of our 34 pasteurizing plants, with this limited staff we did our utmost to improve conditions both in the country and maintain a reasonable amount of supervision over the pasteurization of milk and cream in the city. Needless to state that we were not satisfied with this inadequate supervision, but lack of funds prevented the employment of more men.

With the advent of the typhoid epidemic in March, 1927 the authorities began to realize that we needed more and better trained men. Not only as dairy and city milk inspectors but also to control the operations of pasteurization plants and in the laboratory to permit of a better bacteriological control of milk at all times.

The control of milk production becomes effective when it is systematically carried out by well trained veterinary inspectors, who must be able to discuss and help the dairyman with his various problems, such as barn, dairy and ice house construction, ventilation systems, lighting, feeding, proper cooling and storage of milk, and last but not least, the keeping of his herd free from diseases, which would render the milk dangerous for human consumption, and also unprofitable to the dairyman.

I am pleased to state here, that we now have nine veterinarians, one lay inspector and one supervisor, looking after the production of our milk and cream supply for the City of Montreal. And that we have succeeded in getting very satisfactory results from our milk producers, who now all have officially tested herds, an abundant supply of ice, good dairy utensils, clean, well groomed cows, good clean well lighted and well ventilated barns, clean well built milk houses, not connected with their stables and very few cows with mastitis or other udder troubles. The result of all these improvements is that we are receiving milk which is equal to any on this continent for cleanliness, keeping quality and bacteria count.

Some authorities on milk control maintain that dairy inspection in the country is unnecessary and that all that is needed is to control the quality of the milk upon its arrival at the dairy, by the mythelene blue test, the bromo-thymol test, the sediment test and bacteria count. Our experience has shown that while all these tests are excellent and useful, the personal contact of the inspectors with the dairymen is well worth the expense of maintaining an efficient staff of veterinary inspectors in the country most of the time. During about one month each fall, we keep these inspectors in the city and have them run sediment tests and temperatures of the milk from the milk producers in each of their respective districts, in this way they are able to get a very good idea of the progress of their work amongst the producers. This taking of sediment samples and temperatures is done by the combined staffs of country and city milk inspectors, this sampling is done regularly throughout the year by the city milk inspectors.

We have carried on a campaign for better cooling for several years, our by-law requires that all milk shall be cooled down to 45° F. within 2 hours after milking and delivered to the city not over 50° F. We have accepted it until last year at a temperature of 60° F. but this year we have insisted that it be under 55° F. To obtain this end our country inspectors have instructions to insist that all producers store at least two tons of ice per cow, and three tons if possible. No producer is allowed to ship his milk to Montreal unless he has an abundant supply of ice or satisfactory artificial refrigeration.

Our country inspection is supplemented by a staff of 7 lay inspectors each of whom is in charge of a district of the city (which by the way is divided into 7 districts with three food inspectors in each district, one milk, one meat and one general food inspector). Each of these city milk inspectors has to supervise the transportation and sale of milk, cream, ice-cream, butter-milk, butter, cheese and other milk products in all conveyances such as railway cars, trucks, delivery wagons, etc., and in all stores, restaurants, hotels and any other place where milk or its products are offered for sale.

During the summer of 1927, we succeeded in having appointed a group of 7 lay inspectors (under the supervision of an experienced supervisor). These inspectors immediately after their appointment and before they were taken on permanently, had to follow a course of lectures on milk bacteriology, chemistry and general plant management at the end of which time, they were examined by a board of independent public health officials, and found competent to act as pasteurization plant inspectors.

This group of inspectors supervise the pasteurization of over 95% of our milk supply, and also look after the establishment of the 30 remaining raw milk dealers who are allowed to sell their milk under the name of "special milk," which is milk produced on farms having a score of over 80 points, and a bacteria count under 25,000 Bact. p.c.c. in Winter and 50.000 Bact. p.c.c. in Summer.

They each have a group of pasteurizing plants and dairies to visit regularly, where they supervise all the operations, take bacteriological samples, check the recording thermometer charts, washing solutions, sterilization thermometers, etc., they must also keep a record of all the dairymen supplying each pasteurizing plant with milk and cream. They also have to keep a record of all employees and see if any new employee has been properly examined at the municipal laboratory to be sure that this employee is not a typhoid carrier. All regular plant employees were examined during the epidemic in 1927 and the distributors have been done since then. These inspectors are moved from one group of plants to another every six months.

All this plant inspection is supplemented by the laboratory with Dr. Bolduc in charge to whom we deliver from 130 to 150 bacteriological samples every week.

Milk from all our dairies is sampled every week both for chemical and bacteriological analysis.

We use two tests on all bacteria samples, the plate count and the brilliant green test for the presence of the B. Colli group. This systematic sampling has produced very satisfactory results in the methods employed and the quality of the milk, cream and ice cream sold here.

THE FLORIDA MILK LAW

JOHN M. SCOTT
Chief Milk Inspector
Florida State Department of Agriculture

The Florida Milk Law under which the State Department of Agriculture is now doing milk inspection work was passed by the State Legislature in the Spring of 1929, although it did not become effective until October 1st, 1929.

This Law was entitled "An Act to Define and Regulate the Sale of Milk and Cream in the State of Florida, and Provide for the Enforcement of the Regulations Made Under This Act."

SECTION 1 in part is as follows:

"Milk is hereby defined to be whole, fresh, clean, lacteal secretion obtained by the complete milking of one or more healthy cows, properly fed and kept, excluding that obtained within fifteen days before, and five days after calving, or such longer period as may be necessary to render such milk practically colostrom-free; and shall contain not less than eight and fifty one-hundredths per cent (8.50%) solids not fat and three and one-quarter per cent (3.25%) butter fat.

"Cream is hereby defined to be that portion of milk, rich in milk fat, which rises to the surface of milk on standing, or is separated from it by centrifugal force, which is fresh and clean, obtained from fresh milk produced by healthy cows, properly fed and located or kept, and shall contain not less than eighteen per cent (18%) of milk fat and not more than two-tenths per cent (2/10%) of solid reacting substance calculated in terms of lactic acid. . . ."

These definitions are not new; in fact, they are the same or very similar to the definitions of milk and cream found in nearly all city ordinances that govern dairy products.

SECTION 2 of the law reads "No person by himself, or his agents, or servants, shall sell, offer for sale, expose for sale, or have in his possession with intent to sell, any milk or cream herein defined by this Act, provided that nothing in this Act shall apply to producers of milk in Florida who produce and dispose of the milk from five cows or less, by sale or otherwise, in such county where such milk is produced."

This is without question the most unpopular part of the entire law. It is unpopular among the dairymen, especially those who milk six cows or more. A half-dozen or more dairymen in any one community each may keep and milk five cows and thus produce and sell as much milk as a dairyman who milks thirty cows, yet all of this milk from the half-dozen five-cow dairies goes to the consumer without any inspection by the State Department of Agriculture. However, should these dairies be located so that they are supplying some town or city, the local city ordinance in most cases will take care of them.

"SECTION 3. It shall be the duty of every person, firm, association or corporation who ships or sells milk and cream in the State of Florida or brought from points outside of the State after the effective date of this Act to cause the same to be so labeled or identified in such manner or form as may be prescribed by the Commissioner of Agriculture as will advise the consumer of the nature and kind of milk or cream and will indicate the state or county in which same was produced, and all distributors or receivers of and for milk and cream shall be required to furnish all customers, wholesale or retail, with information to be placed upon the containers in which the milk or cream is handled showing the source of production of the milk or cream as hereinbefore required."

Prior to the passage of this law, large quantities of milk and cream were shipped into Florida each year during the tourist season. This milk and cream came from Georgia, Alabama, Tennessee, Virginia, Indiana, Ohio and perhaps some other states. Much of the milk shipped into Florida prior to 1929 was cheap milk purchased for manufacturing purposes, which had been pasteurized and shipped to Florida, where it was bottled and sold to consumers with no indication on the bottle cap as to where it was produced. We do not know, but we suspect that it was often mixed with fresh Florida milk and sold as fresh Florida product. Some of the cream that was shipped into Florida was of a low grade, some of which had been purchased for manufacturing purposes, which had been neutralized and shipped to Florida, where it was bottled and sold as fresh cream.

As the dairy industry of Florida grew, the dairymen of the State felt that the industry should have some State protection. It was believed that if all milk and cream were labeled so as to indicate the state of production, there would in this way be created a greater demand for Florida milk and cream.

Examples of the designs used on the milk and cream bottle caps are here shown:

Any advertising may be put on the bottle caps that the producer or dealer wishes.

"SECTION 4. All milk and cream shall, when sold in bottles or other receptacle to consumers or to dealers for resale to consumers, be plainly and conspicuously labeled in such manner as may be prescribed by the Commissioner of Agriculture as will show the grade under which it is sold and the source of production of same indicating the name of the state in which the milk or cream was produced, providing that no such milk or cream shall be offered for sale until upon examination by the proper official of the Board of Health it is found to meet requirements of this bill or the requirements of the city or town in which it is to be offered for sale.

"SECTION 5. It shall be unlawful for any milk, either imported or domestic, to be repasteurized, and it shall also be unlawful to mix domestic milk with milk brought in from any point outside of the State of Florida prior to sale to distributors, retailers or consumers."

Sections 4 and 5 make it very clear that all milk and cream must be labeled so as to show the source of production, indicating name of the state, and that milk or cream brought into Florida from another state cannot be mixed with Florida produced milk or cream and then sold to a dealer or to the consumer as a Florida product. In other words, these two sections stress the point that one of the purposes of this law is to have all milk and cream so labeled that the consumer may know exactly the source, quality and grade of the milk or cream that he buys.

"SECTION 6. It shall be unlawful for any person, firm, association or corporation, except the initial producer doing business in the State of Florida, to receive, offer for sale, transport, prepare or deliver for transportation or sale, as milk processors or dealers, any milk or cream, without first obtaining from the Commissioner of Agriculture a State License as a dealer in milk and cream. Applications for state License as provided under this Act shall plainly state under oath of the owner or manager of the individual, company, firm, association or corporation applying for same that all products of milk or cream which they desire to sell in this State are to be produced from healthy herds and under proper sanitary conditions, and the Commissioner of Agriculture may require from applicants a statement under oath from the proper official or officials of any state, county or municipality outside of this State when milk produced outside of the State is proposed to be sold in the State, certifying to the condition of production or handling of such milk or cream as shall be proposed to be shipped from their jurisdiction into the State of Florida to be handled by the applicant, and also as to the health of any and all herds from which all milk or cream is to be shipped into this State from points outside of the State. Upon filing of such application as herein set forth, the Commissioner of Agriculture shall issue to the applicant a State License upon receipt by him of the sum of Twenty-five Dollars ($25.00), provided that license for one-half year may be issued for the sum of Twelve Dollars and Fifty Cents ($12.50). All licenses issued shall become null and void at the expiration of September 30th of each year, after which new licenses shall be obtained upon the payment of the fee herein provided for the next ensuing year. Provided that nothing contained in this section shall apply to any common carrier.

"Section 7. The Commissioner of Agriculture may at any time, for just cause, and after reasonable notice and hearing, revoke any license that may have been issued under the next preceding section of this Act when it shall have been made to appear that any licensee has violated any provisions of this Act or any reasonable rule or regulations prescribed for its enforcement.

"Section 8. The provisions of this Act may be enforced under the supervision of the State Board of Health of the State of Florida and by local health officers of the various municipalities of the State of Florida as to milk or cream sold or offered for sale within the jurisdiction of such municipality.

"Section 9. The Commissioner of Agriculture is hereby authorized to employ field and other agents and clerical assistance at such times and for such periods as may be necessary to enable him to enforce the provisions of this Act and to incur and pay any of the expenses thereof out of the "General Inspection Fund" created by Chapter 10149, Laws of Florida, Acts of 1925, on vouchers approved by the Supervising Inspector and Commissioner of Agriculture, including traveling expenses, and the same are hereby appropriated for that purpose of said General Inspection Fund, provided, however, that the sum of not exceeding Fifteen Thousand Dollars ($15,000) per annum shall be expended under the provisions of this Act for its enforcement.

"SECTION 10. The Commissioner of Agriculture shall from time to time, as he may deem expedient and necessary, make and promulgate rules and regulations for carrying out and enforcing the provisions and requirements of this Act, which rules and regulations shall be issued by him in pamphlet form for distribution to the public upon request therefor.

"SECTION 11. It shall be unlawful for any person to obstruct or resist any authorized inspector designated by the Commissioner of Agriculture or acting for any State, County or local Board of Health in this State while such inspector is in the reasonable performance or discharge of any duty imposed upon, authorized or required of him by the provisions of this Act, or by any rule or regulation prescribed hereunder.

"SECTION 12. Any person who shall violate any of the provisions of this Act, or shall do or commit any act herein declared to be unlawful, or shall violate any reasonable rule or regulation made or promulgated by the Commissioner of Agriculture by virtue of the authority herein given shall be punished by a fine of not more than Five Thousand Dollars ($5,000.00), or by imprisonment of not more than twelve months in the county jail.

"SECTION 13. This law shall be construed as an Act intending to secure to the people of Florida the assurance that milk sold or offered for sale to the public is produced under sanitary conditions and is wholesome and fit for human consumption and is being offered to the public under its correct designation as to grade and quality and as to source of production. . . .

"SECTION 15. Whenever any municipality shall have established any standard of qualification for sale of milk or cream within its jurisdiction which is in excess of the requirements of this Act defining milk and cream, nothing in this Act shall be construed as superseding or rendering ineffective or invalid any local regulation of any such municipality prescribing standards of milk or cream and requirements under which same shall be produced in order to be sold within the jurisdiction of the particular municipality, but compliance with the standard fixed by this Act shall be sufficient as to all inspections made by or under the supervision of the State authorities outside of such particular municipality."

Since the passage of this law, the Legislature passed what is now known as the Milk and Milk Products Law. In addition to the provisions of the old law, the new law provides for the supervision of the manufacture and sale of all dairy by-products. Under the new law all milk products must be labeled so as to indicate the true contents of the bottle, can or package; for example, buttermilk, if churned, shall be labeled "Churned Buttermilk;" cultured buttermilk shall be labeled "Cultured Buttermilk"; renovated butter shall be labeled "Renovated Butter."

The new law also prohibits the sale of recombined or reconstructed milk and yellow imitation butter.

The Florida Milk and Cream Law has now been in operation nearly two years and has worked very successfully. We have had nearly 100 per cent co-operation from the dairymen and milk dealers of the State.

It took about six months for all dairymen to get the proper bottle caps. Today there are very few or no dairymen who are not using the proper milk and cream bottle caps, about the only exceptions being in cases where the dairymen's supply of caps has become exhausted before the new supply arrives. Under such circumstances the State Inspector gives the dairyman permission to use an emergency cap until his new order arrives.

The milk dealers of the State have adjusted their businesses so as to comply with the law. They found that the people of Florida had a preference for Florida produced milk. As a result, the dairy industry of Florida has made a very rapid growth during the past two years.

Three years ago large quantities of milk were shipped into Florida. This amounted to about 200,000 gallons a year. The shipped-in cream amounted to about 200,000 to 250,000 gallons. From October 1, 1930 to April 1, 1931, the period covering the tourist season, only 4,275 gallons of milk and 150,000 gallons of sweet cream were shipped in.

MEASURING EFFICIENCY OF MUNICIPAL MILK CONTROL

IRA V. HISCOCK

Professor of Public Health, Yale School of Medicine

NEED FOR MILK CONTROL

Probably no phase of public health administration has received more intensive study over a long period of years than methods for safeguarding milk supplies. The need for such study is apparent when one considers the value of milk as a food, the history of milk-borne disease, and the diversity of methods of protecting this essential food.

Milk and its products, butter, cream, cheese, buttermilk, skim milk, and ice cream constitute the most important articles used for human food. As a city increases in size, its milk supplies tend to merge more and more until finally thousands of people may be supplied from one plant which receives its product from hundreds of farms widely scattered. It is easy to understand why milk supplies, unless properly controlled, may be the vehicle of outbreaks of disease, for milk is a natural growing medium for several disease-producing bacteria. A service is, therefore, necessary for the control of milk supplies from the source of production to the point of delivery, together with an endeavor to educate the public as to the value of an adequate supply of clean, safe milk, and the necessity of proper home care of milk.

AIMS

The two essential features to be considered are (a) that production of milk on the farm must be so conducted that the possibility of infection will be reduced to a minimum, and (b) that subsequent pasteurization must be so scientifically applied that any infection which does occur, despite the farm production precautions, will be prevented from reaching the consumer.* The meeting of either of these requirements alone is not sufficient, for although pasteurization is the one safeguard, it is not a panacea and it cannot make of unclean milk an ideal food, nor will the most thoroughgoing inspection of the farms prevent the occasional infection of a raw milk supply with the germs of one of the communicable diseases, or with the germs from diseased udders.

While enormous sums of money have been expended in the provision of personnel for the supervision of milk supplies, and while great strides have been made in many localities in improving the quality of milk and milk products, methods and types of organization differ considerably, and there is yet much opportunity for improvement especially in the small cities and rural areas. Furthermore, many cities and counties lack adequate, trained personnel. The extension of full time county health units with trained personnel is perhaps the outstanding need at present. Regardless of local provisions, the further need for organized effort and leadership from the State or Province is evident. Such provision is especially important in the development and enforcement of appropriate legislation, the maintenance of trained advisory and supervisory service, and the measurement of results. Valuable assistance may also be secured from federal departments.

Methods of Measuring Efficiency

Many methods of measuring the efficiency of control measures have been utilized, with varying degrees of success. It is difficult to devise a single type of "yard-

* Much of the material here presented is based upon the chapter on Milk Supervision in the 1932 edition of *Community Health Organization*, published by the American Public Health Association.

stick," applicable in all localities and under varying conditions. There are certain elements and fundamental principles, however, which have been fairly well established.

In attempting to measure the efficiency of municipal milk control, it is important that those engaged in the evaluation process become as familiar as possible with local conditions, the economic, industrial and social factors relating to the population, the geography of the area, transportation facilities, and the like. An analysis of trends of infant mortality, diarrhea and enteritis, non-pulmonary tuberculosis, and communicable disease outbreaks traced to milk is desirable. Personal contact with those engaged in the production and handling of milk and with leading citizens, including inspections of methods and equipment, a study of bacteria, butterfat, dairy inspection, and per capita milk consumption records over a long period, are among the necessary procedures to be followed. Efforts should also be made to gain an impression of the public's attitude toward the local milk supply. The time necessary for such a study will vary with conditions, but it should be emphasized that a hurried check-up is likely to lead to incorrect impressions and misunderstanding on the part of all concerned.

Our most progressive cities maintain in their health departments special inspection and laboratory divisions for insuring the supervision of milk supplies. In certain instances, as in the Oranges in New Jersey, several small cities cooperate in the maintenance of a well organized service. In others, the service is a part of a county-wide or a state-wide program.

The State Department responsible for milk control may from time to time conduct special surveys. In California, this survey consists of periodic Surprise Milk

Contests, while in Kansas and New York, for example, extensive surveys have been made of a large number of cities and towns to give a cross section of the general situation. Such surveys consist of chemical, bacteriological, and sediment examinations of samples of milk collected from wagons, milk depots, and stores, and in most cases of inspection of dairies producing milk or the depots or pasteurizing plants distributing milk. Several states during the summer months utilize a mobile laboratory in which analyses may be made in the field. The American Child Health Association, the United States Public Health Service, the Dairy Division of the U. S. Department of Agriculture, and the American Public Health Association, have all contributed to our knowledge of the status of milk control and of survey methods.

The Appraisal Form of the Committee on Administrative Practice of the American Public Health Association contains a section designed for measuring, by a cross section method, the effectiveness of milk control practices in a city. This form has its limitations but is very useful, in conjunction with the personal inspections and supplementary studies of the surveyor in formulating an impression of the degree of efficiency of milk supervision in a municipality being surveyed. Before submitting a report of the results and conclusions of such a study, however, it is highly important that the surveyor review his findings with those responsible for milk control in the community studied, to be sure that correct interpretations have been made and sound conclusions drawn.

The United States Public Health Service, and several states in which the Standard Milk Ordinance is in force, have surveyed and rated cities on the basis of the Grade A Raw Milk and Grad A Pasteurized requirements of the Ordinance. These grades are widely used as milk

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standards in several sections of the country and are valuable in making comparative ratings, but as in the use of the Appraisal Form previously mentioned, much care and judgment should be exercised by the surveyor.

As pointed out in the report of the subcommittee on Milk Production and Control of the White House Conference, a proper milk sanitation rating is one which measures the percentage extent to which all practicable public health precautions have been applied. In addition to rating the results of enforcement effort, it is believed that the characteristics of the effort itself should be rated in order to make apparent how effort and result are related, and what specific defect in effort led to any given low "Result Rating." The rating of effort may be accomplished, as suggested by the White House Conference Committee, by establishing a schedule of enforcement measures, such as inspection, sampling, etc., and estimating on a percentage basis the degree of completeness with which each measure has been applied. The average of these percentages, weighted on a relative importance basis, will yield a useful effort rating. This principle has been applied in the Appraisal Form for City Health Work.

For a comprehensive understanding or evaluation of control measures, it is believed necessary to ascertain if certain elements considered essential for the adequate protection of the public are provided. These items may be assembled in tabular form, with relative weights assigned, for a rating schedule, if desired.

It is perhaps possible to devise a rating schedule to be used in different localities in measuring the efficiency of milk control, but such a schedule should be used with great care and adapted somewhat to meet the local situation as observed in detail by the surveyor.

Ordinances

Is there in force an ordinance based on and including the provisions of the state statutes, which prescribes the safeguards with which milk should be surrounded on the farm, at the pasteurization or milk plant, and during delivery? In order to enable the health officer or milk control official to secure compliance with these requirements, it is advisable that the ordinance include either, and preferably both, of the following enforcement devices:

(a) All producers and distributors should be required to hold permits which may be revoked by the health officer for violation of any item of the ordinance, and

(b) All milk supplies should be graded and the health officer should be authorized to lower the grade of any supply if any item of sanitation is found violated. The ordinance should include definitions of milk and milk products.

Inspections

Is a systematic and thorough inspection service provided by trained inspectors? If personnel were adequate, monthly inspections of dairy farms would be desirable. It is considered necessary, under practical conditions, that inspections be made at least twice, and preferably four times, a year of all farms supplying the city; and four times, preferably eight times, per year, of producing farms distributing raw milk to the consumer. Several milk control officials feel that the dairy farms should be inspected by veterinarians much more frequently. Standards of certified medical milk commissions may be accepted as model in this regard. If the state or county maintains an effective inspection service, the local community may be relieved of much of this responsibility for dairy farm inspection, and concentrate its efforts on pasteurization and city milk plants. The Standard Milk Control Code, published by the U. S. Public Health Service, is a valuable aid to inspection in that it constitutes a handbook or manual of milk sanitation requirements, and may be used to advantage irrespective of the type of milk ordinance in force. The results of inspections should be recorded on a standard score card,* or on a standard inspection blank and later transferred to a loose leaf ledger form. Samples of such forms may be purchased from the Government Printing Office at Washington. The American Public Health Association, Committee on Administrative Practice, has published a useful set of administrative record forms for tabulating monthly inspection and laboratory activities. If a milk control division maintains careful records, well analyzed, the surveyor has available one useful index of efficiency.

Creameries, milk stations, ice cream plants, and other plants handling milk products need inspection every week. Special consideration should be given to the methods of sterilization of bottles, cans, and equipment; to the effectiveness of operation of pasteurizing machinery; to refrigeration methods; to the health of the workers; and to general cleanliness. The surveyor must observe these conditions first hand, preferably on more than a single unannounced visit, as well as reviewing the records of the local inspector, if a fair impression is to be obtained. Modern inspection service is largely educational in nature and the content of local inspection service should be noted.

Pasteurization

Pasteurization should be defined by law, and the pasteurization of all milk, except possibly a small amount of

* Obtainable from the State health department, the U. S. Dairy Division or the U. S. Public Health Service.

milk of certified or similar quality, should be required by ordinance.* There are several large and small cities in which all of the milk supply is safeguarded by pasteurization. Pasteurization plants should be controlled by at least weekly inspection and laboratory tests, and by continuous temperature records. All pasteurization machinery should be equipped with both indicating and recording thermometers complying with standard specifications. All indicating thermometers should be carefully checked by the inspector regularly against a standardized inspector's test thermometer; and all recording thermometers should be checked daily by the plant operator, and at least weekly by the inspector, against the previously checked indicating thermometer.

Temperature Standards

In measuring the efficiency of control measures, an important factor to be noted is the attention given to proper refrigeration. Obviously, temperature standards should be enforced with regard to milk in transit and that held for sale. While practical conditions govern somewhat the details of these standards, efforts should be made to have milk cooled promptly after pasteurization to a temperature of 50° F. or lower, and held at a temperature as low as this until it is delivered to the consumer. For milk distributed directly to the consumer without pasteurization, similar standards are necessary.

Laboratory Control

The public health laboratory is a vital factor in milk control work, and the scope of work and results obtained are perhaps the most sensitive index of the efficiency of

* The Appraisal Form for City Health Work of the A. P. H. A. gives full credit to a city on this point only if 100% of the milk supply is pasteurized.

local milk control. These results must be closely scrutinized in relation to local conditions, for it is observed that bacteria counts on the Western Coast, for example, run consistently much lower than in most other sections of the country. As a result of extensive milk control work over a long period of years in New York State also, it has been found practical to set a bacteria standard considerably higher than is considered feasible in many other states. Hence local or State bacteria standards should be studied in applying this measuring rod.

If an efficient system is in practice, samples of milk and milk products for bacteriological and chemical examination should be collected at frequent intervals from stations, creameries, wagons, and stores. A tabulation of these results over a period of a year, with supplementary tests made by the surveyor, should give a fair index of the situation.

In several cities it is the practice to publish periodically the results of a series of laboratory analyses from each dealer. If this practice is followed, consideration may be given to the desirability of expressing the results in general terms, or under group headings, as under 5,000, 5,000 to 10,000, and so on. It should be borne in mind that the bacterial count represents only one item in the grade requirements, and its publication may cause the consumer to differentiate between various milk supplies on a basis of fictitious accuracy. Certain milk control officials prefer to publish the grades only, and to determine the grade on the basis of all sanitation requirements, including both inspection and analysis.

The interest of local milk concerns in the provision of supervision may be an indication of the extent of progress in control work. Valuable assistance may be rendered by the health department to milk concerns that wish to establish their own laboratories and system of inspection of dairies for the supervision of their own supplies, thereby arousing personal interest, closer supervision and improvement in supplies with resulting benefit to the public. Producers and distributors may be readily instructed by an efficient health department through conferences, letters, and pamphlets.

Herd Tests

The extent of systematic herd testing is another index of the efficiency of control measures, and records should be carefully analyzed. All cattle producing milk to be sold raw should be required to be tuberculin tested in accordance with accepted official State and Federal regulations, with prompt removal of reacting animals from the herds. In several localities, it is required that all dairy cattle, whether producing milk to be sold raw or pasteurized, be regularly tuberculin tested. Physical examinations should be sufficiently thorough to include efforts for the detection of mastitis. In an increasing number of areas, systematic testing of herds for Brucella abortus infection is being undertaken in order to control contagious abortion and to meet the problem of undulant fever.

Special Provisions

Although there is not a general agreement on the subject, it is believed by many officials that all bottled milk, by ordinance requirement, should be plainly marked to show the name of the producer or distributor, the grade, and the date of production or pasteurization.

All milk sold in eating establishments should be served in the original container and opened in the presence of the consumer. In the most progressive communities, all handlers of milk to be sold raw and all handlers of milk in the process of pasteurization and after pasteurization are subject to a systematic and frequent medical examination, including laboratory tests which are perhaps the most important feature of the examination. An efficient department has carefully prepared regulations for the control of carriers and cases of communicable disease on farms, the quality of water supplies on farms and in plants, and methods of bottling and capping.

It is believed that persons engaged in the handling of milk should be assembled by the health officer or milk control official at least once a year for the purpose of giving practical instruction in the importance of personal habits in the protection of milk. Producers should be systematically instructed in modern methods of milk production, through letters, pamphlets, and personal contact with trained inspectors. There should also be an educational program for consumers regarding the value and care of milk.

Conclusions

The foregoing statements have been made in an effort to outline practices which will be found if efficient milk control measures have been formulated. One who attempts to evaluate the effectiveness of supervision needs to study the local situation carefully with these modern practices in view. It is obvious that important factors and many details of supervision have been omitted. Any efforts to develop a comparative numerical rating which will apply satisfactorily to municipalities of different sizes and types and in widely separated localities should be attempted with caution, because a fair evaluation cannot be made by a simple "rule of thumb" procedure. Consideration of many local factors, by those trained in milk control work and evaluation methods, is essential if mutual benefit is to result from efforts to measure the efficiency of a program of milk supply supervision.

Periodic ratings of the public health status of milk supplies are necessary in order to insure a constantly maintained alertness and efficiency on the part of the responsible officials, and in order to provide a measure of progress from year to year. So far as practicable, such ratings should be based upon a common standard in order that they may be comparable. Milk control officials may render a valuable service through joint conferences on these subjects, including representatives of adjoining states or other areas. Continued study is desirable for the development of a common standard applicable to varied conditions, and certain adaptations to local situations may be necessary. These ratings or appraisals should be made by experienced workers and with a spirit of co-operation if sound progress is to result.

REPORT OF THE COMMITTEE ON DAIRY AND MILK PLANT EQUIPMENT

GEORGE W. PUTNAM, *Chairman*

Director of Research, The Creamery Package Mfg. Co., Chicago, Ill.

The past reports of your Committee have endeavored to indicate the trend in new dairy and milk plant equipment for the information and use of the members.

DIRECT EXPANSION COOLING

A marked trend in equipment for the cooling of milk in the past few years has been toward the use of direct expansion coolers, using ammonia in contrast to the older method using brine. Advantages of direct expansion are that it is much more flexible in that the temperature of cooled milk can be easily controlled to as low a point as desired without change in the milk flow, by simply lowering the ammonia suction pressure at the cooler; further that the danger of corrosion and getting brine into the milk is eliminated.

In the case of milk held in storage tanks, such tanks need only to be insulated when provided with a direct expansion cooling cone or cylinder and an agitator. This eliminates the necessity of a brine jacket and the possibility of any brine leaks into the milk tank, developing through corrosion of the tank lining.

Iron pipe coils for direct expansion in the milk cooler room are quite generally used, so that many of the newer plants are equipped throughout with direct expansion equipment for cooling. Plants handling as low as 500 quarts of fluid milk per day are operating on direct expansion cooling throughout the plant.

In addition to the points mentioned, brine piping, pumps and brine tanks are elminated and materially

greater efficiency is secured through using ammonia direct, without brine as an intermediate heat transfer agent.

Power Conveyors

Another noticeable trend in handling of milk cans and bottle crates is toward the increased use of power driven or drag-chain conveyor, in contrast to the older gravity roller conveyor. Drag-chain conveyor has the advantage of flexibility and positive movement and eliminates all problems of lifting cans or crates to a certain height to secure elevation for their transfer on a gravity roller conveyor. Bumping of cans or crates together, with occasionally breakage in the case of bottles, also stopping of travel due to wedging, is eliminated and in general a more orderly and efficient handling of these units is secured.

Certified Dairy Farm Equipment

A constructive movement toward improving equipment on certified farms has been under way for the last few years. Rectangular vats of either the spray or flooded jacket type have been favored for cooling and storage vats. The use of a cooling and storage vat has resulted in a more uniform ratio of fat and solids not fat, and, incidentally, more even cream line by comparison with the old method of running from a surface cooler direct into the filler. It also cuts down the labor of cleaning and sterilization from two to three times a day to once a day. Another advantage is that a cooling and storage vat cuts out the necessity of rushing the milking and bottling, since they can be done at different times with the same help, which makes for greater care in both operations. After milking and cooling in the vat, the milk can be bottled when convenient. On some certified farms having surplus milk, the cooling vat is connected

K-W
Milk Strainer
Fitted with Baffle Cup

Fitted with dome

Dome with strap handle

A STRAINER fitted with a special perforated dome which breaks up the pressure of the poured liquid and thereby prevents the pressure from pushing particles of dirt through the strainer cloths.

The strainer cloth is placed over the mouth of the dome and then the cloth and dome are forced into the neck of the strainer as illustrated.

In the K-W Milk Strainer you have a better strainer with the practical dome arrangement which saves time, effort and annoyance and offers more efficient service.

This dome or baffle cup breaks up the force of the poured milk and allows the milk to flow evenly through the strainer cloth without undue pressure at any one point.

Can be furnished with or without handle on dome, as preferred.

No. S516
Capacity—16 Qt.
Diameter at top—13½"
Diameter at neck—5¾"
Approximate shipping weight, 72 lbs. per doz.

Strip or Garget Cups

For inspecting quality of milk from each cow. A seamless steel cup fitted with removable fine mesh strainer—all parts carefully tinned—easy to keep clean.

No. SC1 Capacity 1 qt.

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up with steam and the surplus milk is pasteurized and sold as the highest grade pasteurized milk. The replacement of ice with refrigerating machines in many plants has made it easier to handle milk colder.

The use of milking machines in a milking "parlor" with vacuum transfer of the milk to automatic weighing bottles, is one of the latest developments in certified dairy equipment. This automatic milking equipment in a small milking "parlor" or barn minimizes the exposure of the milk to contamination and has many labor saving advantages. It must not be overlooked, however, that this equipment requires thorough daily cleaning and sterilization and that all parts must be constructed so as to be accessible.

Thursday, Sept. 10

2 P.M.

HIGH TEMPERATURE-SHORT TIME PASTEURIZATION

By

C. A. Holmquist

Director, Division of Sanitation

New York State Department of Health

Pasteurization of milk had its origin in the heating of milk in bottles in the home for feeding infants about 1873 or some ten years after Pasteur had discovered that heating wine to temperatures of from 122° F. to 140° F for a "few minutes" killed the bacteria and yeasts which caused wine to sour. Between 20 and 30 years elapsed, however, before pasteurization was used for the treatment of market milk supplies.

The so-called "flash" method of pasteurization was developed on a commercial scale between 1890 and 1900, and was widely adopted between 1900 and 1907. These early flash pasteurizers, in which milk was heated momentarily from 158° F. to 165° F., were not provided with automatic control or safety devices. The manually operated controls were crude and required the constant attention of the operator. Carelessness on the part of the operator, changes in the flow and temperature of the milk or of the heating medium or a breakdown of the apparatus imparted a cooked taste to the milk or, what was more serious, allowed large quantities of improperly pasteurized milk to pass through the apparatus. These conditions led to the discredit of flash pasteurization in this country and to the development of the so-called "holding" method of pasteurization in 1907.

Although this latter method has been in use for a quarter of a century, the temperature and holding time requirements of milk codes still differ due to the fact that there is no single thermal death point for pathogenic bacteria and to differences in opinion as to the factor of safety considered necessary to compensate for irregularities in efficiency and operation. The relatively long exposure of the milk to pasteurizing temperatures in holders and the decrease in infant mortality resulting from the use of pasteurized milk inspired confidence in the minds of public health authorities in the holding method.

It was found, however, that nearly all of the earlier holding pasteurizers were defective and that some of the milk passed through them was not held at the pasteurizing temperature for the required length of time. The extensive engineering and bacterial tests carried out at Endicott, N. Y., in 1922 and 1923, in which a large number of both state and federal public health authorities as well as private agencies participated, revealed many serious defects in various types of commercial pasteurizers then in general use.

In the short flow cylindrical holders there was short circuiting and some of the milk passed through the holders in a few minutes when so operated as to give a theoretical holding period of 30 minutes. Leaky valves and dead ends were found which permitted improperly pasteurized milk to escape into the pasteurized milk. Other defects were discovered by tests carried out for several years by the United States Public Health Service in Chicago and by certain state and city health departments.

# Indicates Holding-Time Exactly!

TAG Now Offers the FIRST Temperature-Holding-Time Recorder for Pasteurizing

MANUFACTURERS of batch or vat type pasteurizers have so improved their apparatus that most of it is now capable of meeting State and Municipal requirements in all respects except one — the equipping of the holders with a recording device to show accurately the exact length of time the milk has been held. The New TAG Temperature-Holding-Time Recorder fully meets this requirement.

By the ingenious use of a second pen electrically connected with a mercury bottle switch on the outlet valve, or on both inlet and outlet valves where the milk is preheated, a time line is given on the chart which accurately checks with the temperature line.

The full story is contained in Catalog No. 520-T—just off the press. There's interesting information on other TAG Dairy Instruments in it too. Get your copy FREE!

Here is a typical valve in the open position. Note that when it is in the closed position the small roller on the switch fits into the notch on the top outer edge of the plug valve as shown. The minute the valve is opened to drain off the milk the contact is broken and that fact is instantly recorded on the chart.

The TAG Universal Scale Indicating Thermometer with Full 1/16" Degree Divisions Over the Entire Range of Cooling, Preheating and Pasteurizing.

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Park & Nostrand Ave's., Brooklyn, N.Y.
TAGLIABUE Mfg. Co. BROOKLYN

"When Writing Mention This Report"

The manufacturers of apparatus have shown great ingenuity in correcting the defects and in developing new types of apparatus so that most of the holding pasteurizers now in commercial use are capable of meeting definitions of pasteurization within narrow limits. However, it is as yet almost impossible to determine from recording devices now available the exact time that the milk is held in the holders and, almost without exception, there are no automatic safeguards to prevent milk from being held at temperatures below the required pasteurizing temperature in the so-called holding apparatus.

Marked improvements have been made in the design of automatic control and safety devices since the days of flash pasteurizers and interest in high temperature pasteurization has been revived. These devices, which have made possible high temperature pasteurizers, have been developed for their particular use and consist of instruments designed (1) to automatically control the rate of flow of milk and prevent it from being held less than the required time; (2) to automatically stop the milk pump if the temperature of the milk drops to a predetermined point; and (3) to automatically control, within narrow limits, the temperature to which the milk is heated.

There are now two general types of high temperature pasteurizers in commercial use. In one the heating medium is electricity and the other hot water. These new pasteurizers may more appropriately be called high temperature-short time pasteurizers than flash pasteurizers, because they are designed to hold the milk for a certain predetermined time after it has been brought up to the required temperature.

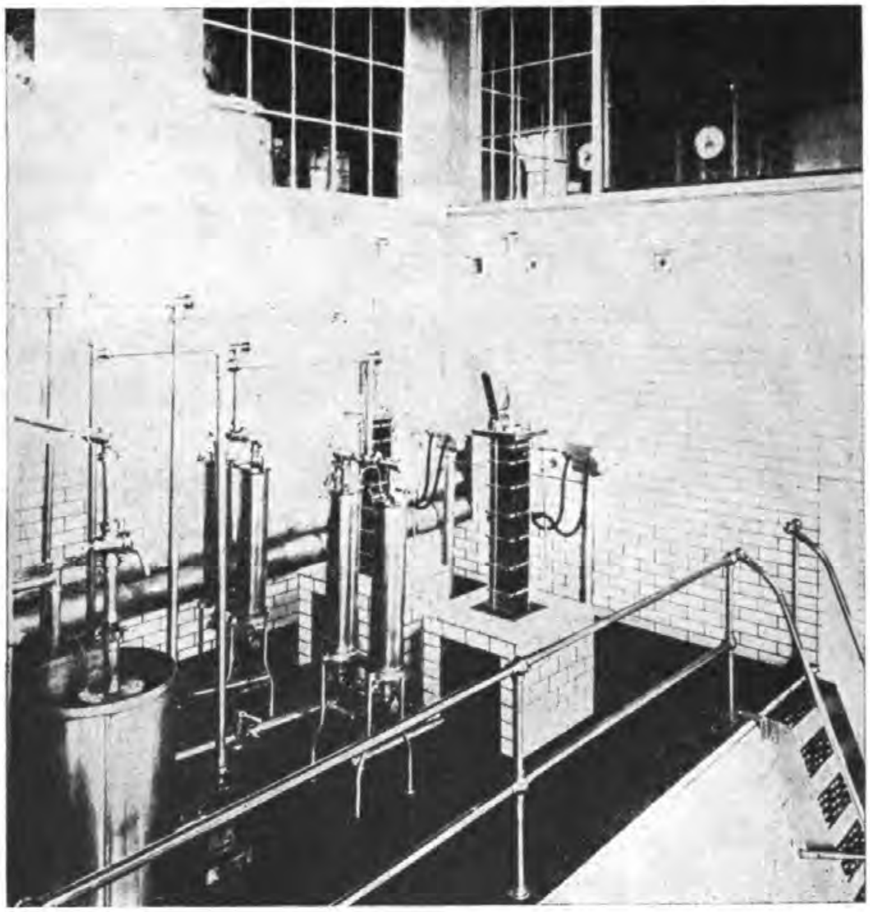
"Electropure" Pasteurizer

The first modern high temperature-short time pasteurizer developed was the electrical type marketed under the trade name of "Electropure." When first introduced about ten years ago, the controls were only semiautomatic and needed the constant and careful supervision of a trained operator and, therefore, could not be considered practicable or dependable. The apparatus and controls, however, have been improved and perfected until the more recently installed "Electropure" pasteurizers when operated under certain conditions and under certain temperature and time requirements, have been found to be dependable, reliable and of equal efficiency to the holding type of apparatus now in use.

During the past ten years the "Electropure" high temperature-short time pasteurizer has been tested a number of times by different public health agencies. The last of such tests were those carried out in New York City in June, 1927 by the New York State Department of Health in cooperation with the United States Public Health Service and the Department of Health of New York City, and included both engineering and bacterial tests.

Description of Electropure Apparatus: The apparatus tested consisted of the following units, named in the order in which the milk passed through or over them: (1) a milk storage tank; (2) a constant head tank; (3) a multiple speed milk pump; (4) a regenerator or top section of a surface cooler; (5) a hand control micrometer valve ; (6) a milk filter; (7) an electric heating chamber; (8) a section of sanitary milk piping connecting the heater with the regenerative cooler; and (9) a brine cooling or lower section of a surface cooler. These units, with the exception of the electric heating chamber, consisted of standard equipment.

The electric heater was a rectangular chamber 24 inches high and 3″ by 4″ in cross sections. Two sides of the chamber were composed of carbon electrodes separated by hard rubber insulators so arranged as to hold the electrodes 3 inches apart. The milk after partial heating in the regenerative heater was raised to the required or predetermined temperature by the electric



Electropure Pasteurizer

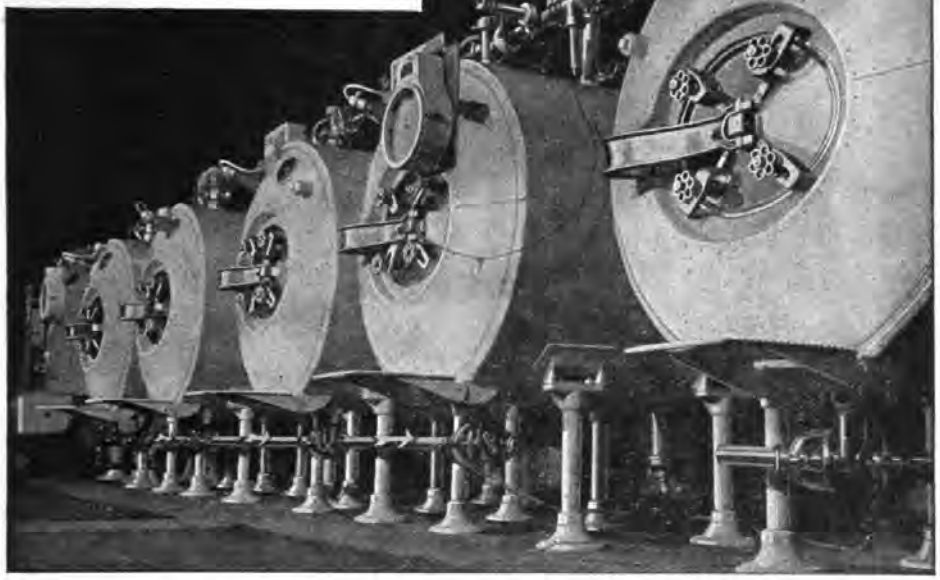
current as it flowed through the heating chamber between the electrodes. The outsides of the electrodes were sprayed with cold water, which kept them cool, so that the heating of the milk was due entirely to electrical resistance of the milk itself.

The temperature to which the milk was heated in the electrode chamber was controlled by means of a thermostatic device for varying the speed of the milk pump in such a way that an increase in the temperature of the milk increased the speed of the pump and a decrease in the temperature of the milk slowed down the pump. Inasmuch as the electric output of the current is practically constant, variations in the rate of flow of the milk naturally control the temperature to which the milk is heated. In other words, a lowering of the velocity of the milk through the heating chamber increases the temperature of the milk and vice versa.

Heating and Holding Time: In the apparatus tested, the heating period of the milk in the space between the electrodes in the heating chamber varied from 8.4 to 14.9 seconds, depending upon the temperature of the raw milk and the temperature at which the apparatus was set to operate. The calculated holding time, or the time required for milk to pass from the tops of the electrodes to the cooler inlet, varied from 11.1 to 19.7 seconds. The apparatus was provided with a safety device consisting of a thermostatic or thermo-electric instrument so connected as to stop the milk pump if the temperature of the treated milk dropped to the minimum temperature for which it was set to operate. Another safety feature of the apparatus was that it was so designed that when the milk pump stopped, the milk flowed back into the heating chamber and prevented milk heated to less than the minimum cut-out temperature reaching the cooler.

Tests: The tests of this pasteurizer extended over a period of two weeks and were as stringent as could be devised. Thirteen runs were made with infected milk at mean outlet milk temperatures from 164.6° F. to 139.9° F. with corresponding pump stop or cut-out temperatures set at from 162° to 138° F. These tests were designed to determine not only the efficiency of the apparatus but also the minimum safe operating temperature and the time and temperature factors of safety necessary for commercial operation. More than 1500 gallons of Grade A milk, artificially inoculated with heavy doses of pathogenic bacteria, were used in the tests. Tubercle bacilli of bovine origin tested for virulence were inoculated in the milk before pasteurization in sufficient quantities to give more than 10,000 guinea pig infecting doses per cubic centimeter of milk. During the tests observations were made to determine the effect of introducing abnormal or stress factors which might occur in commercial practice. These factors were introduced while the apparatus was treating milk inoculated with B. tuberculosis and consisted in (1) suddenly increasing the rate of flow of milk by manipulating the hand control valve, (2) introducing resistance to lower the voltage of the electric current approximately 10 per cent, and (3) shutting off the electric current for three minutes. Under all of these abnormal or stress conditions, the automatic pump stop control served to shut off the flow of milk whenever milk reached the control bulb at the temperature at which it was set at the time of the test. Although some milk at a lower temperature than that at which the cut-out control was set passed the control bulb, the hydraulic conditions were such as to cause this milk to flow back into the heating chamber below the control bulb and prevent this milk from reaching the cooler. Before the milk pump could start again, it was necessary that the milk in the chamber be heated to such a temperature that the hot vapor rising from it would produce a temperature at the pump stop control bulb equal to or higher than the temperature at which the automatic control was set. The temperature of this small volume of milk was at times near the boiling point. The introduction of stress conditions, therefore, resulted in overheating the milk rather than underheating it.

"Good to the last drop"



Pfaudler Automatic Continuous Holding Systems have demonstrated, time and again, that they pasteurize every drop of milk in the cleanest, surest and safest way. Do you know why? We'll be glad to explain.

IF we may paraphrase the slogan of the Maxwell House Coffee people, "good to the last drop," as it applies to the Pfaudler Automatic Holding System, it means that every drop of milk is pasteurized.

There are many reasons for this. What we would like is an opportunity to explain, either personally or by letter, the "whys" which have been actually demonstrated on the many installations now in operation. Address your inquiry to—

THE PFAUDLER CO., Dairy Division, :: :: Rochester, N. Y.
On the Pacific Coast: THE PFAUDLER SALES CO., 122 New Montgomery St., San Francisco, Calif.
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"When Writing Mention This Report"

Results of Bacterial Tests: It was found from these tests that under normal operating conditions milk rendered highly infectious with B. tuberculosis when heating in the electropure apparatus operated at a mean temperature of 153.9° F. and held for a period of 12.4 seconds, was rendered non-infectious to guinea pigs. The pump stop temperature during that run was 150° F. The next lower pump stop temperature at which the apparatus was tested was 138° F. In other words, there were no test runs between the pump stop temperature of 150° F. and 138° F.

These tests demonstrated to the satisfaction of the Public Health Council of the State of New York that this high temperature-short time process of pasteurization was equally as efficient, dependable and safe as the so-called holding process of pasteurization, and it was approved by the Council and the State Department of Health on the condition that every particle of milk be heated to a temperature of not less than 160° F. and held at that temperature for not less than 20 seconds. This condition provided factors of safety of at least 6.1° F. and 7.6 seconds. Although this temperature factor of safety is approximately that generally accepted as satisfactory for the holding process of pasteurization, the time factor is negligible when compared with that required for the holding process. When dealing with temperatures around 160° F., however, seconds count more than minutes at temperatures of from 142° F. to 145° F.

Since these tests were made in 1927, a number of improvements have been made in the commercial electropure apparatus now in use, the more important of which are as follows:

(1) The milk pump has been moved to a position between the regenerative heater and the filter, thus putting the portion of the regenerative heater

through which the unpasteurized milk passes under a negative head.

(2) An electric pump speed control device has been developed making a large number of pump speeds obtainable by the combination of a variable speed motor, an automatically operated motor rheostat, a hand rheostat and anti-hunt resistors. This device replaces the three automatic pump speeds and the hand control micrometer valve of the former type of control.

(3) Both bell and light alarms have been added to warn the operator if abnormal conditions occur.

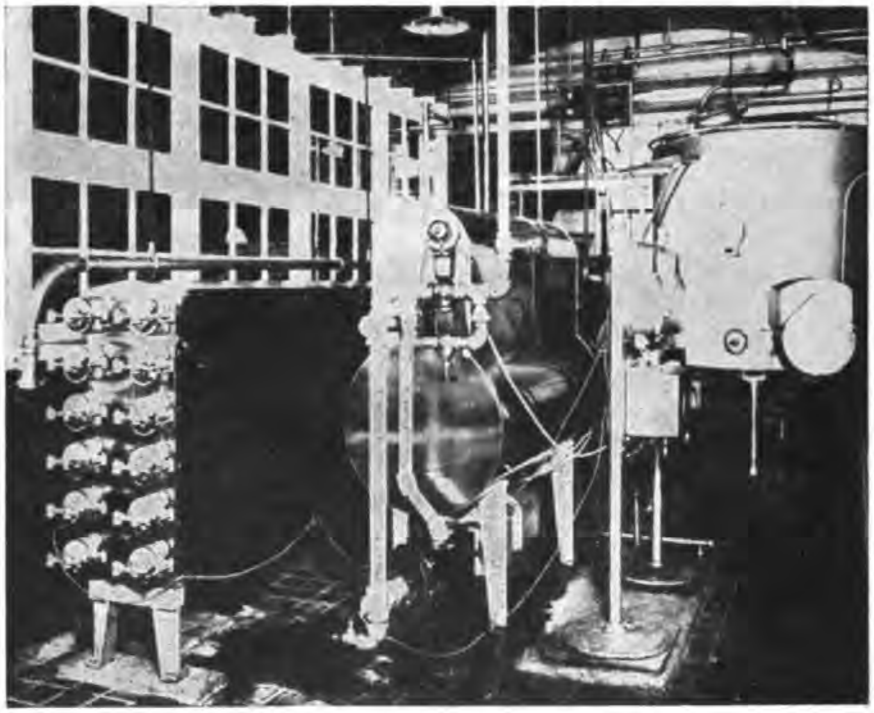
(4) The automatic milk pump stop, or minimum safe temperature cut-out, has been improved.

Hot Water Processes of High Temperature-Short Time Pasteurization

Two makes of hot water high temperature-short time pasteurizers, known as the Precision Pasteurizer and the Isotherm Pasteurizer, have been developed and put on the market. One of each of these pasteurizers has been in satisfactory operation at commercial pasteurizing plants in Albany, N. Y., for a little more than a year under constant observation and supervision of the Bureau of Milk Control of the State Department of Health. Another make of this type of high temperature-short time pasteurizer, known as the York Plate Pasteurizer, is being developed but is not yet being used for pasteurizing milk at any market milk plant, although it has been used as a milk heater in connection with separate holding apparatus.

Precision Pasteurizer

Description of Precision Pasteurizer: Engineering and bacterial tests were made with the Precision Pasteurizer by the United States Public Health Service. The New York State Department of Health participated in making these tests. This pasteurizer was similar in design to internal tubular heaters used for heating milk in con-



PRECISION PASTEURIZER

nection with certain types of holding pasteurizers, and consisted of inner milk pipes through which the milk flowed in one direction enclosed in larger water pipes through which the heating water flowed in the opposite direction. The heater tested had a rated capacity of 6,000 pounds per hour. It was composed of two separate units, one for heating the milk and the other for heating the water used as a heating medium. The milk heater in turn was divided vertically into two sections, one of which operated as a roughing heater and the other as a final heater. Each milk heater contained 10 twelve-foot tubes of 1½-inch sanitary milk piping.

The water supplies for heating the two heater sections were entirely separated and had independent heat controls. The water heaters consisted of three tanks (two 30-gallon tanks located directly above a 240-gallon tank). The water for heating the milk in the first, or roughing section of the milk heater, was circulated by means of a pump from one of three 30-gallon tanks through the heater tube. This tank was provided with a steam jet and the bulb of a vapor tension thermometer was inserted in the tank. The thermometer connected with this bulb had two electric contacts which could be set at any temperature. These contacts so actuated a control valve on the steam line that when the temperature of the water dropped more steam was applied, and vice versa.

The water used for heating the final section of the milk heater was similarly heated in a 30-gallon tank under similar control, but this tank was connected directly with a 240-gallon tank located beneath it. The mixing resulting from passing the water through this larger tank, served to so smooth out the temperature variations that the fluctuation in the temperature of the water used in the final heater was less than 1° F. The ratio of the quantity of heating water to milk was 6 to 1.

The bulb of a vapor tension thermometer was placed in the milk tube of the final milk heater in the third from the last tube, or about 36 feet from the final outlet of the heater. This bulb was connected with an indicating dial thermometer provided with electric contacts so arranged that if the temperature of the milk at this point dropped below the temperature at which the contact was set, the milk pump would stop automatically.

Heating and Holding Time: The temperature of the milk is raised to about 130° F. in the regenerative heater, from 130° F. to 143° F. in the roughing heater, and from 143° F. to 160° F. in the final milk heater. The time required for milk to pass through the roughing section and the final milk heater was 48 seconds respectively, giving a total heating period of 96 seconds. The holding time, or the time required for the milk to pass from the shut-off bulb in the final heater to the top of the cooler, was 15.5 seconds.

Tests: Ten test runs were made with milk infected with organisms of bovine tuberculosis reported to contain 5,000 guinea pig infecting doses per cc. Tests were also made for efficiency in the reduction of bacteria (plate count) and of B. coli. Two of the tests were made to determine the effect of abnormal conditions that might be expected in practice, including failure of electric current, failure in the electric current operating the heating water pump while the milk pump continued running, steam failure for two minutes, and opening of the milk valve wide.

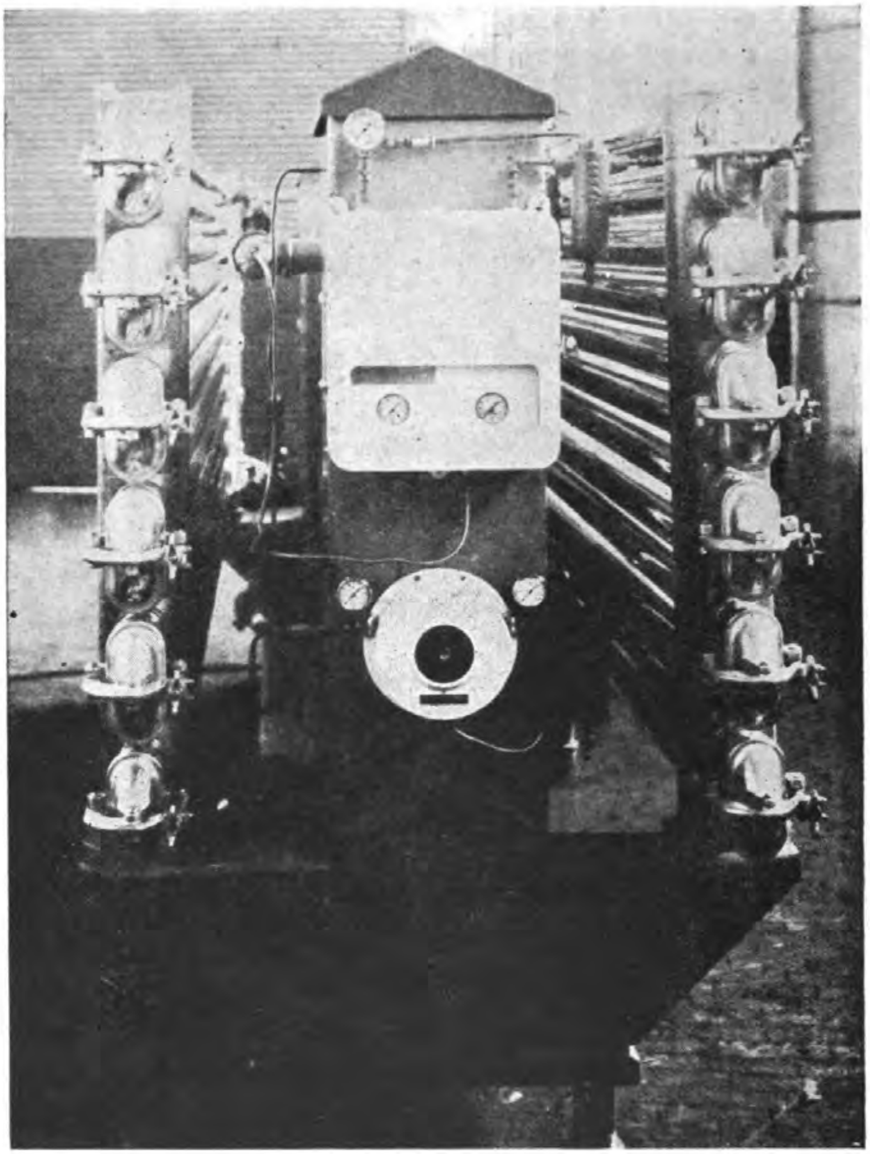
Complete failure of the current for three minutes caused the milk temperature to rise slightly, due to longer contact with the heated water pipes. Failure of current supplying the heating water pump, failure of the steam supply and opening the milk valve wide, caused the milk pump stop or cut-out to function stopping the flow of milk.

Results of Bacterial Tests: From the unpublished tentative report of the United States Public Health Service on these tests it appears that under normal operating conditions guinea pigs were not infected from milk collected from the fifth tube of the final heater where the mean temperature of this milk during sampling was 149.4° F. The milk was subjected to temperatures above 149.3° F. for an additional 26 seconds before it left the heater. This was the lowest temperature at which any run was made. With outlet temperature of 158.4° F., there was 96 per cent reduction in the average plate count and 100 per cent reduction in the B. coli.

Isotherm Pasteurizer

The Isotherm pasteurizer tested was quite similar in design and construction in essential features to the Precision pasteurizer. The unit tested had a rated capacity of 9,000 pounds per hour. It consisted of two milk heater sections each having 12 thirteen and one-half foot tubes within tubes, in which milk was heated by circulating hot water flowing through the outer tubes in the opposite direction from that in which the milk flowed in the inner tubes. The last two tubes were not supplied with heating medium and were designed as "holder" tubes.

The milk heater was divided vertically into two distinct sections, with independent automatically controlled water systems serving each heater. Each water system consisted of a water tank of about 30 gallons capacity, circulating water pump, and air controlled automatic steam valve for regulating the rate of introduction of steam used to heat the circulating water. It was also equipped with air pressure control apparatus and recording thermometer provided with three pens. One pen showed the true temperature and was actuated by a bulb in the milk near the automatic pump stop control. The second pen showed a temperature about 5° below the actual and was actuated by a bulb in the milk line between the pasteurizer and the cooler. The third pen showed, on the margin of the chart, the time during which the milk pump was in operation. There was also an automatic device for stopping the milk pump in the event that the temperature of the milk flowing through the pasteurizer should drop below any predesignated minimum temperature. The pump used for forcing the milk through the pasteurizer was of the piston type directly geared to a constant speed electric motor.



Isotherm Pasteurizer

Heating and Holding Time: The temperature of the milk is raised to about 130° F. in the regenerative heater, from 130° F. to 142° F. in the roughing heater, and from

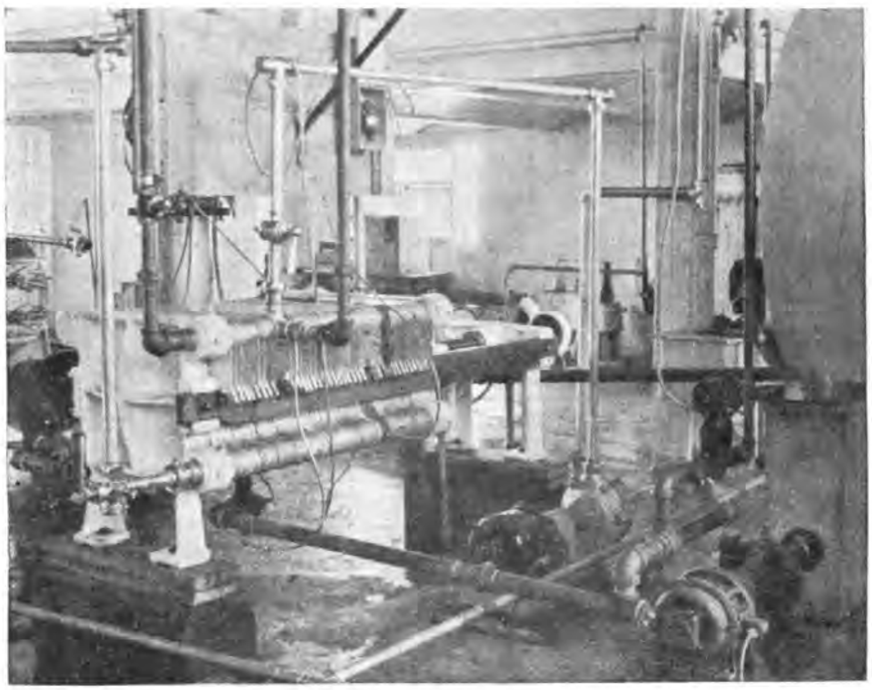
142° F. to 160° F. in the final milk heater. The time required for the milk to pass through both sections of the heater was 150 seconds. The holding period, or the time required for the milk to pass from the shut-off or stop pump bulb of the heater to the top of the cooler, was 15.6 seconds.

Tests: Engineering and bacteriological tests were made of the Isotherm pasteurizer by the New York State Department of Health with the pasteurizer in daily operation at a commercial plant. These tests showed (1) that the temperature of the milk could be satisfactorily controlled within very narrow limits; (2) that the pump stop control operated satisfactorily to prevent the passage of underheated milk through the pasteurizer; (3) that underheated milk would still be within the influence of the heating medium when the pump stopped; (4) that the difference in temperature between milk at the center of any tube and near the outer wall was insignificant; (5) that failure of the electric supply, steam supply or air supply would result, either directly or through the operation of the automatic pump stop, in overheating the milk rather than in underheating the milk; (6) that the recording thermometer records of operation were satisfactory; and (7) that the apparatus can be satisfactorily operated in an average commercial milk plant.

Bacterial Tests: Although no bacterial tests were made to determine the efficiency of this apparatus in devitalizing pathogenic organisms, a series of tests made to determine the reduction in standard plate count showed an average reduction of over 96 per cent. The average reduction obtained was the same, or slightly better, than that obtained by pasteurizing duplicate samples of the untreated milk in test tubes at 143° F. for thirty minutes.

York Plate Pasteurizer

This high temperature-short time pasteurizing apparatus was composed of grooved plates separated by thin separator sheets of tinned copper. The milk to be heated or cooled flowed in or along the grooves of the plates in one direction and the heating liquid flowed in the grooves in the adjacent plates in the opposite direction, the heat being conducted through the separator sheets which lie between the adjacent plates. When in operation, the



York Plate Pasteurizer

plates and separators were held together by approximately eight tons pressure. The apparatus is composed of four main sections, which may be described briefly as follows:

(a) A regenerator section, consisting of fifteen plates. These plates were arranged in five passes of three plates each operated in parallel. The raw milk flowed into and through this section and received a preliminary heating from the pasteurized milk which was flowing on the opposite side of the separator sheets of the plates in this section.

(b) The heater section consisted of ten plates. These plates were arranged in five passes of two plates each operated in parallel. The milk leaving the regenerator section flowed through this heater section and there received its final heating to 160° F. The time required for the milk to pass through the heater section was 24 seconds.

(c) The holder section consisted of one especially designed holder plate. This section in the heater tested held milk for 12 seconds, according to a color test. It is the intention of the New York State Department of Health to require for any installations in New York State not supplying New York City that this section be designed to give a 15-second holding by color test, and thus put the operation of this heater on the same basis as other hot water, high temperature-short time pasteurizers.

(d) The cooler section consists of 8 plates. These plates were arranged in two passes of four plates each, operated in parallel. Here the milk which had passed through the regenerator was cooled by brine which flowed on the opposite side of the separator plates.

To prevent leakage to the outside of the machine, a hard rubber gasket was placed near the outer edge of each plate, containing flow grooves. Any milk which might pass through the gaskets would go to the outside of the machine and thence to the floor. A gasket was also placed at the opening of each plate. Leak protector grooves were provided to prevent any milk that might pass the gasket reaching the interior of the machine.

The apparatus was provided with two vapor tension temperature controls for thermostatically controlling the temperature of the milk leaving the heater and entering the holding section. It was also equipped with a thermostatic device for automatically stopping the milk pump if the milk leaving the heater dropped to a predesignated temperature.

Tests: Engineering tests of this apparatus have been made by the United States Public Health Service and tests of its bacterial efficiency, as determined by reduction in standard plate count, have been made by the Pennsylvania State Department of Health. At both of these tests, members of the New York State Department of Health were present.

Observations of these tests showed that the operation of this pasteurizer under artificially produced stress conditions resulted in overheating the milk rather than underheating it and in making the detention periods longer rather than shorter than those obtained from normal operation.

The bacterial test with this apparatus had not been completed at this writing, but preliminary results available indicate that it gives a satisfactory reduction in total bacteria plate count.

Thermophile Studies

Studies have been made by Dr. M. W. Yale and Dr. Robert S. Breed of the New York State Agricultural Experiment Station, Geneva, N. Y., on the relation of high temperature-short time pasteurization to the number of thermophiles in milk treated in such pasteurizers. The report of these studies has not been published, but Dr. Yale who is to discuss this paper will, no doubt, review the preliminary results of the studies made so far. I understand, however, that these results indicate that the high temperature pasteurizers studied are not favorable for the development of these organisms.

Cream Volume Studies

Our observations indicate that milk which has been heated rapidly to 160° F. may be held at that temperature for 20 seconds without appreciably affecting the cream volume. Any material increase in the holding time at this temperature, however, noticeably reduces the cream volume. This has been confirmed in a recent publication of the New York State Agricultural Experiment Station by J. C. Marquardt and A. C. Dahlberg on the result of their studies "The Creaming of Milk Pasteurized at High Temperature."

Summary and Conclusions

The tests of the operation of the types of high temperature–short time pasteurizers in which the New York State Department has participated or made, and for which data are available, have shown that they are of equal efficiency to the holding pasteurizers now in use. They are simple in construction, simple to clean and sterilize, and their operation should not be difficult in the hands of intelligent operators. Furthermore, the holding time is so short in these high temperature pasteurizers (from 15 to 20 seconds) that there is no incentive for the plant operator to attempt to further shorten it. These pasteurizers, moreover, are built for fixed minimum holding periods, which it would be impracticable to alter without detection.

All of the high temperature–short time pasteurizers described have been approved by the Public Health Council of New York State as satisfactorily meeting the definition of pasteurization of the State Sanitary Code enacted by such Council, which code has the effect of law in New York State outside of New York City. They have also been approved by the Department of Health of the Commonwealth of Pennsylvania.

In my opinion, high temperature–short time holding pasteurizers have established their place as dependable, safe and efficient apparatus for the pasteurization of milk, and I believe that their use ultimately will be generally recognized by public health authorities. Owing, however, to the fact that the early flash pasteurizers were discredited, public health officials may be slow to accept this new process of high temperature pasteurization. Another factor that may retard their general adoption is the relatively high cost of the automatic control and safety devices necessary to operate them satisfactorily, which may limit their use to the larger or moderate size plants until less expensive controls are devised.

Our studies and experience indicate that there are certain requirements that should be covered in regulations enacted by public health authorities to govern the operation of high temperature–short time pasteurizers, among which the following are the more important:

1 The minimum temperature and holding time should be stipulated.

2 The installation and proper operation of an automatic pump stop should be required.

3 The maximum capacity of the milk pump should not be permitted to be greater than the rate which will give the designated holding time.

4 Proper records of pasteurization, including the record of time during which the milk pump is in operation, should be required.

5 The procedure to be used in sterilizing equipment and in starting and completing the processes of pasteurization should be subject to the approval of the health officer.

6 A dependable source of electricity should be required.

7 All electrical connections should be so made that the temporary failure of any power circuit will result in automatically stopping the milk pump.

THE RELATION OF HIGH TEMPERATURE—SHORT TIME PASTEURIZATION TO THE NUMBER OF THERMOPHILES IN MILK

(A PRELIMINARY REPORT)

M. W. YALE and ROBERT S. BREED

New York State Agricultural Experiment Station
Geneva, N. Y.

Five market milk plants were studied during the summer months of 1929, 1930 and 1931. Electric pasteurizers were studied at two plants in Pittsburgh, Pennsylvania, and at one plant in Ithaca, New York. These pasteurizers had been operated commercially for several years with daily pasteurizing runs of six to seven hours at the Pittsburgh plants and of two to three hours at the Ithaca plant.

Hot water pasteurizers were studied at two plants in Albany, N. Y. One plant used the Precision pasteurizer and the other the Isotherm pasteurizer. The daily pasteurizing runs ranged from two to four hours. Studies were made after commercial operation for one to two months and again after one year of operation.

Examination of over 100 samples of raw milk from the mixed raw supply of the four plants showed that usually less than 500 thermophiles were present per cc, as determined by agar plate counts at 56° C. The maximum number found was 1500 per cc which may have been due to some undetected returned milk which was mixed with the raw supply. Only three samples gave counts exceeding 500 per cc.

Examination of 100 samples of pasteurized milk showed that conditions were not favorable for the development of thermophiles as the number of thermophiles present in the pasteurized milk at the end of the pasteurizing run was but slightly higher than the number present in the raw supply. The maximum number of thermophiles found in the pasteurized milk was 42,000 per cc. This count was obtained at one of the plants using the electric pasteurizer and was largely due to repasteurization.

At the plants using the electric pasteurizer without repasteurization, the maximum number of thermophiles found was 7,900 per cc. at the Pittsburgh plant and 370 per cc. at the Ithaca plant.

At the plant using the Precision pasteurizer, the maximum number of thermophiles found was 140 per cc., and at the plant using the Isotherm pasteurizer 1,100 per cc.

Such slight differences in counts as were observed appeared to be due to differences in operating conditions rather than the type of pasteurizer. Thus far, no plant using high temperature—short time pasteurization of 160-162° F. for 15 to 20 seconds has been studied where the number of thermophiles has approached the number that occasionally occurs at plants using low temperature—long time pasteurization of 142-145° F. for 30 minutes.

THE TEMPERATURE BEHAVIOR OF MILK PASTEURIZERS OF THE THIRTY-MINUTE HOLDING TYPE

By

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The necessity for the testing and approval of pasteurization equipment by public health authorities has now become firmly established. It is generally recognized that health authorities may not safely permit milk to be labeled "pasteurized" unless the process of pasteurization has been carried out in apparatus which has been demonstrated by rigid scientific tests to be properly designed and capable of practical operation.

In the operation of commercial pasteurization machinery it is obvious that at any given moment every portion of the milk will not be at precisely the temperature shown by the recording or indicating thermometer. Entirely aside from the accuracy of the thermometers themselves, some milk will almost certainly be colder than the recorded or indicated temperature. Therefore, in approving any given make of pasteurization equipment, the health officer must be able to answer the question:—At any given moment how great is the difference apt to be between the actual temperature of the hottest milk and the actual temperature of the coldest milk?

"When Writing Mention This Report"

The Public Health Service Milk Code recommends a maximum limit of 1° F. for this difference. This paper is intended to assist the health officer in determining whether and under what conditions any given design will satisfy this requirement. The material herewith presented represents a condensed discussion of temperature tests of many designs of standard pasteurization equipment of the thirty-minute holding type.

Tests of Vat Type Batch Pasteurizers

Altogether eighteen different models of vat type batch pasteurizers were tested at the milk plants in which they were in routine commercial operation. The tests were conducted by taking temperature observations by means of thermocouples during actual milk runs. The thermocouples were placed in pairs at various (usually 6-8) critical points in the apparatus in an attempt to learn the maximum simultaneous temperature difference between the hottest and coldest portions of the milk. In every case one pair of thermocouples was placed at what was estimated would be the coldest zone, and another pair at what was estimated to be the hottest zone.

The designs of vat pasteurizers tested included the following:

Horizontal revolving coil vats of various makes.

Square vats containing a revolving vertical coil.

A horizontal oscillating coil vat.

A horizontal vat with stationary heating and cooling manifolds and a separate agitation device.

Horizontal spray type vats, equipped with oscillating paddle agitators.

Cylindrical vats equipped with a steam jacket and with an impeller type agitator.

Cylindrical vats equipped with a water jacket and with an impeller type agitator.

The following table summarizes the results of the temperature observations upon those vats which were equipped with what was considered improper outlet devices, and in which the agitator was kept in operation throughout the holding period. By "improper outlet devices" is meant any outlet valve equipment which is not truly or essentially flush as defined in the Public Health Service Milk Code.

TABLE NO. I

MAXIMUM SIMULTANEOUS TEMPERATURE DIFFERENCES BETWEEN HOTTEST AND COLDEST MILK IN VAT TYPE PASTEURIZERS EQUIPPED WITH AGITATORS BUT NOT PROVIDED WITH FLUSH TYPE VALVES

Vat No.	Run No.	Temp. Diff. °F.	Vat No.	Run No.	Temp. Diff. °F.
1	1	20.7	5	1	12.0
	2	20.5		2	10.1
	3	20.6		3	8.2
2	1	26.8	6	1	43.8
	2	21.0		2	47.4
3	1	9.8	7	1	12.5
	2	9.2		2	2.7
	3	10.2			
4	1	9.8	8	1	24.0
	2	9.1		2	19.3
	3	8.7			

It will be observed from the results given in table 1 that if a vat is not equipped with a correctly designed outlet, that is, with what is known as a flush type valve, some insufficiently heated milk will leave the holder at the end of the run and thus re-contaminate all or a significant portion of the batch. This was found to be true of every one of the eight different designs which were tested. The temperature differences ranged from 2.7° F. to 47.4° F. depending upon the volume, shape and location of the dead space between the vat proper and the outlet valve. In every case the agitation device was kept in motion during the holding period, which indicates that the motion imparted to the milk by the agitation device was not sufficient to displace the milk in the outlet pocket.

Table No. 2 gives the results of correcting the outlet designs:—

TABLE NO. II

MAXIMUM SIMULTANEOUS TEMPERATURE DIFFERENCES BETWEEN HOTTEST AND COLDEST MILK IN VAT TYPE PASTEURIZERS EQUIPPED WITH BOTH AGITATORS AND FLUSH TYPE VALVES

Vat No.	Run No.	Temp. Diff. °F.	Vat No.	Run No.	Temp. Diff. °F.	Vat No.	Run No.	Temp. Diff °F.
1	1	0.7	3	1	0.7	8	1	0.7
	2	0.6		2	0.7		2	0.7
	3	0.6						
	4	0.4	4	1	0.6	9	1	0.5
	5	0.5		2	0.5		2	0.4
	6	0.5					3	0.5
			5	1	0.7			
2	1	0.9		2	1.0	10	1	0.3
	2	0.8					2	0.5
	3	0.7	6	1	0.3			
	4	0.5		2	0.3			
	5	0.7						
	6	0.8	7	1	0.7			
	7	0.5		2	0.6			
	8	0.5		3	0.7			

It will be observed that after flush type valves had been installed the maximum simultaneous temperature differences between the hottest and the coldest portions of milk were not greater than 1° F. in any one of the ten different makes studied. These makes included every standard type of vat on the market today. It will be noted, however, that in every case the agitation device was kept in operation throughout the holding period. In order to determine whether it would be possible to dispense with agitation during the holding period if the outlet were equipped with a flush type valve, 15 runs

were made on four different makes of vats. In each case the agitator was stopped during a significant part of the holding period. It will be observed from Table 3 that in all but three of the 15 runs maximum simultaneous temperature differences of more than 1° F. were observed. In eight of the runs temperature differences of more than 5° F. were observed. It must be concluded, therefore, that agitation should be maintained throughout the holding period, even though a flush type outlet is provided, if it is desired to confine the simultaneous temperature differences within a 1° F. range.

TABLE NO. III

MAXIMUM SIMULTANEOUS TEMPERATURE DIFFERENCES BETWEEN HOTTEST AND COLDEST MILK IN VAT TYPE PASTEURIZERS EQUIPPED WITH FLUSH TYPE VALVES BUT IN WHICH THE AGITATORS WERE NOT OPERATED

Vat No.	Run No.	Temp. Diff. °F.	Vat No.	Run No.	Temp. Diff. °F.
1	1	4.5	3	1	2.8
	2	7.1		2	0.9
	3	1.9		3	5.0
	4	2.3		4	0.5
2	1	14.0	4	1	13.8
	2	17.7		2	0.7
	3	13.8			
	4	7.4			
	5	7.6			

It should be noted here that tests made with the new plug outlet valve of the flush type, with which several of the recent horizontal coil vats have been equipped, showed satisfactory results in that there were not temperature deviations greater than 1° F. if agitation was maintained throughout the holding period.

CONCLUSION

From the above test results it may be concluded:—

(1) That the manufacturers of batch-type vats have

found it easily possible to comply with the requirement of the Standard Milk Code that the simultaneous temperature difference between the hottest and the coldest portions of the milk during the holding period shall not exceed 1° F.

(2) That in order to obtain this result all vats should be provided with satisfactory flush-type valves, and with an agitation device which should be kept in operation throughout the holding period.

Tests of Pocket Type Pasteurizers

Six different makes of pocket type pasteurizers were tested. The holders included rectangular holders divided into pockets, holders composed of individual rectangular tanks set side by side, holders composed of separate cylindrical tanks placed side by side, and cylindrical holders divided into wedge-shaped pockets. The designs tested included some with and some without flush outlet valve, and some with and some without agitation devices.

TABLE NO. IV

Maximum Simultaneous Temperature Differences Between Hottest and Coldest Milk in Pocket Type Pasteurizers Equipped with Agitators but not Provided with Flush Type Valves

Design No.	Run. No.	Temp. Diff. °F.
1	1	5.3
	2	5.7
	3	4.9
2	1	12.0
	2	9.5
	3	8.5

Two of the designs were equipped with agitators, but were not equipped with flush-type valves. Table No. 4 gives the maximum simultaneous temperature differences between the hottest and the coldest milk observed during six runs made upon the two designs.

It will be observed that agitation apparently does not compensate for the lack of flush-type valves; in other words, that the action of the agitator does not penetrate sufficiently into the outlet pocket between the vat proper and the outlet valve.

One of the designs tested was provided with both agitators and flush type valves. Four runs were made upon this design, with the results shown in table 5:—

TABLE NO. V

MAXIMUM SIMULTANEOUS TEMPERATURE DIFFERENCES BETWEEN HOTTEST AND COLDEST MILK IN A POCKET TYPE PASTEURIZER EQUIPPED WITH BOTH AGITATORS AND FLUSH-TYPE VALVES

Run No.	Temp. Diff. °F.
1	0.7
2	0.4
3	0.6
4	0.5

It will be observed that this design was easily capable of keeping the temperature differences below 1° F.

Twenty-four runs were next made on three different pocket-type designs equipped with flush-type valves but not equipped with agitators. Table No. 6 gives the maximum simultaneous temperature differences observed during these twenty-four runs.

It will be noted that in fifteen of the twenty-four runs temperature differences of more than 1° F. were observed, and that the temperature in four cases exceeded 2° F. It may be concluded, therefore, that if properly insulated pocket-type designs are equipped with flush-type valves, and are properly preheated immediately before the beginning of the runs, but are not equipped with agitators, the maximum temperature difference between the hottest and the coldest milk may be above 1° F.

TABLE NO. VI

MAXIMUM SIMULTANEOUS TEMPERATURE DIFFERENCES BETWEEN HOTTEST AND COLDEST MILK IN POCKET TYPE PASTEURIZERS EQUIPPED WITH FLUSH-TYPE VALVES BUT NOT EQUIPPED WITH AGITATORS

Design No.	Run No.	Temp. Diff. °F.
1	1	1.7
	2	1.0
	3	0.9
	4	1.0
	5	0.8
	6	0.8
	7	0.6
	8	0.4
	9	0.5
2	1	2.3
	2	1.8
	3	1.4
	4	1.5
	5	2.1
	6	4.9
	7	1.3
	8	1.6
	9	2.1
	10	1.4
	11	1.4
	12	1.6
3	1	0.6
	2	0.7
	3	0.6

It should be noted, however, that in every one of the above-mentioned runs care was taken to see that the holders were properly pre-heated immediately before the first batch of milk was admitted to the holder. It must be anticipated that in actual practice preheating may, without fraudulent intent, be forgotten altogether occasionally, or be inadequate. In these cases much greater temperature differences between the hottest and the coldest milk would be the result. The inner walls of the holders would then cool the first batch of milk, and the cold portions of milk would drop to the bottom of the pocket by gravity and be discharged with the first milk leaving the pocket. In other words, this would result in a layer of colder milk accumulating in the bottom of the holder, probably too small in quantity to be recorded upon the recording thermometer during the relatively short time this cooler portion of milk would be flowing past the recording thermometer bulb. Thus the fact that a certain quantity of low temperature milk had escaped to the cooler and possibly re-contaminated the rest of the batch would not be noticed either by the plant manager or by the health officer. It is believed, therefore, that newly installed equipment should be required to be provided with agitation devices, which will prevent such sub-temperature layers from collecting at the bottom, and will insure that the temperature shown on the recording thermometer chart represents the temperature of all portions of the milk within 1° F.

Conclusions

From the above results it may be concluded:—

(1) That it is possible for the manufacturers of pocket type pasteurizers to comply with the requirement of the Public Health Service Milk Code that the simultaneous temperature differences between the hottest and the coldest portions of milk during the holding period shall not exceed 1° F.

(2) That in order to obtain this result all pockets should be equipped with flush type outlet valves (or satisfactory valveless outlets), and with agitators. NOTE:—Since the observed temperature differences in the case of pocket designs equipped with flush valves, but not equipped with agitators were not glaringly great, health officers will be justified in waiving the agitation requirement for existing installations. It is even possible that future tests of improved designs may show that agitation is unnecessary.

TESTS OF CONTINUOUS FLOW TUBE-TYPE PASTEURIZERS

This type of pasteurizer consists of a thermostatically controlled flash heater, the milk from which passes through a regenerator, then into a set of holder tubes designed to give a total holding period of thirty minutes, thence back into the regenerator, and finally to the cooler and bottle filler. The holder pipes are located in a housing which is heated by steam coil pipes. In the first, or older design tested, the heating coil was confined to the bottom of the holder housing. In the newer type of this pasteurizer which was studied, the heating coils were distributed to various points in the holder housing, and were governed by thermostatic control.

At the effluent end of the holder was located an effluent riser pipe. In the older design tested, the riser pipe was not equipped with a valve. In the new design it was equipped with a flush type valve.

Tests were made to determine the temperature of the milk in the riser pipe since, although a large part of the pipe was water-jacketed it was anticipated that sublegal temperatures would be encountered.

As a matter of fact three test runs gave temperatures as low as 114.8° F., 112.4° F., and 118.8° F., respectively, for the milk in this riser pipe.

Five test runs were next made to determine the temperature behavior of the milk as it passed through the holder. Thermocouples were placed at various points in the holder pipe and a series of temperature observations made during the five test runs. The results were then plotted to determine how much, if any, the temperature of any given portion of milk dropped during its course through the machine below the lowest temperature recorded for that portion of milk at either the inlet or outlet recording thermometer positions.

The following table gives these maximum temperature deviations below the recorded temperature:—

TABLE NO. VII

Run No.	1	2	3	4	5
Maximum downward Temperature deviation below recorded temperature	0.8	0.5	0.9	1.1	1.3

It will be observed that in three of the five runs the temperature deviations were below the 1° limit specified by the Public Health Service Milk Code, but that in the two remaining runs the temperature deviations were slightly above the allowed limit. These slightly excessive deviations were the result of the fact that the steam heating coil during these five runs was confined to the bottom of the holder housing, and the temperature of the air in the housing was therefore far from uniform.

Subsequently the manufacturers corrected this defect and distributed the heater coils at various points throughout the holder. Still later they also included a temperature controller for the air in the jacket of the holder.

TABLE NO. VIII

Run No.	1	2	3	4	5	6	7	8
Maximum downward temp. deviations below recorded temp.	0.7	0.4	0.7	0.5	0.6	0.1	0.4	0.1

Eight runs were next made on the newer type of holder, which gave the following maximum downward deviations.

It will be observed that the maximum downward deviations in temperature did not in any of the eight runs exceed 1° F.

It should be noted that in every one of these runs care was taken to preheat the holder adequately shortly before the first admission of milk. It must be anticipated that in commercial practice preheating will occasionally not be adequate. In these cases the first milk into the holder would be cooled below the legally required temperature, but might be insufficient in quantity to insure that its sub-legal temperature would be recorded by the outlet thermometer unless the latter were located directly in the outlet end of the final holder tube. Therefore it is believed that the bulb of the outlet recording thermometer should be so located.

Conclusions

As a result of the above tests the following conclusions were reached:—

(1) That the continuous flow tube type pasteurizers now being marketed are so designed as to make it easily possible to maintain the legally required temperatures for all portions of milk within a maximum deviation of 1° F. throughout the holding period.

(2) That the effluent riser pipe should in all cases be required to be provided with a flush type leak protector valve.

(3) That the outlet recording thermometer bulb should be located in the outlet end of the last holder tube.

(4) That the health officer should assure himself that the steam heating coils in the jacket are distributed in sections through the holder housing and not confined to the bottom of the holder; and that a thermostatic tem-

perature controller be provided to control the temperature of the air in the housing. It is further suggested that it might be advisable to provide for the agitation of the air in the housing in order to secure still more uniform air temperatures.

General Specifications To Govern Approval by Health Authorities of Pasteurization Apparatus of the Thirty-Minute Holding Type

In addition to the suggestions made in this paper regarding the temperature characteristics of the various types of thirty-minute pasteurization equipment and regarding means for insuring uniform temperatures throughout the holder it is suggested that the health officer require all automatic pocket type and continuous flow tube type pasteurizers to be equipped with a milk pump cut-out which will stop the flow of milk immediately if the temperature thereof should drop below the legally required minimum. Furthermore, it is recommended that the health officer require rigid compliance with all of the requirements included in items 16a to 16f in the Public Health Service Milk Code. These relate to:—

16a—The design and location of indicating and recording thermometers.

16b—Specifications for the maintenance of the minimum legally required temperature and time.

16c—Specifications for the design and operation of inlet and outlet valves.

16d—Specifications for the heating of air and foam above the milk in vat and pocket designs.

16e—Requirements as to the design of vat and pocket covers.

16f—A requirement governing the pre-heating of automatic pocket and continuous flow holders.

The time allowed for this paper will not permit treating each of these subjects in detail, for which the text of the Public Health Service Milk Code should be used.

In conclusion it is desired to acknowledge gratefully the assistance rendered by the City Health Department of Chicago in making possible many of the tests covered in this paper, and in particular to the personal assistance given by Mr. George W. Putnam, formerly Director of the Bureau of Milk Sanitation of the City Health Department, and Mr. Lewis Shere, formerly Assistant Director of the Bureau of Milk Sanitation of the City Health Department.

EFFECTS OF CATTLE FEEDING AND PASTEURIZATION ON FOOD VALUE OF MILK

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In a previous report (1) the results of experiments were presented which tended to prove that the nutritive value of milk is influenced by the ingredients of the food eaten by the cow, that the milk of cows upon a proper diet does not produce anemia in the rat, and that the heating of milk tends to lessen both its growth promoting and hematogenic properties.

The belief that milk is not a complete food and that its exclusive use brings about a lack of growth and vigor in the young, and that the hemoglobin and red corpuscles of the blood do not develop in a normal manner is being widely accepted. This opinion rests largely upon the work of Steenbach and Hart (2) who some years ago found that young rats fed an exclusive milk diet developed an anemia. This fact created great interest in the subject of "nutritional anemia" and has stimulated an active reconsideration of the entire subject of milk as a nutritive substance. The degree of interest created in these subjects is attested to by the ever increasing number of reports of experimental work done in this field. A very brief review of Chemical Abstracts, the Journal of Biological Chemistry, the Journal of Nutrition, Archives of Pediatrics, various health, dairy or home magazines will convince one of the public as well as the scientific interest in the subject.

In our experiments above referred to weanling albino rats were used whose mothers had received only milk as a diet during their nursing period; the young were weaned upon an entire milk diet, none of the experimental animals having tasted food other than milk. The cages in which the animals were housed were constructed of galvanized wire mesh, special care being taken that no iron or copper was exposed. The food containers consisted of glass jars of suitable shape. The preliminary tests consisted in the feeding of a group of six rats upon milk obtained from a well fed Jersey herd. Repeated examination of the blood and frequent weighings of these animals over a period of several months failed to indicate either the development of anemia or any retardation in growth. After seeking some advice as to our difficulty it was decided to repeat the experiment. With the second group of animals, however, market milk was used because of the greater ease with which it could be obtained.

The animals of this group soon indicated by appearance, weight and blood count that they were not developing as the animals of the first group had done. It was then determined that these experiments should be repeated and extended to include a comparison of several types or grades of milk, these grades being (1) certified milk, 4% unheated, (2) the milk from cows fed upon a special feed mixture, 4.4-5% unheated, (3) the commercial market milk, 3.8-4% heated (pasteurized). The herd from which the certified milk was obtained was at the time of the experiment receiving a warm diet of ground first grade alfalfa hay and grain which were hydrolized and predigested, to which a complex mineral mixture consisting of bone meal, blood meal, copper sulphate, manganese iodide, iron sulphate, arsenic, aluminum chloride, zinc chloride, silicates and dulse were added. The special milk came from a Jersey herd receiving a liberal dry grain ration plus an abundant supply of first grade alfalfa hay and the mineral mixture as above with the addition of dry fish meal (liver and viscera). The third source was commercial pasteurized milk obtained from a market in the vicinity of the laboratory. The diet of the cows producing this milk was entirely unknown but may be assumed to be that of the average dairy cow. All of the special feeding in the herds from which the first two milks were obtained was done under the supervision of Professor Oscar Erf, Professor of Dairying at the Ohio State University. These experiments extended over a period of five months, and as the time advanced it became more and more evident that the various groups of animals were not developing equally. The control group, those being fed upon the certified milk, and those fed upon the milk of the cows receiving the special feed were all in good condition with sleek coats, clear eyes, playful, and of gentle disposition, while those fed upon the market milk were dull, listless, irritable, with rough coats and dull eyes. The weight curves and the blood counts also showed variations. At the end of the five months

The control group showed an average gain of 55 grams
The certified group showed an average gain of 57 grams
The special group showed an average gain of 88 grams
The market group showed an average gain of 33 grams

The red cell count at the end of the same period was:

The control group—an average gain of 3,200,000
The certified group—an average gain of 2,700,000
The special group—an average gain of 2,000,000
The market group—an average loss of 1,700,000

This experiment was repeated upon three other series of rats and in each experiment these results were duplicated to a surprising degree. During each of the tests it was noted that the rats receiving the market milk consumed more milk per rat per day than those receiving the special or certified milk, yet as indicated above, their growth was retarded and they became very anemic. In one experiment a group of six young rats averaging 20 grams in weight and with an average red cell count of 5,500,000 was placed upon the special milk diet for a

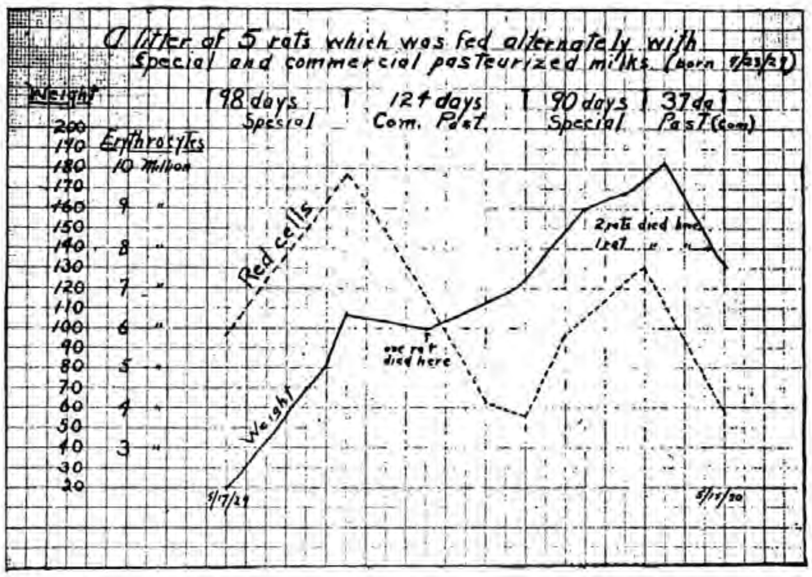

FIG. 1

Illustrating the variations in weight and red blood count due to changing from an exclusive diet of milk from properly fed cows to an exclusive diet of the market milk (pasteurized).

period of 98 days. At the end of this time the average weight was 110 grams and the red blood count 9,700,000. They were then placed upon the heated market milk for 124 days. During this entire period the weight increase was but 15 grams and the red blood count indicated a loss of 5,900,000 cells. These same rats were again placed upon the diet of special milk for a period of 90 days during which there was an average weight increase of 57 grams and a regeneration of red blood cells until the normal count of 9,600,000 was again reached. These rats were again given a diet of pasteurized market milk for 37 days. At the end of this time the group had lost an average of 37 grams in weight and the red blood count indicated a loss of 5,800,000 cells. Thus by varying the diet from the special to the pasteurized market milk it was possible to repeatedly retard or accelerate the weight and to increase or decrease the red blood count to a marked degree.

Further experiments were also reported in which two portions of the same sample of the milk of the cows on the special diet were used, one portion being heated to 62° C. for 30 minutes, the other being used unheated. The results of this test indicated a loss of 21 grams in weight and 6% in hemoglobin, with a decrease of 1,200,000 red blood cells in those fed the heated fraction. This portion, however, showed a gain of 95 grams in weight, 3,300,000 red blood cells, and 30% hemoglobin over the group fed upon the commercial heated milk.

A further experiment indicated that the addition of cod liver oil and tomato juice to the diet of commercial pasteurized milk did not increase its nutritive value sufficiently to equal that of the milk from the cows upon the special feed. In this test the animals upon the special milk gained 122 grams, those upon the commercial pasteurized gained 54 grams, and those fed the commercial pasteurized plus cod liver oil and tomato juice showed an average gain of 78 grams.

Since the completion of this series of experiments the authors have reviewed the literature of the subject somewhat and have been able to find numerous reports of experimental work done which seem to bear an interesting relationship to the work here presented.

One of the most recent and striking of these is the result of the work of Thomas and MacLeod (3) and of Krauss and Bethke, (4) who have proved that the antirachitic Vitamin D is greatly increased in the milk of cows fed upon irradiated yeast or irradiated ergosterol. Thomas and MacLeod find that Vitamin D can be increased in the milk as much as sixteen times in this manner. Hess (5) and his co-workers have utilized this fact clinically and report many advantages in both the prevention and treatment of rachitis by the feeding of "antirachitic cow's milk," stating that when rachitic infants were fed upon such milk that definite calcification was brought about within thirty days.

Roessler (6) in experimenting along similar lines found that "the milk of cows on a green fodder diet had the same effect as ergosterol, but that winter milk did not possess this property."

Hunt and Krauss (7) have proved that the milk from cows on green pasture has a higher Vitamin G content than cows on dry feed, and that cows on pasture during a vigorous plant growth produce milk with higher Vitamin G content than those on pasture that is overmature. These authors also state that Vitamin B is influenced in the same manner but to a less degree. Ernst (8) states that both quality and quantity of milk are dependent upon the quality of the cow's food, and also that the texture and quality of butter is determined by the diet of the animal. Brown and Sutton (9) have proved that the administration of Manhadon (fish) oil to producing cows not only "lowers production, but also the percentage of butter fat and the total amount of butter fat."

Daniels (10) found that vitamins are present in the milk only in the proportions existing in the diet of the animals producing it, and further that "milk sterilized by the now existing methods cannot be relied upon to supply any of the antiscorbutic Vitamin C." Osburn and Mendel (11) and Steenbach, Sell and Buell (12) have proved that milk heated in the open air loses Vitamins A, B, and D. Daniels and Loughlin, (13) comparing rats fed slowly pasteurized milk and that rapidly boiled, state, "those fed the slowly heated milk grew slowly, reached only one-half normal size, and failed to reproduce. Those fed the quickly heated milk grew normally and to all appearances were perfectly nourished animals.

Ladd, Evarts, and Frank (14) in an extensive feeding experiment with young children showed that certified milk was superior in nutritive qualities to either Grade A pasteurized or Grade A pasteurized plus cod liver oil and orange juice. They indicate the difference may be due to the more exact and scientific feeding of the cattle.

Catif and Pollaske (15) have proved that normal young goats fed exclusively upon autoclaved cow's milk suffered a complete retardation of growth within a few days in eight of ten experimental animals.

Daniels and Stussey (16) have shown that rats fed boiled milk grew to one-half their normal size and did not reproduce, while Mattak and Golding (17) were able to show marked variation in growth and weight curves between rats fed upon milk after heating at various temperatures. They also observed marked changes in reproduction in those rats fed upon diets of raw, pasteurized, and boiled milk, the rats upon the raw milk producing 41 living young representing 524 nursing days, those upon pasteurized milk had 22 living young who had 169 nursing days, while those on boiled milk failed to reproduce entirely.

That this apparent deleterious action of heat is not confined to milk is indicated by the report of Freidberger (18), who found that animals fed raw foods eat only one-third as much as do those fed the same foods cooked, and also that the animals fed raw food gain about twice as fast as do animals subsisting upon cooked food alone. The addition of vitamins to the cooked food did not change the biological effect of the food mixture. The same author found that rats fed raw eggs gained 140 grams in weight in two and one-half months, while their litter mates gained only 88 grams in the same time on boiled eggs.

Morgan and King (19) observed decided retardation in growth as the result of feeding cooked cereals. An editorial appearing in the Journal of the American Medical Association for January, 1931 (20) states that "relatively long heating even at a moderate temperature in open utensils tends to decrease the content of all known vitamins, notably at neutral or alkaline reaction. Likewise the inorganic salts tend to be leached from material being cooked and especially with vegetables are frequently entirely discarded." Richardson (21) writes that, "Raw milk is of an importance which cannot be over-estimated in the diet of the pregnant or nursing mother as it is a great source of vitamin essential to the growth and development of her child."

Lachet (22) indicates the growing belief among investigators that carotin, the yellow coloring material of plants, is definitely correlated with the physiological activity of the fat soluble Vitamin A. Hart (23) states that we now know, or think we know, that carotin is the precursor of Vitamin A "and that Vitamin A is more abundant in the milk of pasture fed cows than those stall fed." This is of interest in the present connection because of the fact that carotin in association with chlorophyll is the pigment which gives the characteristic green color to the grass and to the leaves of trees and plants. Chemists inform us that the chlorophyll of the green grass and vegetables is almost identical in chemical composition with the hemoglobin of the blood, apparently performing much the same function in the plant as does the hemoglobin in the animal body. As has already been indicated, it is the actively growing green grass and the hay that maintains its green color that give the high vitamin potency to milk.

A further interesting observation along this same line is that of Koessler and Maurer, (24) who assert that Vitamin A is essential for normal blood regeneration, and that there is a definite relationship between a state of chronic Vitamin A deficiency and certain anemias of man.

This brief survey of the work being attempted in this field indicates the trend of the thought that is stimulating the research now being carried on in an endeavor to solve some of the many unknowns in the problem of milk in its relation to nutrition.

In a subsequent series of experiments carried on in our laboratory since the former report, the animals used were again weanling rats who had never tasted food other than the mother's milk. They were housed and cared for as the animals of the first series. These rats were divided into groups of six each. The first group was the control receiving a normal diet of grain, vegetables, and bread. The second group received the mixed herd milk unheated, the third group were fed the same milk after it had been heated to 145° for 30 minutes. A fourth group of rats were fed upon the milk obtained from cows that were fed upon dry winter feed and had no grass or other green food during the time of the experiment. The fifth group of animals in this series were given the milk of cows who were upon official test and who were producing from 90-100 lbs. per day during the period of observation. This experiment has been of comparatively brief duration, extending over a period of only eleven weeks, to date yet in this short time rather striking results have been obtained. The experimental animals were all born within a period of three days and all closely approxi-

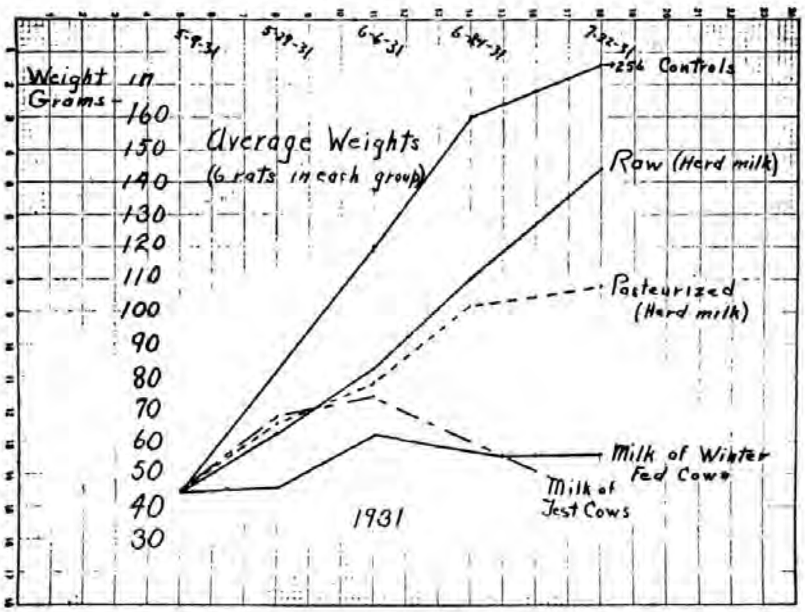

FIG. 2

Chart presenting the average gain in weight of groups of rats fed exclusively upon different grades of milk.

mated 42.5 grams in weight and a blood count of 5,300,-000 red corpuscles when weaned. During the period of the experiment the following results were noted: The control group gained 113 grams in weight and 4,700,000 red blood cells. The group upon unheated herd milk gained 100 grams in weight and 2,340,000 red blood cells. The group receiving the herd milk pasteurized gained 66.5 grams and lost 2,300,000 red blood cells. The group fed upon milk from the cows upon winter feed gained 12 grams in weight and lost 2,480,000 red blood cells, while those fed the milk of the cows upon official test gained 9.5 grams in weight and lost 3,601,000 red blood cells.

The herd from which the milk used in this series of experiments was obtained was a Holstein herd that was being fed a warm hydrolized ground alfalfa hay and grain diet similar to that used in the series of experiments previously reported. The mineral ration, however, was

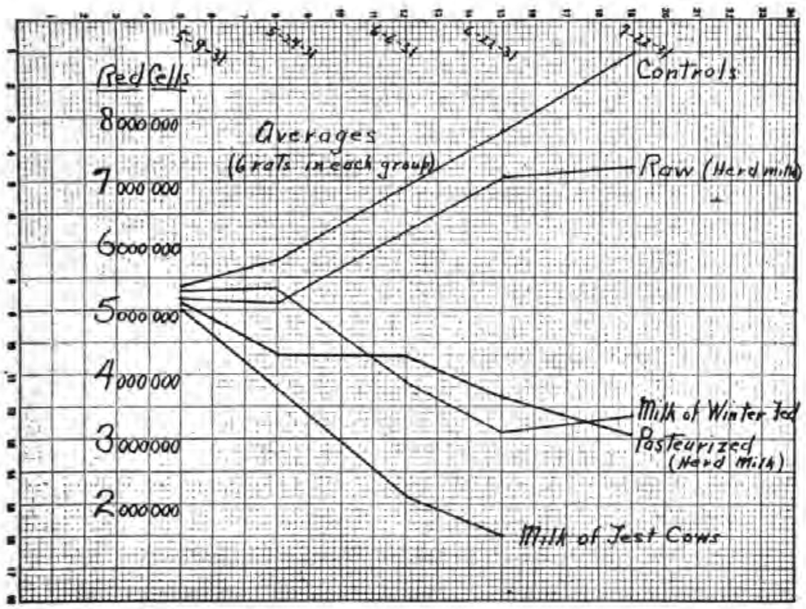

Fig. 3

Chart presenting the average variation in the red cell count made by the same rats as shown in Chart 2.

omitted as was the ration of fish meal. The cows upon winter feed received a dry grain mixture of corn, oats, oil, and cotton seed meal with a poor quality of hay (timothy and clover) and a small amount of silage. The cows upon official test were fed the warm ground feed as were the general herd but were fed to their capacity. The animals fed upon the milk from these test cattle showed very early lack of growth and vitality and at the end of six weeks three of the group died. Shortly after this a fourth died and the remaining rats were placed upon a diet of unheated herd milk with lettuce. One of these rats died within a few days. The other, however, soon began to show increasing activity and in thirty days it had gained 52 grams in weight and the red blood cells had increased from 1,500,000 to 6,300,000.

On discussing these results with the herdsman, he remarked that it only confirmed the fact that experi-

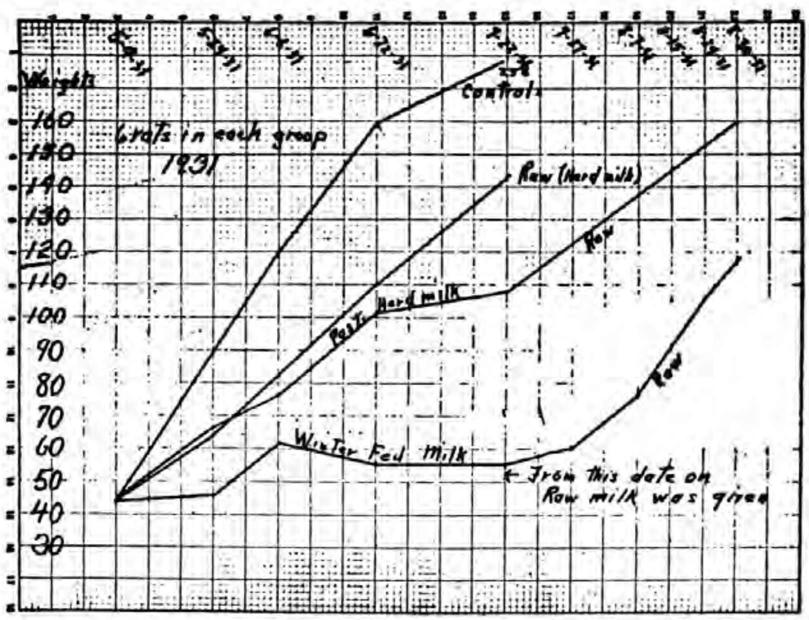

Fig. 4

Chart illustrating the increase in weight following the change to a diet of milk obtained from a properly fed herd receiving abundant green pasture. Those formerly upon pasteurized milk gained 51 gms., while those formerly upon milk of the cows upon winter feed gained 67 gms. in 40 days.

ence has taught the breeder, namely that the calf of a high producing cow does not thrive on its own mother's milk but remains weak and lifeless. Such calves when placed upon milk from cows of lower production soon develop normally.

At the conclusion of this experiment the rats of groups three, four and five, or those which had received the heated herd milk, the milk of the cows upon the winter feed, and the rat that had been rendered anemic by the use of the milk from the high producing cows, were removed to another laboratory and placed upon a diet consisting of the unheated milk from a Jersey herd that was receiving a liberal dry grain ration plus minerals and fish meal, supplemented by an abundant bluegrass pasture. These animals showed a quick response to the

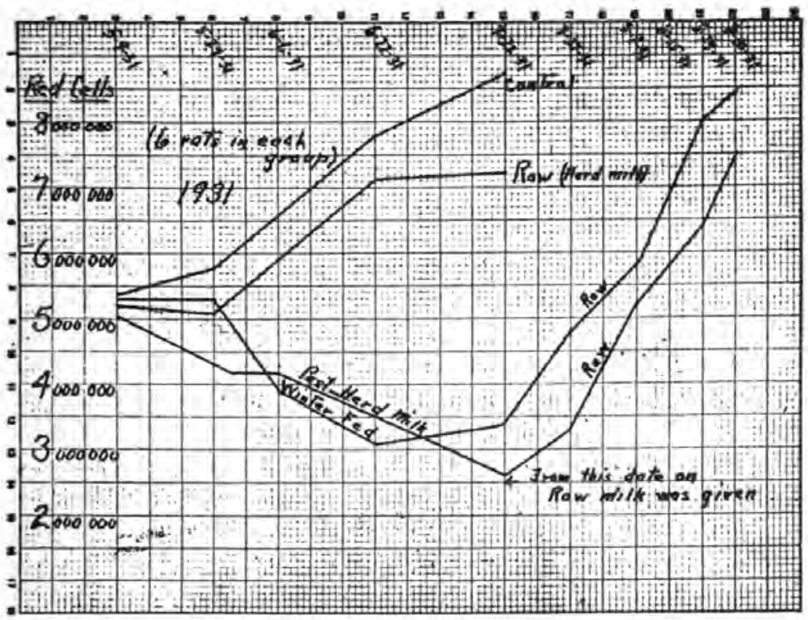

Fig. 5

Illustrating the rapid increase in red blood corpuscles following the change to the diet of milk indicated in Fig. 4. Those rats formerly upon the pasteurized milk gained 4,900,000 and those formerly upon the milk of winter fed animals gained 5,100,000 red blood cells in a 40-day period.

changed diet and within a thirty day period showed the following gains: The group previously on pasteurized milk gained in weight an average of 51 grams and showed an increase of 5,000,000 red blood cells. Those formerly fed on milk from winter fed cows made an average gain of 63 grams and an increase in red blood cells of 5,500,000. The rat from the group fed upon the milk of the test cattle gained 108 grams and 6,700,000 red blood cells in 71 days upon a diet of raw milk, with lettuce occasionally during the first 30 days.

In still another series of rats which are at present un-

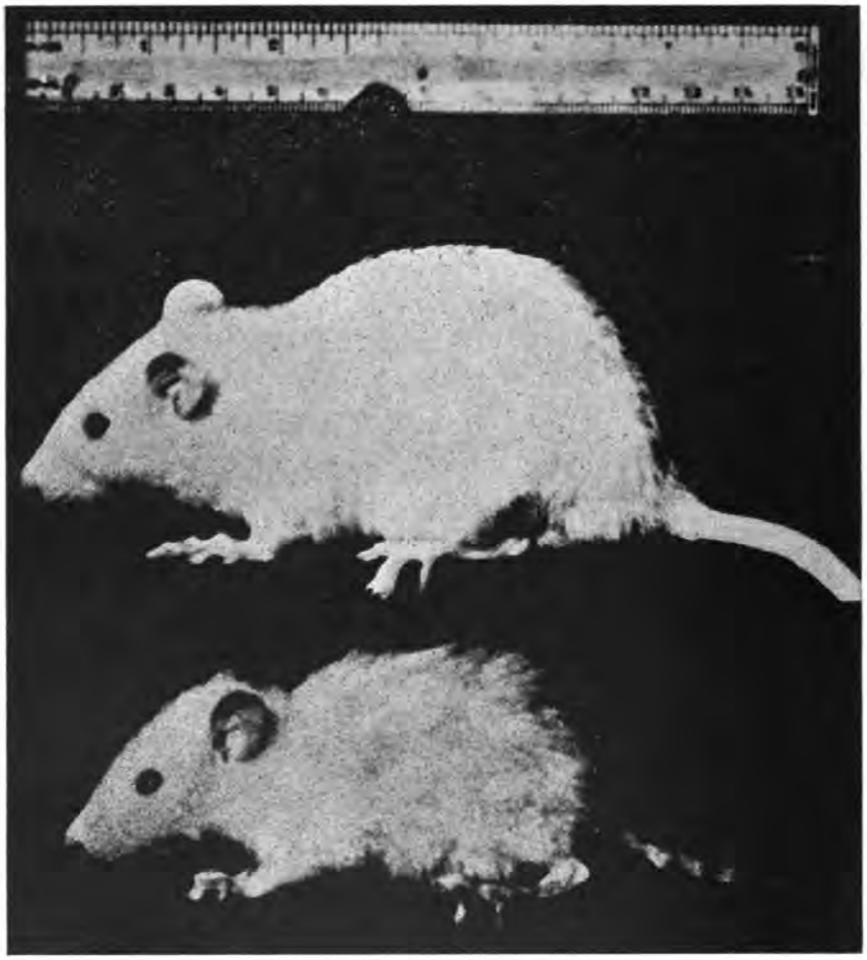

Fig. 6

Photograph showing the difference in size and general well being between the upper rat fed raw herd milk and the lower rat which received the milk from cows upon winter feed.

der observation two grades of milk are being used, one the unheated milk of a Jersey herd fed upon the diet just described, the other the commercial pasteurized milk as delivered at the laboratory. Each of these samples of milk is divided into three portions, the first portion of each sample is fed as received. The second portion of each sample is heated to 145° F. for 30 minutes (pasteurized). The third portion is boiled for 10 minutes.

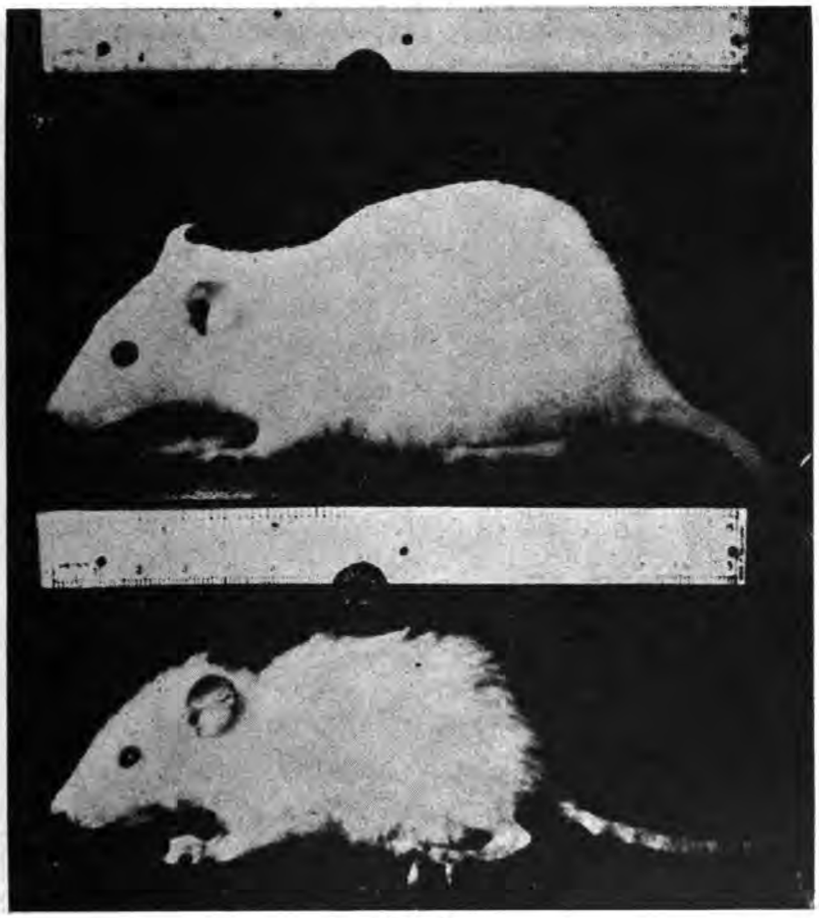

Fig. 7

The lower photograph is typical of the rats as they appeared after an eleven weeks' diet of milk from cows fed upon dry winter feed. The upper photograph shows the same animal after receiving an exclusive diet of milk from a properly fed herd over a 40-day period, there being a gain of 67 gms. in weight and of 5,100,000 red blood cells during this time.

The rats used in this series were all born within a period of 48 hours and were placed upon the test diets somewhat earlier than those of the preceding series, the average weight being 20 grams and the red blood count 5,500,000 and hemoglobin percent of 90 plus. At the end of the first month these groups are showing decided differences as indicated by their general appearance, activity, weight, blood count, and hemoglobin.

In the experiments outlined 230 animals have been used and the observations have continued over a period of approximately three years. Some of the work has been repeated a sufficient number of times, with entirely consistent results, to have become quite convincing. Other observations, those using the milk from the test cattle and those using the boiled milk, are as yet less certain in our experience.

Although the question of reproduction was not a part of the experiment, it has been observed that in no instance has there been a litter of young born from animals receiving heated milk, while in the series of 1929 there were 23 rats in 5 litters born from the animals receiving the various types of raw milk.

Conclusions

1. The results of these experiments indicate that milk is subject to a wide variation in its food value.
2. This variation depends primarily upon the diet of the cow and secondarily upon the procedures to which the milk is subjected before its consumption.
3. The milk from properly fed cattle is apparently a complete food, and when taken exclusively brings about normal growth and a normal blood picture in the albino rat.
4. Experiments seem to prove that the application of heat to milk (or other foods) causes a decrease in the nutritive value, as indicated by the growth curve, the red blood cell count and hemoglobin percent of the albino rat.

In closing we quote from an editorial (25) in the American Journal of Public Health, 18:634, 1928, as follows: "Milk varies with the season and the feeding of the cows especially in regard to vitamin content. The public deserves the right to know that there is a great difference between the milk of pasture fed cattle and that obtained from the winter stall fed animals unless especial care is taken to provide a diet sufficiently high in vitamin and mineral content."

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TO WHAT EXTENT SHOULD WE ENCOURAGE PASTEURIZATION?

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To what extent should we encourage pasteurization? This question, in our opinion, can be answered very simply. All milk and cream should be pasteurized. We anticipate, however, that there are a few sanitarians who do not agree with us and it is for this reason that we have been invited to present this discussion. We shall make no pretense of giving a complete review of the administrative and epidemiological data that warrants our conclusion, but must content ourselves with brief but reliable references. We shall draw freely from the admirable report of the Committee on Milk Production and Control of the White House Conference on Child Health and Protection (1).

The purpose of pasteurization is to prevent the spread of communicable diseases. Armstrong and Parran (2) state that prior to 1908 there had been 179 recorded epidemics in which milk had played the major part in the transfer of infection. These authors, writing in 1927, added 612 new epidemics to this list, including a total of 42,637 cases with 410 deaths. During the six years, 1924 to 1929 inclusive, there were recorded (1) 258 epidemics (177 of which were typhoid fever) resulting in 10,906 cases and 371 deaths. The record for 1929 is not

an enviable one, 44 epidemics with 1959 cases and 48 deaths. Do we need further evidence to show the need of milk control to avoid needless sickness, distress and economic loss? Many communities still lack a milk supply that is clean and safe at all times. The cities in which milk-borne epidemics occur with greatest frequency are those with from 10,000 to 25,000 population and to a lesser extent, the rural sections and towns under 2,500 population. It is no strange coincidence that those are the same communities with high typhoid death rates, unsafe water supplies, and lack of organized health service. It is very probable that the list of epidemics is quite incomplete, especially in towns and cities with the poorest health organization. Nevertheless, an annual crop of 44 outbreaks is sufficient evidence of the need of an effective milk control program.

How can we prevent the transmission of communicable diseases through the agency of milk? Pasteurization when properly applied will serve this purpose. By pasteurization, we mean some process of heating every particle of the milk or milk product to a sufficient temperature and holding for a sufficient period of time so as to kill all pathogenic organisms. We believe that the so-called holding process has been the most effective procedure for accomplishing this purpose but it is not visionary to anticipate that research will develop new methods, possibly with higher temperatures and shorter periods of time, which will accomplish the same purpose. The process cannot be called pasteurization unless it is effective in killing pathogens. It is also understood that after treatment the milk will be promptly chilled so as to prevent after-growths and at all times will be handled in such sanitary fashion as to avoid contamination following heat treatment. Under such method of treatment it is obvious that pasteurization will prevent the spread of communicable diseases.

Investigators have not infrequently reported that milk-borne epidemics have been due to pasteurized milk. However, careful epidemiological study, wherever made, has indicated that the milk has not been pasteurized in the manner above described or has been accidently contaminated after treatment. Armstrong and Parran (2), state that of the 612 epidemics tabulated in their report of 1927, 179 were due to raw milk, 29 to pasteurized milk, 3 to certified milk, and 356 to milk of an undetermined character. Godfrey (3) reporting on 16 outbreaks attributed to infection by pasteurized milk, states that in one instance milk had nothing to do with the infection, in four cases the milk was pasteurized by a flash system which was not effective in killing pathogens, in one case the thermometer records were incomplete, and in seven instances the process of pasteurization was properly carried out but the evidence seems conclusive that the infection was introduced into the milk after treatment.

Of the 44 epidemics in 1929 reported by the White House Conference, 13 were traced to chronic carriers, 18 to sick persons continuing to work in dairies, 5 were reported as being due to contaminated and unsterilized bottles which were returned from homes where sickness prevailed, 4 were said to be due to a polluted water supply, and 1 was attributed to diseased dairy cows. It is therefore apparent that of the 44 epidemics, 31 or 76 per cent of the total were caused by carriers of infection or by missed and mild cases which existed on the dairies. These 31 epidemics involved 183 odd cases, 90 per cent of the total and in addition to this there were 23 deaths or 51 per cent of the total deaths. Pasteurization, when effectively controlled, will prevent epidemics due to car-

riers and missed cases on dairy farms and would therefore have eliminated 76 per cent of the epidemics which occurred in the year 1929.

We subscribe wholeheartedly to the statement made by the White House Conference to the effect that "it has long been understood, and is being increasingly emphasized, that milk of an insanitary quality or a high bacterial content cannot be made into a high grade, wholesome milk through the process of pasteurization." Theoretically, at least, it would be possible to start with sewage and make a potable water supply, judged from chemical and bacteriological standards but nobody wishes to knowingly drink sewage even after it has passed through a treatment plant. Likewise, it would be possible to begin with a contaminated milk supply, one containing barnyard filth and dirt, but again individual and public opinion would revolt against such a milk supply even though it might be bacteriologically safe. What is needed therefore, is a proper balance between farm inspection and country quality control on one side and pasteurization and subsequent supervision on the other. Furthermore, it has been shown that a milk with high bacterial content, even when freed of pathogenic organisms, is not suitable for infant feeding. Therefore, we do not claim that pasteurization is a substitute for the clean and sanitary production of milk but is an added safeguard which assures, insofar as humanly possible, that any chance infection which may have reached the milk is rendered harmless.

There are three principal objections which are frequently cited by those who oppose the universal pasteurization of all milk and cream. In the first place, it is stated that the process of pasteurization is not always well carried out and therefore does not prevent milk-borne outbreaks of disease. This is true only of inadequate methods of milk treatment which cannot properly be termed pasteurization. If a flash system is employed which does not destroy the disease producing organisms, the process should not be called pasteurization. If holding tanks are poorly designed so that there are dead pockets in corners and in valve entrances or exits, any failure is not due to pasteurization but is due to the imperfections of the equipment itself. If the recording thermometers are inaccurate with resulting low temperatures, again the equipment is at fault. The fact that a method of milk treatment is not properly carried out does not mean that the process of pasteurization has failed.

Secondly, it is stated that some communities, especially in rural and semi-rural areas, are not prepared to accept and adopt any regulations which require pasteurization of the entire milk supply. This is probably true and until the local citizens can be properly educated and local viewpoint changed, it will be necessary to tolerate the various grades of raw milk. The United States Standard Milk Ordinance has undoubtedly accomplished a vast amount of good particularly in the South and in the smaller cities and towns but should, in our judgment, be considered merely a makeshift until public opinion has been aroused to the point where there will be a demand for universal pasteurization. The solution to this problem involves the establishment of a full time health service in every local area throughout the country with well-trained personnel properly equipped to promulgate a modern public health program and blessed with sufficient funds to maintain such organization. We believe that the most important single feature in a good milk control system is the establishment of a full-time local health service which, through health education, will immediately, and at the same time diplomatically, enlighten the local public with respect to problems of milk sanitation and more especially convince the local citizens that pasteurization is the greatest single safeguard in preventing the spread of milk-borne diseases.

The third objection to universal pasteurization comes from those who are particularly interested in the sale of certified milk. We believe that the plan of milk certification has done wonders to elevate milk standards during the past three decades but we likewise are of the opinion that the time has come when in addition to certification, pasteurization should be required to take care of any chance infection which may reach the milk supply. There have already been too many milk-borne outbreaks due to certified milk, very few of which are reported in the literature. Pediatricians are becoming more and more of the viewpoint that pasteurization of milk does not render the product indigestible for infants. The practice of boiling milk for infant feeding is answer enough to the assertion that the heating of milk interferes with digestibility or causes constipation. It is sometimes stated that pasteurization destroys vitamins and in this manner causes scurvy and rickets. The most recent work in this field leaves us with the impression that the vitamin content for pasteurized milk is about the same as that found in normal cows milk. Furthermore, granting that there may be a reduction in some of the vitamins due to pasteurization, a well-balanced diet makes up for any deficits which may exist. Fruit and vegetable juices are generally advocated to make up such deficiencies.

In summary, we believe that the pasteurization of milk is the most important single factor in preventing the spread of milk-borne infection. We believe that the first essential in bringing about universal pasteurization is the establishment of full-time local health units, with trained personnel and suitable appropriations. We concur most heartily in the recommendation of the White House Committee which states that all health authorities should persistently recommend to American consumers that pasteurization is an added factor of safety in a milk supply. Since properly pasteurized milk will promote health and prevent sickness, universal pasteurization should be promoted.

References

1 Report of the Committee on Milk Production and Control of the White House Conference on Child Health and Protection, Public Health Reports, 46, 769 (April 3, 1931).

2 Charles Armstrong and Thomas Parran, Jr., Public Health Reports Supplement No. 62.

3 Edward S. Godfrey, *Nations Health*, 5, 1, (January 5, 1923).

REPORT OF COMMITTEE ON FOOD VALUE OF MILK AND MILK PRODUCTS

IRA V. HISCOCK, *Chairman*

The most recent comprehensive report on the subject of Nutrition is contained in the publication of the Proceedings of the White House Conference on Child Health and Protection. An admirable resumé of the findings of several committees was presented by Dr. Lafayette B. Mendel,* who remarked that every writer on child welfare stresses the outstanding importance of milk in the diet of the young. "It remained for modern science," said Dr. Mendel, "to transfer the dictum 'a quart of milk for every child' from the domain of empirical belief to the field of experimental justification. Some protagonists find the oustanding value of milk in that it is a 'protective food;' it is the best single supplement to insure that there shall be no outstanding inadequacies. Others look upon milk as an almost ideal foundation upon which an optimal diet can be built."

Professor Mary Schwartz Rose, in her review of a standard distribution of food groups for a 3-year-old child, assuming an energy requirement of 1,300 calories per day, suggests the following:

Food Groups	Calories
Milk	48%
Cereals	20%
Fruits and Vegetables	20%
Sugar	2%
Fats	6%
Meats and Eggs	4%
Total	100%

In commenting upon the conspicuous place of milk in the dietary of the young, Professor Rose states that

* See the *United States Daily*, Sec. 11, Vol. VI, No. 29, April 6, 1931, p. 85

"milk owes its importance in the diet to the excellent quality of its proteins and their supplementary value for the cereal proteins; to the completeness of its assortment of mineral elements and the excellent proportions in which they occur; to the high content of calcium, which makes milk almost indispensable for ideal storage of this element during growth; to the presence of Vitamins A, B and G in quantities which make generous use of milk day by day a practical guarantee against deficiency of any of the three; and to the presence of an appreciable amount of Vitamin D in association with a calcium-phosphorous ratio very favorable to the calcification of bones and teeth."

With the progress of laboratory studies, coupled with clinical experience, much knowledge has been gained regarding the modification of milk for the artificial feeding of infants. Dr. Grover Powers, in the White House Conference report, suggests that from clinical experience it seems very likely that the majority of infants thrive best on milk when it is so modified for them that between 10 and 20 per cent of the total calories are in protein, between 15 and 30 per cent in fat and between 40 and 65 per cent in carbohydrate. Budin showed that the cooking of cow's milk greatly enhanced the value of the milk in the feeding of infants. Similarly, as Dr. Powers has pointed out, investigators have fed milk which has been alkalinized, acidified, peptonized, treated with colloids by the addition of starch solution or gelatine, concentrated or dried, with a growing realization that however dissimilar some of these processes and however diverse the changes produced by them in the milk, one effect on the milk common to all is brought about such that when the milk is acted upon by rennin, the protein is precipitated in finer curds than is the case with raw milk.

In discussing the food value of milk, the vitamins are usually emphasized. It should be stated that much uncertainty exists as to the Vitamin B content of milk, and its Vitamin A and C content is known to vary considerably. Many articles of food exceed milk with respect to the content of one or another of the vitamins, though few individual food products exhibit an equal variety of them. To a certain extent the vitamin content of cow's milk doubtless depends on the vitamin content of the cow's ration.* These and other shortcomings of milk have been discussed in detail in previous reports of this committee.

The Nutritive Value of the Processed Milks has received much attention.† Condensed milk contains about 42 per cent of sugar and 27.4 per cent of water. A number of investigations have shown that the vitamin content of condensed milk is practically the same as ordinary raw whole milk. There has been a tendency in recent years away from the use of condensed milk in infant feeding, although many pediatricians still continue to use it in special cases. Its principal use is for household and culinary purposes, and in bread making and the manufacture of ice cream.

Evaporated milk has increased in popularity in infant feeding in recent years. The antiscorbutic vitamin is completely destroyed. Otherwise the fat value of evaporated milk is not sufficiently different from fresh milk to warrant an unfavorable comparison. It is practically sterile bacteriologically and of superior digestibility.‡

* See report by Thomas and MacLeod, *Science,* 73: 618, June 5, 1931.

† See The Nutritive Value of the Processed Milks, James A. Tobey, *Clinical Medicine and Surgery,* Vol. 38, No. 6, June, 1931.

‡ See Preliminary Committee Reports of the White House Conference on Child Health and Protection, the Century Co., 1930, p. xxxv. Also see Infant Feeding with Evaporated Milk, James A. Tobey, *The Medical Woman's Journal.*

Powdered whole milk and skim manufacture has increased considerably. Dried milk is used as a general substitute for liquid milk, infant feeding, household and culinary purposes, and industrially in bread making, the manufacture of candy, confectionery, and ice cream. From the standpoint of nutritive properties it may be said that dried milks manufactured by either the spray or roller processes compare favorably in all respects except the antiscorbutic property with fresh milk. A recent development in the use of powdered milk is its employment to reinforce ordinary recipes for children, thereby increasing caloric value, and nourishment from added fat, protein, carbohydrate, minerals and vitamins.

The subject of commercial irradiation of milk is receiving much attention and undergoing rapid development. In the early days, the irradiation of milk was attended with some destruction of Vitamin A. This damage is now averted by improved methods, particularly the brief period during which fluid milk is exposed to the activating rays. It is important to secure sufficient Vitamin D in children's food without harm to Vitamin A.

In studies of the comparative antirachitic and calcifying properties of irradiated milk and milk derivatives by Supplee and his associates,* it has been shown that negative antirachitic and calcifying properties were obtained from the irradiated non-saponifiable fraction of milk fat, as determined by the curative method with white rats and the preventive method with chickens. Milk irradiated in fluid form and subsequently dried by the double roller process showed marked antirachitic properties. The degree of potency which may be imparted to milk irradiated in fluid form is, with limitations, determined by the fat content and period of exposure, other things being equal.

* *The Journal of Biological Chemistry*, Vol. XCL, No. 2, May, 1931.

Evidence pertaining to the effect of the ultra-violet rays on the Vitamin C content of milk is at variance, presumably due to differences in methods of treatment. Supplee and Dow* have found that ultra-violet irradiation of milk in liquid form, as a thin film for a few seconds and under conditions that imparted to it marked antirachitic properties, caused a slight but definitely measurable destruction of the antiscorbutic vitamin. This degree of destruction, under the conditions prevailing, is probably of no greater consequence from the nutritive standpoint than the inherent variations in the Vitamin C content of nonirradiated fluid milk. Dry milk irradiated by ultra-violet rays for periods of three and twenty minutes and under conditions that imparted to it marked antirachitic properties showed no evidence of the destruction of Vitamin C due to such irradiation.

In studies of the antirachitic properties and artificial activation of butter, Steenbock and Wirick † have concluded that it is practicable to activate butter by the introduction of irradiated ergosterol.

In this report, an effort has been made to direct attention to certain of the most important and interesting reports and observations of the past two years. Previous reports have discussed in detail the food value of other milk products, such as cheese and ice cream.

* *Amer. Jour. of Diseases of Children,* June, 1931, Vol. 41, pp. 1353-1362.

† *J. Dairy Sci.,* Vol. 13, 497, Nov., 1930.

Thursday, September 10
8.00 P.M.

REPORT OF COMMITTEE ON MILK PLANT PRACTICE, INTERNATIONAL ASSOCIATION OF DAIRY AND MILK INSPECTORS

DR. H. A. HARDING, *Chairman*

Chief Dairy Research Bureau, The Mathews Co.

Detroit, Mich.

The year has brought forth little which is unusual in the way of milk plant practice. There has recently appeared U. S. Department of Agriculture Technical Bulletin No. 249 by C. J. Babcock, entitled, Some Factors Affecting the Viscosity of Cream, which will probably exert a measurable influence upon the future handling of this product. It has appeared too recently to have had any measurable effect as yet.

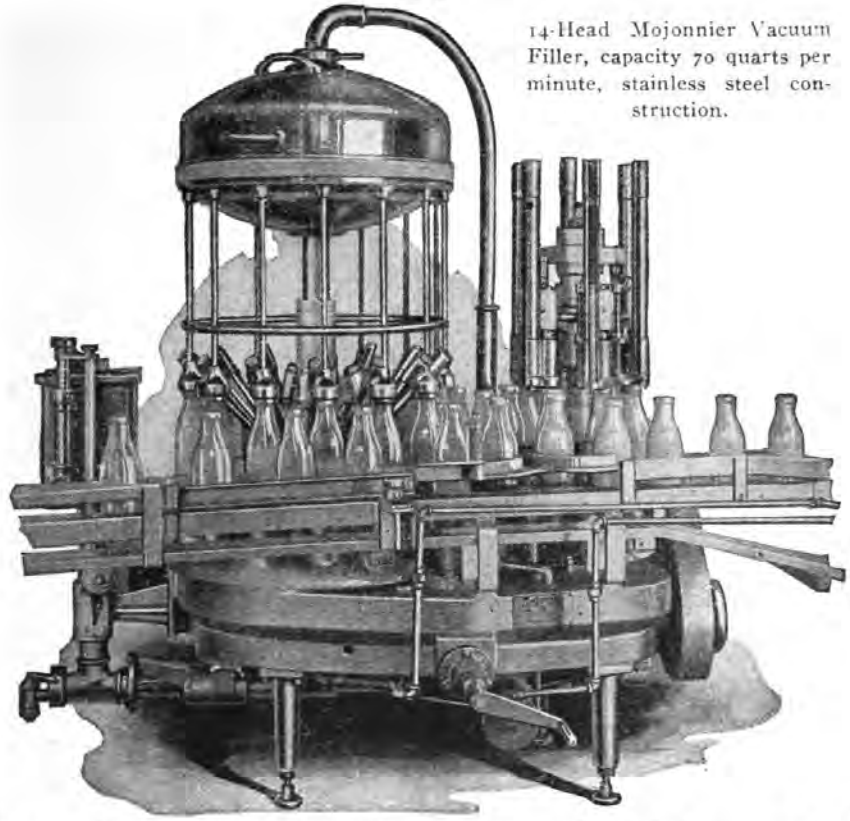
BETTER RAW MILK SUPPLY

There is a general agreement that the quality of the pasteurized milk depends largely upon the quality of the raw milk before pasteurization. On this account there is an increased attention to this matter on the part of both milk plant operators and dairy inspectors. Activities along this line seem to have fallen into three different categories.

The earlier attempts, dating back to about 1900, were directed toward a general inspection of the conditions surrounding the production and transportation of the raw milk supply. This general inspection has usually lasted about ten years in individual cities. It undoubtedly accomplished results though it was somewhat difficult to measure the progress made largely because the effort was distributed over the entire milk supply. Because the amount of time of the inspector necessarily used in going to the producing farms and because of the expenses incident to transportation and living in the field, this form of inspection is probably the most expensive per unit of improvement of the three forms to be here discussed.

Following soon after the introduction of general milk inspection, particularly in New York State, and developing out of it in a measure, is the effort to provide a special grade of raw milk which is more desirable than the general supply. This more desirable grade of milk has generally carried the designation "A" milk. In some states this has differed from the general supply largely on the basis of its conditions of production and its bacterial count. In some states the requirement of production from tuberculin tested cows is added. This classification has perhaps reached its most complicated form in the case of the Standard Ordinance. In developing this Grade A milk the supervision has usually included both inspections of the dairy itself and laboratory tests of various kinds.

The development of a grade of milk especially desirable because coming from tuberculin tested cows has been carried out both in connection with the Grade A movement and also in regions where this Grade A classification was not in use. This movement to eliminate the cow, which will react to the tuberculin test, is widespread in the United States and has reached such proportions as to have completely covered a number of these states. A similar movement has been under way in Canada for a number of years with regard to individual city supplies.



14-Head Mojonnier Vacuum Filler, capacity 70 quarts per minute, stainless steel construction.

The attempt has also been made in some cities to carry out a combined field and laboratory inspection of the raw milk with the object of gradually bringing the entire supply into a more desirable condition. A prominent illustration of this is the development of the "approved dairy" in the case of Cleveland, Ohio.

A promising development in the efforts at improving the raw milk supply has been taken recently at Rockford, Illinois. In this case the city inspection force centralizes its effort upon a supervision of the sediment and methylene blue testing of the milk as delivered at the milk plants. The actual testing is done largely by representatives of the milk plants but the process is supervised and checked by the milk inspector. Milk falling below certain limits is excluded. The results of these tests are taken by the producer and milk dealer as a basis for their financial arrangements but the milk inspection service is not in any way directly responsible for these financial arrangements. This situation has brought about a co-operation of the milk producers who furnish an inspection of the producing farms, the milk dealers who carry out the actual testing of the milk and the board of health which supervises the entire situation. The results of this effort, so far as it has gone, have been to bring about a decided improvement in what was previously a good city milk supply of raw milk. It seems to have been brought about with less expenditure of city money than is common in such extensive and productive milk improvement efforts. Your Committee commends this Rockford experiment to the attention of milk inspectors.

Pasteurization

The year does not seem to have been marked by anything unusual in this part of the milk field unless the attention which has been given to flash pasteurization by some health officials might be so regarded. As the results of these studies have not been made generally available, your Committee withholds comment regarding them.

Continued progress throughout the country is being made in the requirement of flush self-draining valves and the use of recording thermometers having a temperature scale such that the temperature of pasteurization may be recorded accurately. The requirement of an additional mercury thermometer with an open scale so that the temperature at any time can be read accurately on this thermometer is also spreading but it is not nearly as common as that regarding improved recording thermometers.

The agitation regarding destruction of foam on milk during the holding process is not being pushed actively in most places. At the same time this foam problem is very generally being handled in a fairly satisfactory manner. In many types of apparatus it seems impracticable to do away completely with the presence of foam upon milk in the holder and at the same time it is possible to keep the amount of this foam within limits where it is probably not objectionable.

There seems to be little change in the problem of thermophilic bacteria in pasteurized milk. The knowledge of their common presence is spreading very generally though it seems to be less understood in the western and southwestern states of the Union.

Cooling of Milk

While there have been no radical changes in this particular during the year there is an increased attention on the part of milk plant operators to the desirability of prompt and low temperature cooling of the milk after pasteurization as a means of developing a deep cream

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layer in the bottled milk. This knowledge has led to a desire to have the bottles into which the milk is put as nearly the temperature of the milk as practicable so as to prevent a warming of the milk and consequent loss of cream showing. In the case of many of the smaller type of soaker bottle washers, this has tended to reduce the temperature of heat treatment. Milk inspectors would do well to be watchful of the temperatures to which milk bottles are exposed in connection with washing. The State of Pennsylvania requires that the bottles shall be heated to a minimum of 165° F. for three minutes or when heated with a hot spray, the temperature of this spray shall be 180° F. As a general proposition, the temperature treatment of milk bottles has not received the attention which it must have if the pasteurized milk is to be as safe as it should be. Commercial bottle washing operations have been observed where the highest temperature in the soaker tank washer was 98° F. Obviously, treatment at this temperature does not result in safe bottles.

In justice to the manufacturers of washing machinery, it should be stated that there is a general movement on their part to provide soaker type bottle washers in which proper temperature treatment of milk bottles is possible. However, the existence of these machines does not relieve the milk inspection of the responsibility of seeing that the machines are operated at proper temperatures.

Tests for Keeping Quality of Milk

An increasing number of studies have been made of the relation of various available tests to the actual period through which milk will remain sweet and in satisfactory condition.

In the case of the better grades of raw milk the two tests which are most commonly employed are the direct

microscopic count for low count milk and the methylene blue reductase test for the general milk supply. Each of these seem to be giving fair satisfaction in their respective fields. In the case of the pasteurized milk the bacterial plate count is most commonly used though the relation between the plate count and the keeping period of the milk does not seem to be as close as in the case of the raw milk. At the last meeting of the Association attention was drawn to the advantages of holding the pasteurized milk at 70° F. and noting the interval before the acidity became noticeably changed. A number of studies of this have been made during the year but the results are not as yet available for discussion. In some cities there is the practice on the part of some milk distributors of neutralizing their milk at the time of pasteurization. Such milk has a poor keeping quality. Holding samples of such milk at 70° F. brings out very clearly the lack of keeping quality and when coupled with the acid titration makes plain those cases where neutralization has been practiced.

Friday, September 11

9.00 A.M.

CERTIFIED MILK AND ITS RELATION TO MARKET MILK

H. N. Heffernan, *Assistant Secretary*
Medical Milk Commission and Certified
Producers' Association of America

Milk control problems are man made and must be man solved.

Nature provided milk for direct consumption by offspring under which conditions milk control problems do not exist. When man first started drinking the milk of animals it was probably consumed at the place of milking by the milker or his immediate family soon after the milking, and although there were possibilities for contamination, few persons were involved in any one case. As man's habits changed and population increased milk continued to be a desirable food, the problem of supplying it to even more concentrated populations became more and more complex and new sanitary problems were introduced from time to time. Man had to meet the problems in self defense by developing milk control or he would be obliged to submit to nature's automatic device for balancing the concentration of any species of animal including man.

As a result of this development the first two control agencies were municipal and the Medical Milk Commissions. In a short time these agencies were joined by that of the state.

The Bureau of Dairying of the United States Department of Agriculture soon realized its responsibility and

developed the score card, later sent inspectors into the field to assist the state and local milk control officials in their problems. In the past seven or eight years the United States Public Health Service has added a milk division to its interstate program.

When we study the comprehensive regulations enacted by various states and municipalities, it might be concluded that the entire responsibility for the production of clean milk rests upon the shoulders of state and Local Milk Control Officials. We do not believe that they should be made to assume the entire burden of insuring clean milk.

A fair share of the responsibility for clean milk production should rest with the producer and distributor. They know that sanitation in milk starts on the dairy farm and with the dairy cow. For that reason many companies have their forces of field men who work with individual producers, interesting and instructing them in the principles of clean milk production.

The relationship of Certified Milk in this respect is no different than the relationship of the large milk distributors supervision.

One major distinction may be made between private and official supervision with respect to the degree of compliance with regulations that may be anticipated. It is only natural to expect a closer and more consistent conformity with the existing requirements when the dairyman is rewarded for his efforts to produce a quality product than one when his chief stimulus is simply a sense of duty to an official source. This does not in any way underestimate the value of official activities, but is a simple statement of fact.

When we consider the important developments that have taken place in the milk industry in the past few years, we see that the features that have attracted most attention have to do with the processing of milk rather than its production. Milk today is a big business, but the organization and expansion of this business represents an expansion and consolidation in the processing and marketing of milk. The production end is still centered in the small farmer. We see in every progressive city wonderful buildings devoted to the receiving, processing, and distributing of milk. We see filters, clarifiers, pasteurizers, coolers, and bottlers.

All these things are essential but they raise a question that must be considered. It is said that man does not keep pace with his own machinery so we wonder if the fundamentals of milk production have kept pace with the processing of milk. In other words, have we not developed artificial processes to insure satisfactory milk at the expense of refinements of production?

We admit the desirability of filtering and clarifiying milk to secure a satisfactory product under certain conditions, and we admit the necessity and importance of pasteurization for much of our market milk. Yet it is true that aside from the factors of salability and safety, these processes have not added to the intrinsic value of milk as a food product.

If we further admit that to keep pace with the modern methods and standards in other lines milk must continually be improved, shall we bring about this improvement by processing or start with the fundamentals of production?

In reality the problem is one of production. The necessity for producing a milk fundamentally sound in every respect beginning with the dairy calf and dairy cow, and utilizing all the scientific knowledge available to get a milk that contains every desirable element that can be incorporated by natural means given this prod-

uct, it then may be consumed raw or modified by any process that is proven to be beneficial.

Certified Milk production sets the standard for quality of all milk. The producers of Certified Milk are the leaders in establishing high standards of purity of this product. The public should have clean milk not cleaned milk.

Certified Milk has been a pacemaker for milk prices and Certified Milk farms do not offer their products in competition with market raw or pasteurized milk. Our Certified Milk farms have exerted a most beneficial influence on the general milk supply and the producers of this milk are recognized as leaders in sanitary milk production.

Milk production is not yet a fixed science: far from it. The splendid influence of Certified Milk on the general milk supply of this country should compel those responsible for the public health and hygiene to support and encourage the Certified Milk farm and should require support until production of clean milk becomes a fixed science. No one in public health work has any moral right to oppose such an effort, on the contrary should encourage in every way possible the continuance of this leadership.

Let us keep steadily in mind that it is to the Certified Milk producers that all other milk producers look for leadership in developing methods for economic production of thoroughly trustworthy milk; for developing methods of protecting milk in transit from the cow's udder to the table of the user; and for up-to-dateness in all matters pertaining to the milk producers means of making a living.

Physicians entrust to Certified Milk producers the furnishing of safe dependable food which carries the utmost in nutritive value for their most cherished patients.

Public Health doctors look to Certified Milk producers to set the pace in putting into operation methods for protecting the most important food of their wards, the people. Mothers of families rely upon Certified Milk producers to guard against any let-down in their trusted standards for protecting purity of the chief food for children. Even advocates of pasteurization of all milk made of Certified Milk an exception to their demands.

Because they realize better than most the obstacles to be surmounted in producing pure, safe milk and difficulties in the way of this accomplishment, none are more zealous than are the advocates and producers of Certified Milk for pasteurization of all milk produced under conditions which cannot be fully controlled.

It should be borne steadily in mind that the very large milk concerns (those handling the largest volume of pasteurized products) are now, either directly, or through their subsidiaries, also the largest producers of Certified Milk. The executives of these large milk concerns realize, as do comparatively few others, the necessity of Certified Milk to meet the requirements of the medical profession. This does not, however, diminish in any way the realization of these men of the even greater necessity for pasteurization of all milk produced under conditions other than those required for Certification. These executives have an advantage in that they are constantly in touch with the whole field. That they fully appreciate the whole range of the needs of this field is asserted by the manner in which they steadily strive to meet them.

The Board of Directors of the Certified Milk Producers' Association and the Association of Medical Milk Commissions realize that all of our farms and commissions have not functioned a hundred per cent. Our Certified Milk industry after the World War expanded by leaps and bounds; in some instances got out of our control. But during the past two years Certified Milk has started cleaning house and we hope inside of the next two years to have our commissions and farms functioning properly. I know that you have had to face this same condition in the processing of milk.

As milk control officials and you men who are directing milk control work in the various cities and states no doubt know it is hard to get a plant in shape that has gotten off on the wrong foot.

The results of the survey made for the Hoover Conference show the necessity of all of us putting our shoulder to the wheel to get our milk plants in shape. Here again the Certified Milk Industry will be the leader in correcting its weak spots in the production of milk.

You milk control men who are willing to assist the owner to get his plant in shape should be broad and give a helping hand to the weak Medical Milk Commission or farm. Do not lose sight of the fact that every time you give aid to a Certified Milk farm you are helping a producer.

If the producer will continue to make an effort to produce high quality milk, keep in mind that during this time of financial readjustment, we as milk control officials, must help the producer in every way possible if the milk industry is to survive. This is a moral duty you must assume during this period of economic readjustment.

FACTORS AFFECTING THE ACCURACY OF BACTERIAL COUNTS

A. H. ROBERTSON

Director of Food Laboratory
New York State Department of Agriculture
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Ever since Professor H. W. Conn first applied a modification of the present agar plate technic, the accuracy of bacterial counts for judging milk supplies has frequently been challenged. Often the challenge is founded on a false sense of the relationship between counts. The causes of this misunderstanding will be discussed later.

The importance of accurate bacteriological work, particularly where premiums are paid for low count milk, can not be over-estimated. The need for accuracy is many times greater than that in any other province where the agar plate is used. The difference of counting or failing to count a single colony may ultimately determine whether the dairyman will receive his premium or not. This applies particularly where two or more counts are averaged.

The same degree of accuracy should be exercised among public health workers when they are obligated to enforce statutes declaring milk to be adulterated if the bacterial counts exceed a certain limit. Unfortunately a custom prevails among bacteriologists in general to tolerate certain excesses assuming that the high count was caused by faulty technic or sampling. A second or third sample may be examined in such cases. Where premiums are paid for low count milk, it is impractical to resample a producer's milk. In fairness to all no count or record should be disregarded

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unless some faulty practice is definitely known to have occurred.

When any unusually variable test is applied as a quantitative measure as is customary in America, then one must submerge the facts on variability and tolerance in order to meet the practical conditions of the application. All variabilities, especially the minor ones, can be best explained publicly by grouping the counts. If anyone wishes the exact bacterial count, the facts may be given emphasizing the class, grade or group to which it belongs. To be sure, the method as a quality measure of milk is not sufficiently delicate to justify these conclusions, but its application as a quantitative procedure, specifically where premiums are paid, makes any form of tolerance a problem from the standpoint of developing the highest degree of accuracy and uniformity. In the interests of uniformity, it is recommended that tolerances be discontinued. Tolerances of any nature are apt to lead to confusion because they are hard to explain satisfactorily, they are never uniform and they always establish a lower standard.

Biologists know that variability symbolizes all of their work since growth in itself denotes a constant change. To expect the same degree of duplication of results in the biological field as in the chemical field is utterly hopeless. In other words, the biologist works with a variable composed of countless possibilities which the chemist does not have to contend with in his quantitative determinations. It is these uncontrollable variables, to which your attention is first invited.

There are at least six major uncontrollable variables influencing the accuracy of bacterial counts. One is the uneven distribution of bacteria in different one cc. portions of milk. Bacterial counts using different dilution waters containing different one cc. portions of milk differ as much as one hundred per cent more than those made from the same dilution water containing the original one cc. portion.

The second and perhaps the oldest of objections is the use of a medium which fails to support the growth of all species of bacteria. While special media which will yield higher counts, have been devised, their costs are greater and at present there is no assurance that the count obtained on it would be any more uniformly proportionate of the total numbers present than the media recommended in "Standard Methods." In fact, there is reason to believe that a higher count, for instance one obtained on lactose agar, would be more variable due to its magnitude.

Bacteria are invariably clumped in twos or larger masses so that no matter what medium is used, it would be impossible to obtain an accurate count of all viable cells. Clumping, therefore, is an inherent handicap which is more pronounced among certain species of bacteria than others. Certain types of utensil contamination yield large masses of bacteria when washed into the milk. It is well-nigh impossible to break up these large masses.

In order that the technic might be uniform, it is necessary to adopt some standard incubation temperature and period. It is recognized that the time and temperature selected has fostered the growth of a fairly uniformly proportionate number of all viable bacteria in milk. A period of 48 hours has been selected in order to make the results available as soon as practical while a temperature of 37° C. probably originated with a desire to grow those species capable of causing disease in the human body. Recently, attention has been focused on the thermophilic and thermotolerant species associated with pasteurized milk. The true thermophiles do not grow at 37° C.

The sixth uncontrollable error involves the personal element. Only constant vigilance, practice and repeated conferences among the workers together with plating and plate counting contests will ever reduce this source of error to a minimum. It has been most gratifying to Dr. F. L. Schacht and myself at the Food Laboratory to acknowledge the hearty co-operation on the part of the dairy interests in a recent series of plate counting contests. The object of these contests has been to reduce the personal equation to a minimum when counting the plate. This matter will bear further comment later.

"Standard Methods of Milk Analysis" have been devised in order that different workers in different laboratories may secure comparable results. They are aimed to govern the controllable errors. The fact that the bacteriologist is applying a highly variable technic, should not be exploited to show the unreliability of the method unless a more accurate substitute can be offered. It should not be used as an excuse for failing to follow as accurately as possible all precautions set forth in "Standard Methods." Failure to conform undermines precedent and creates disregard for all standardized technic.

The controllable factors influencing the accuracy of bacterial counts are as follows:

Taking and Icing the Sample.—No sample is properly taken until the milk has been thoroughly stirred. There is equally as much, if not greater, need for proper agitation before sampling for bacterial analysis as that for butter fat analysis. Of course, the care to be exercised in all instances will depend upon what use is to be made of the results. If premiums are based on the counts or if public health authorities intend to suspend or permanently eliminate a milk supply because the count is in excess of the standard, the utmost care should be used.

Less care may be used in certain types of survey work but any use of careless methods causes a feeling of uncertainty, requires an explanation and creates a disregard for the best technic.

Delayed Plating.—Samples should be taken immediately after agitation, cooled at once to 40° F., and plated at the first opportunity. While it is true that, when milk is held at 40° F. or less for 24 hours, the bacterial counts on some samples will be lower, others higher and still others almost identical, the writer's opinion is that for the sake of uniformity, the sooner all samples can be plated, the more uniform the results may be expected to be.

Sterilization.—All bacteriological equipment which comes in contact with the milk and is used in collecting or plating the samples should be sterilized at not less than 160° C., for not less than one hour. Where ovens are packed nearly to their capacity with glassware, thus retarding the rapid penetration and distribution of heat, the use of temperatures from 180° to 200° C. for from 75 to 90 minutes is recommended. In order to determine sterility, check plates of the agar and dilution waters may be made.

Dilution Water.—To sterilize water in the dilution bottles is a common practice. It saves time in the subsequent measurement of the 99 cc. portions of the sterile water and dilution blanks thus prepared have a greater assurance of being sterile if used on the second or third day following sterilization. In order to be certain of sterility, dilution waters may well be sterilized for one hour at 15 to 18 pounds pressure. From two to five cc. extra are usually added to the bottle to compensate for that lost through evaporation during autoclaving. In no case should the variation in the amount of water remaining in the bottle exceed ± 2 cc. This in itself permits a 4.0 per cent variation in counts. Bottles should be marked so that excessive deviations will be noticed.

Cotton Stoppers.—The custom of using cotton stoppers for dilution bottles has been discouraged by many authorities. While the writer feels that rubber stoppers are better, it must be admitted that one milk company that examines between 200,000 and 300,000 samples annually is using cotton stoppers apparently with success.

Diluting the Milk.—Statutes in some of the States provide for checking the calibration of the pipettes to be used in the laboratories, the results from which are used in basing premiums paid to milk producers. This work for New York State is done at Geneva under Dr. A. C. Dahlberg's direction. In the interests of uniformity, it is recommended that the pipette containing the milk or cream be blown out into the first dilution bottle by touching the top only to the interior of the neck of the bottle, blowing only after allowing sufficient time for drainage. Thereafter the pipettes are not blown out. The pipette with the subsequent dilution waters should be drained either upon a dry surface in the petri dish or in the dilution bottle. Unless care is exercised in this procedure, it would be possible to increase the count by as much as five per cent by each drop coming from the outside of the pipette. The amount of added contamination from dragging the moist end of a pipette over the lip of a dilution bottle, particularly after the latter has been handled several times, is a matter for consideration. Careless technic at this point might occasionally increase the count as much as 100 per cent. These steps are of much greater importance when plating cream and may to some degree explain the more variable counts in viscous substances.

Shaking the dilution.—"Standard Methods" provides for a shaking procedure which insures as much uniformity as possible. No amount of shaking will secure the complete separation of all cells. Bacteria do not have the property of molecular or ionic dissolution like most chemical substances, and consequently the bacteriologist can not be guaranteed of as accurate aliquot portions as the chemist.

Medium.—"Standard Methods" carefully outlines the preparation and designates the composition and pH of the medium. The writer is of the opinion that the pH limits might be reduced as the range from 6.2 to 7.0 is too broad for good technic. The ideal range for milk work is between 6.6 and 6.8. The use of distilled water both for the medium and for dilution blanks is recommended solely in the interests of uniformity.

The media to be used during each day should be thoroughly melted and held at 42° to 44° C. in a water bath, incubator or some other suitable container. This practice insures greater uniformity and avoids bubbles when ready to pour the plates. Bubbles are necessarily incorporated if the flask is shaken vigorously while cooling just prior to pouring. This further obviates the question of using too cool media which prevents the adequate mixing of the dilution water and the agar which in turn offers ideal conditions for "spreaders." Observations in our laboratory in part, confirm those of Drs. Boerner and Robinson of Philadelphia in so far as the depth or the amount of agar in the plate is concerned. However, it is our opinion that there are other factors for "spreader" control of equal, if not greater, importance.

Unless the plate is thoroughly rotated so as to secure a thorough mixture of the agar and dilution water, there is every reason to expect "spreaders." Wherever larger amounts of water than agar occur there is every reason to anticipate foci from which "spreaders" may develop. If these foci be at the surface, a surface "spreader" may form, if on the bottom, a "spreader" between the glass and agar is the result. Occasionally the spreading colonies grow through the medium itself if insufficiently mixed. In addition to this source, there is always the moisture caused by syneresis which, when on the surface of the agar or on the petri dish cover in droplets sufficient to fall back on the agar, may be the center of a much more prolific "spreader" than any other one source. The conditions contributing to excessive syneresis might profitably be studied as an adjunct to controlling "spreaders."

Incubation.—It is well known that plates rarely are incubated exactly 48 hours at 37° C. For the sake of establishing a practical standard, the Food Laboratory recognizes as satisfactory an incubation period of 48 hours $\pm$ 3 hours at temperatures ranging from 35.5° to 37.5° C. At least two thermometers should be in each incubator, one at the level of the lowest and one at the level of the highest shelf.

Close piling of plates invariably prevents the maintenance of uniform incubation temperatures. The department suggests that if four plates are in the pile, two inches be allowed between the top of the pile and the bottom of the next shelf. If two plates are in the pile, at least one inch should be allowed. Not more than four plates should be in any pile. Extra shelves may be provided. A distance of one inch horizontally should separate all piles of plates both from each other and from the wall. If the heating elements are in the bottom of the incubator, a distance of six inches should separate them from the lowest shelf.

Counting the Plates.—Work in our laboratory indicates that counts by different individuals on the same plate may vary as much as one hundred per cent. This excessive variation may in part be attributed to lack of familiarity with the counting devices used in contest but is more likely to have been caused by poor counting equipment or inability of the individual to recognize what should be counted as colonies. Six plate counting contests were conducted in New York State during 1930. The results of these contests indicate that all analysts should be able to duplicate their counts on the same plate within five per cent and the counts of others within ten per cent.

The type of counting equipment found to give the most uniform and the most accurate count consists of a device whereby artificial illumination is obtained from opposite sides of the plate and magnification of at least 1.5 diameters is secured using the common four-inch reading glass at a fixed position. A proper combination of the lens has been found to increase the magnification to about two diameters. A paper, or some other non-glaring-surfaced, Wolffheugel guide plate is recommended to prevent distortion and glare otherwise caused by the added illumination. This type of counting device with certain modifications is now being made on a commercial scale.

Counting Spreaders.—Obviously, unless the plate is counted accurately, all the work is worthless. Inasmuch as there occasionally appears a mechanical separation of colonies or series of spreading colony types which are undoubtedly of the same origin, it is best solely in the interest of uniformity to count each group as a single source on the plates.

Variations in Plates.—Not all plates have the same diameter. The diameters among 40 petri dishes have been found to vary from 88.8 to 92.5 mm. the mean being approximately 91.0 mm. The difference in areas range from 61.93 to 67.20 sq. cms., the mean approaching 65 sq. cms. Consequently, on a crowded plate where only a few square centimeters are examined, the factor to be used for calculating the total count per cc. varies. Since the average diameter approaches 91.0 mm., the average number of colonies per square centimeter should be multiplied by 65 and then by the dilution used.

The continued use of old petri dishes whose bottoms are so badly etched as to interfere with accurate counting is discouraged. Clay tops and rough glass guide plates tend to scratch glassware. When plates are rotated in contact with soapstone tops, they become etched quickly also.

One of the greatest errors both on the part of the public and not a few bacteriologists is the failure to apprehend the correct relationships existing between bacterial counts. Because bacteria in the growth phases common to market milk increase geometrically instead of linearly, the application of our common averaging system to a series of bacterial counts leads to false conclusions. The correct relationship between bacterial counts can best be understood if their logarithms are compared. The use of logarithms transposes an exponentially increasing series, when plotted against time, to a linear series or a straight line relationship. This process establishes a relationship which is more familiar to laymen and consequently reveals a more accurate mean if the logarithms are averaged. To regard a 20,000 count milk as twice as poor as 10,000 count milk is incorrect. Still this is exactly what is done when 15,000 is regarded as the average. A more correct average is the geometric mean which is the count corresponding to the arithmetic mean of the logarithms of the counts to be averaged.

Perhaps this misunderstanding can be illustrated as follows; A 10,000 count milk bears the same relationship to a 15,000 count milk as a milk with a count of 50,000 does to one with a 75,000 count. The relation is not comparable to that between the two counts, 50,000 and 55,000, which would be the corresponding linear relation. In other words a proportionate relation exists. The relationship between two samples of milk with counts of 10,000 and 20,000 is identical with the relationship between two other samples with counts of 45,000 and 90,000 or two others of 150,000 and 300,000.

In summarizing, the writer, would emphasize that the agar plate method is applicable to all types of milk but is the most accurate and feasible technic to be used with milk having a standard plate count of less than 30,000 or possibly 100,000. The microscopic method of counting bacteria is best adapted to milk with a standard plate count in excess of 30,000, or possibly 100,000. No procedure offers any better opportunity of determining the causes of high count milk than the direct microscopic method. Bacterial counts when accurately made and properly interpreted are the best indices of the keeping quality of milk that are known at present. Any attempt to exploit the unreliability and the variability of the method should be preceded by a most careful study of what constitutes variability among bacterial counts. Furthermore the controllable factors should not be confused with the uncontrollable ones when making comparative studies.

The controllable factors are as follows: (1) interpreting the results, (2) accurate sampling, (3) proper refrigeration, (4) adequate sterilization, (5) delayed plating, (6) proper pipetting, diluting and shaking the sample, (7) use of approval pipettes, (8) properly prepared media, (9) media pouring technic with special reference to uniform mixing of the agar and dilution water, (10) pouring media at the correct temperature, (11) excessive interval between diluting the milk and pouring the plate, (12) use of media which has partially dried out due to improper storage, (13) a correct incubation period and temperature with plates arranged so as to secure uniform temperatures, (14) a uniform system for counting spreading colonies, (15) a satisfactory counting device and, (16) a correct averaging system.

THE CREAMING OF MILK

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It is desirable under present conditions that market milk should develop the maximum cream layer possible for its fat content. Fairly complete knowledge of the subject and reasonably perfect plant practices are essential to bring about this result. If milk were homogenized so no cream layer would ever form, the situation would be different but since some cream layer does form under present commercial conditions the cream layer volume should be held reasonably constant from day to day or consumers become dissatisfied. The only volume that can be held constant from day to day and plant to plant is the maximum one. Uniformly deep cream layers add to the market qualities of milk, help sell more milk, and thus improve the diet. Hence, we are all interested in maintaining a maximum cream layer volume.

The creaming of milk is too extensive a subject to consider it in its various aspects in so short a time. For this reason I am confining this address almost wholly to the results of investigations which have been collected by Mr. Marquardt and myself at the New York Agricultural Experiment Station. These studies were commenced about five years ago and they are still in progress for when one phase of the subject has been sufficiently studied other interesting aspects appear. I will

"When Writing Mention This Report"

not endeavor to present a complete account of the subject but our studies give a good idea of the principles involved and some of the practice.

A Theory of Creaming

An extensive list of theories of creaming have been presented in the literature but most of them do not serve

Fig. 1
Photograph of pasteurized Holstein milk held in a thin layer between glass plates with a strong light on the back side taken 30 minutes after cooling.

to explain all of the observed facts. It is now generally agreed that the fat rises in milk as aggregates of globules rather than as individuals. A very clear illustration of milk in the act of creaming is shown in figure 1.

It is necessary to have some idea concerning the procedure used in showing these fat clusters to secure a better understanding of this picture. Pasteurized Holstein milk was quickly cooled to 40° and poured between to 8 x 11 inch photographic plates which were held apart to a rather uniform clearance of 1/25 inch. A focussing carbon arc lamp, similar to lights used for microscopic purposes, was placed about a foot behind this thin sheet of milk. This thin creaming chamber together with the light was held in a room at 40°. Approximately one-half hour after the milk had been cooled the photograph shown in figure 1 was made without any magnification.

The figure shows that the fat clusters have formed in milk and are rising as such into the cream layer. The illustration also emphasizes the necessity of mixing the milk prior to sampling for bacterial counts or fat tests. When all of the large clusters have risen into the cream layer then the cream line, which is the line of demarkation between the cream layer and the skimmilk layer, becomes evident and the milk is said to have creamed.

Some force is evidently at work in milk which tends to cause the fat globules to aggregate under proper conditions. This force I have explained on the basis of electric charges and the variations in these charges have been associated with the concentration of calcium ions. All observations on the creaming of milk which will be given during the course of this talk can be explained on the basis of effects on the solubility of calcium.

The buoyant effect of the light fat clusters continues to act after milk has creamed thereby producing a packing of the fat clusters in the cream layer. This means that the depth of the cream layer is greatest and the percentage of fat in the cream layer is least immediately after the cream layer has formed. For many hours the buoyancy of the fat globules continues to produce contraction of the cream layer volume.

The Average Cream Layer Volume

Several years ago we endeavored to determine variations in the creaming of milk of individual cows and the average depth of the cream layer volume. To avoid any effects from methods of handling milk, the milk was set for cream layer determinations within a few minutes after milking. The milk was placed in 100 cc. graduated cylinders filling them with exactly 100 cc. of milk. This type of container made it possible to read the cream layer volumes as percentages of the total volume of milk without any calculations. The milk was placed in a water bath held at a temperature varying from 37 to 40° F. It is essential to maintain a uniform temperature because the cream layer volume is noticeably shallower when the setting temperature is 50° or above.

During the course of the investigation cream layer determinations were made on more than 900 samples of Jersey milk selected from 2 herds and on more than 600 samples of Holstein milk taken from 1 herd. The results of the individual determinations had to be expressed on some comparable basis due to the great variations in the butter fat content of the milk. The milk varied in test from approximately 2.5 to 7.5 per cent. Uniformity in expression was secured by dividing the percentage which the cream layer was of the total volume of milk by the percentage of fat in the milk. This gave the percentage cream layer for 1 per cent of fat in the milk irrespective of its original fat content.

The data are represented graphically in figure 2. It will be observed that the mean cream layer volume on Holstein and Jersey milk is approximately 4.1 times the percentage of fat in the milk. In other words, Holstein and Jersey milks varied in their average cream layer volumes directly with the percentage of fat. Recently, rather extended studies on the cream layer volume were published by the International Association of Milk Dealers and it is interesting to note that their results

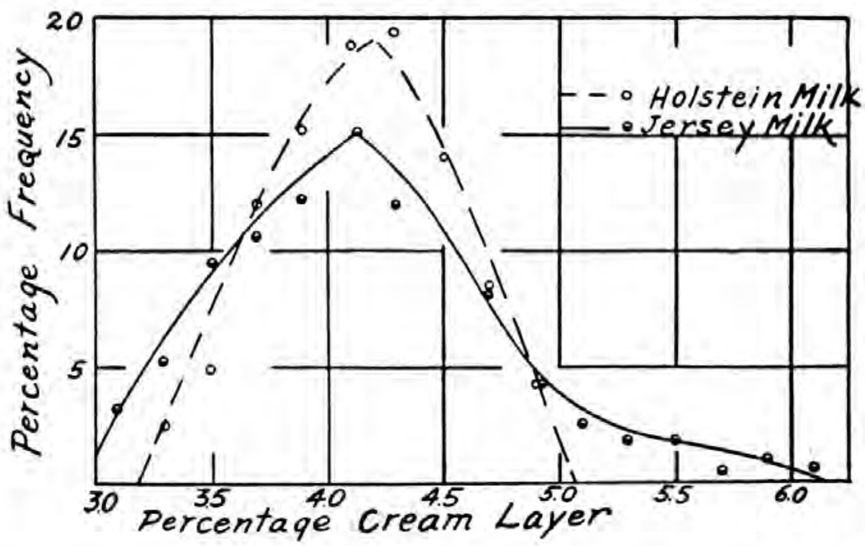

FIG. 2

The creaming ability of Holstein and Jersey milk shown as the frequency, expressed in percentages, wtih which these milks gave cream layers of varying volumes per 1 per cent of fat.

secured in milk plants also show the cream layer volume secured on milk of good creaming properties was approximately 4.1 times the fat content.

These data also illustrate the much more uniform creaming properties of Holstein than Jersey milk. This difference is very noticeable in an extended study of the milk of these two breeds of cattle.

In this connection it should be stated that the percentage cream layer per 1 per cent of fat is not constant for each cow. There is sometimes a tendency for certain cows to always give a fairly high or low cream layer volume but variations from milking to milking are so great that it is impossible to predict the expected cream layer volume on the milk of any cow.

Influence of Aging and Agitation on the Cream Layer Volume

In ordinary dairy practice milk has always been subjected to storage and agitation prior to setting for creaming. For this reason a study was made of the influence of agitation and aging using the creaming properties of the milk set within a few minutes after milking as a control. In all cases the control samples were less than 1 hour old and had not been cooled prior to creaming at 40°.

TABLE I

Influence on Cream Layer Volumes of Holding Milk 18 Hours at 60 and 40° F. Followed by Agitation and Subsequent Pasteurization at 142°—143° F.

Treatment of Milk	Cream Layer Volumes on 4% Raw Milk Stored at	
	60° F.	40° F.
Fresh milk	16.0	16.0
18 hours aging	19.8	13.7
Hauled in truck	20.2	13.6
Pasteurized	16.0	16.1

A few of the data are presented in Table 1. The figures show that storage of milk for 18 hours at 60° produced an increased cream layer volume when this milk was stirred and reset for creaming at 40°. It is also shown that the cream layer volume which subsequently formed on milk which had been stored for 18 hours at 40° prior to setting for creaming was abnormally shallow. These results are particularly interesting in view of the fact that the milk set at 60° for creaming always gives a much shallower cream layer than when set at 40°. Apparently milk which has creamed well does not recream well unless it has been subjected to heat treatment as shown in the table. There are certain circumstances under which these results will not be secured, that is the cream layer volume may not be increased by previous storage at 60° and it may not be decreased by previous storage at 40°. These irregularities are secured because of variations in the percentage of fat in the cream for the test of the skimmilk on creamed milk which has been stored at 40° was always greater than the test of skimmilk on creamed milk stored at 60°.

Table 1 also shows that hauling this milk in partially filled cans on a truck over dirt roads for a distance of approximately 10 miles did not affect its creaming properties. Other studies on agitation verify the conclusion that within moderation the agitation of cold milk does not impair its creaming ability. The storage at cold temperatures has been confused with agitation in previous considerations of this particular phase of the problem.

When milk is properly pasteurized at 142° for 30 minutes followed by surface tubular cooling to 40° the original creaming properties of the milk are restored. This fact is illustrated by the last horizontal column of figures in Table 1. The data also emphasizes the impossibility of using raw milk of unknown history as a control in determining the influence of pasteurization on the creaming of milk. It will be observed from the data that two different lots of milk taken from the same original source had their creaming properties materially varied by the temperature of storage and these variations were subsequently eliminated by pasteurization. In the one case pasteurization apparently improved the creaming of the milk and in the other case it impaired the creaming properties whereas pasteurization actually did not affect this character of the milk.

Pasteurization of Milk With Long Holding Periods

Inasmuch as the creaming properties of mixed raw milk cannot be used as a guide to determine the effect of pasteurization one must resort to the use of milk freshly produced or to milk which has been sufficiently heated to just restore its original creaming properties. The latter method is the only one that can be commercially employed. Our studies show that a temperature of 110° for one-half to one hour or momentary holding at 140° completely restores the creaming properties of milk under nearly all circumstances. For this

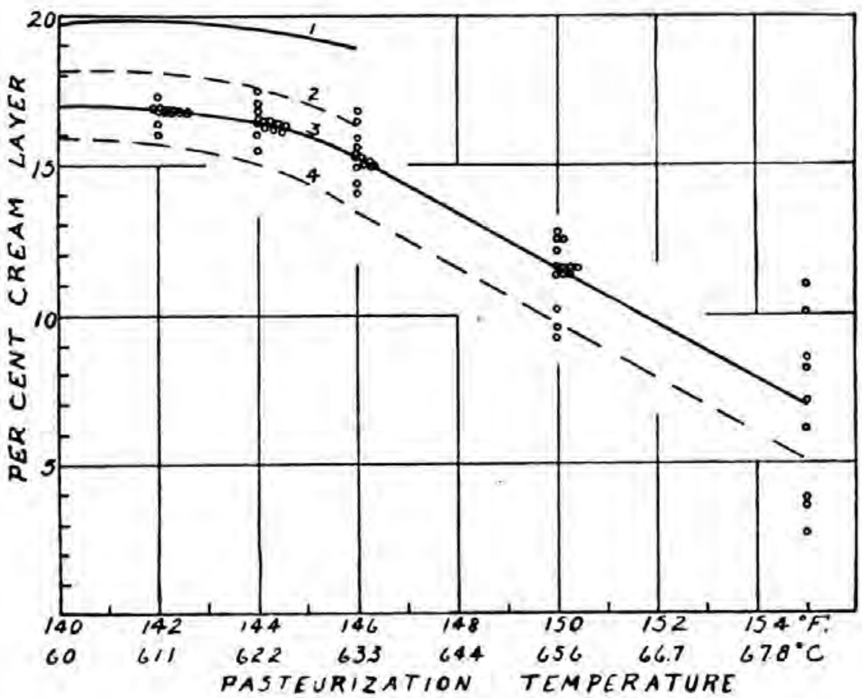

Fig. 3

Influence of temperature of pasteurization with 30 minutes holding upon the cream layer volumes forming on 4 per cent milk. External tubular cooled: 1, 2-hour reading; 3, 24-hour reading. Vat cooled: 2, 2-hour reading; 4, 24-hour reading.

reason I think it preferable in all studies on pasteurization to use the creaming properties of milk heated to 140° as representing the maximum cream layer volume that can be secured on milk.

In our first studies on the influence of pasteurization on the creaming properties of milk, the milk was subjected to temperatures varying from 140 to 155° for 30 minute holding intervals. The milk was heated and held in a spray vat pasteurizer. Part of it was cooled in this pasteurizer and part of it was cooled on the surface tubular cooler.

The data on the creaming of milk pasteurized at various temperatures for 30 minute holding periods are given in Figure 3. The solid line numbered 1 and 3 represent the creaming of milk cooled over an external tubular cooler while the other two dotted lines represent vat cooled milk. Lines 1 and 2 show the cream layer volumes after 2 hours of creaming while 3 and 4 show the contracted cream layer volumes after 24 hours. To avoid confusion in the illustration the individual points for only line 3 are given. In considering this illustration one should immediately recognize the greatly impaired creaming properties of milk heated to temperatures in excess of 145°. For example, no cream layer volumes were evident in 2 hours in milk heated above 146°. Line 3 shows that a temperature of 144° for 30 minutes is the maximum that can be safely employed without affecting the creaming properties of the milk. One should distinguish between average temperatures and minimum temperatures. If a regulation requires a temperature of not less than 144° for 30 minutes it is evident that the milk must be held above this temperature and the cream layer volume will be slightly impaired. Milk plants ought to be able to comply with a regulation of not less than 142 or 143° for 30 minutes without affecting the creaming properties of the milk.

Pasteurization of Milk for Short Holding Periods

In recent years there has been considerable discussion concerning the pasteurization of milk at higher temperatures for shorter holding periods. Modern high temperature pasteurization is not comparable with the old "flash pasteurization" because in former years no consideration was given to a definite holding time. It is evident that the reduction in cream layer volume is a function of both time and temperature; a situation which also holds true for destruction of pathogenic and other bacteria. As long as the holding time can be applied with certainty there is every reason for expecting just as uniform results from pasteurization at high temperatures as from pasteurization from low temperatures for longer periods of time. Our studies have shown that there is a limit below which it is difficult to shorten the time held at pasteurization temperatures and secure uniform creaming properties.

Milk pasteurized at high temperatures was heated by an internal tubular heater to temperatures ranging from 150 to 165° F. The milk passed through the heater in approximately 40 seconds and some of it seemed to require approximately twice this period of time to pass through the tubes. The temperature of the milk delivered by the heater was held within 0.5° and the milk was held at the pasteurization temperature by catching a sample in a pre-heated flask for 5 seconds and then submerging the flask in a constant temperature water bath for the specified period of time. For short holding periods the milk was immediately cooled over a surface tubular cooler.

The influence of the pasteurization of milk at high temperatures for short periods of time can best be summarized by Figure 4. The results show that milk can be held for a period of 5 minutes at 150°, or 1 minute at 155° without affecting the cream layer volume. Rather irregular results appear to have been secured at 160° but at 165° the cream layer volume was decreased without any holding period and showed marked reductions when held for 1 or 2 minutes. It is evident that the maximum detrimental effect of 165° is secured in approximately 3 minutes when the cream layer volume is only about 30 per cent of its normal.

Milk inspectors are more interested in maximum temperatures that milk can be held for specified periods of

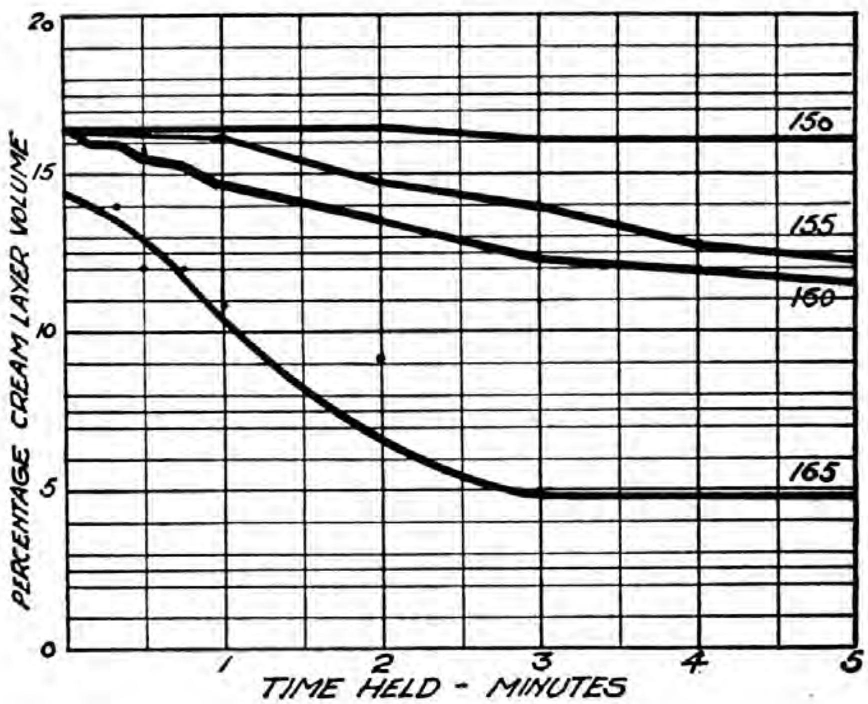

FIG. 4

The average cream layer volumes, calculated for 4 per cent milk, secured on milk pasteurized at 150°, 155°, 160°, and 165° for various holding periods.

time without affecting its creaming properties. Figure 5 gives data to show the maximum period of time that milk can be held at various temperatures with the smallest reductions in cream layer volumes that were experimentally detected with certainty from several tests. Here again it sould be mentioned that in practice the holding time should be slightly less than that shown in Figure 5 to make it possible for milk plants to comply with the regulation without affecting the creaming properties of the milk.

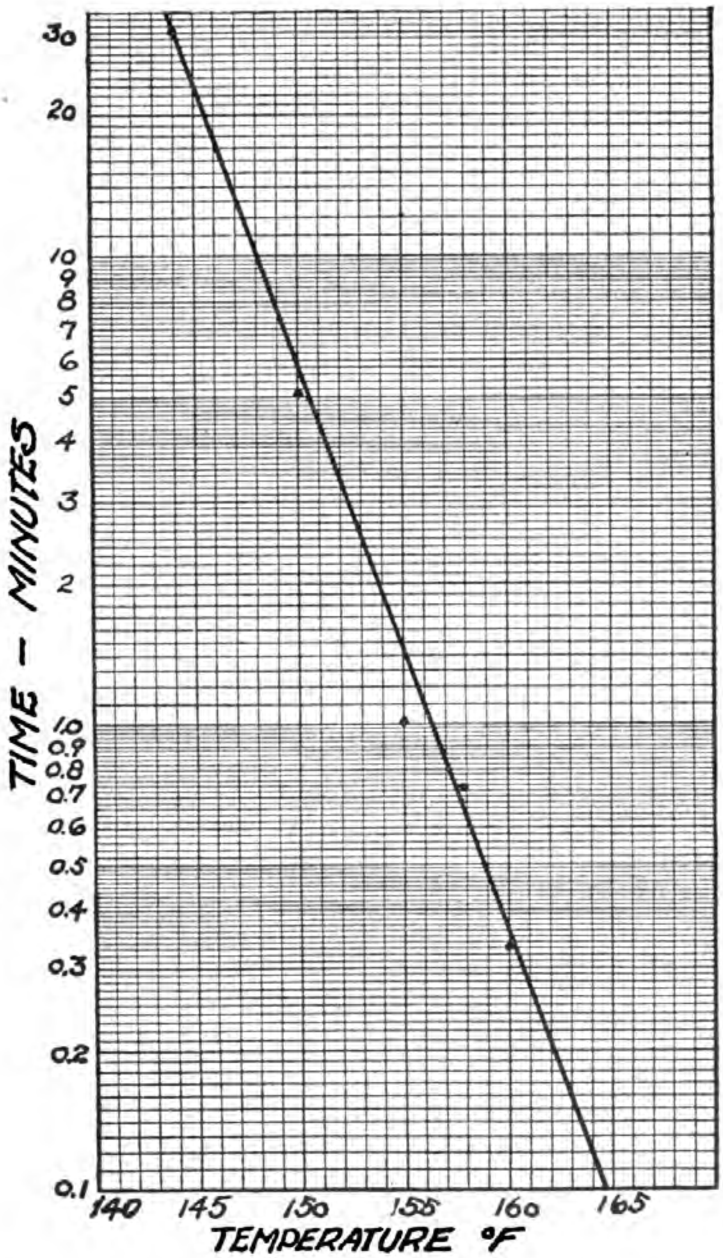

Fig. 5

The maximum period of time that milk could be held at various temperatures with the smallest reductions in cream layer volumes due to heat that were experimentally detected with certainty from several tests, plotted on a semi-logarithmic scale.

The data show a straight line relationship on semi-logarithmic paper so that it is possible to express the relationship of time and temperature of pasteurization as an equation. This relationship is $\log Y = 20.0461 - 0.1289 X$ in which Y is the time in minutes of exposure to the temperature X in degrees Fahrenheit. This graph or equation makes it possible to determine the time which milk can be held at any specified temperature or the temperature at which milk can be held for any specified time without materially affecting its creaming properties.

Vat Pasteurization

It has always been assumed and all previous data show that milk cannot be satisfactorily cooled in a vat without materially affecting its creaming properties. A manufacturer of creamery machinery believed that if he could cool milk with sufficient rapidity to avoid calcium precipitation by low temperatures for relatively long periods of time that it would be possible to cool milk in a vat and maintain good creaming properties. This vat pasteurizer has been used employing brine at 15° for cooling and a spray vat has been used with brine at 10°. In either case it is essential to have the milk agitated rapidly enough to prevent freezing on the cooling surface.

The possibility of pasteurizing and cooling milk in a vat is of special interest to the dairy industry and the public health official because such equipment could be readily adopted to large dairy farms. It obviates the necessity of surface coolers, piping, etc., and very much simplifies the equipment. Consideration of the results presented in Table 2 show that milk was heated to the pasteurization temperature, held hot for 30 minutes, and cooled to 40° in approximately 1 hour. With such rapid cooling the normal cream layer volumes were secured in all instances thus demonstrating that it is possible to pasteurize and cool milk in the vat without injuring the cream layer volume. In this connection it should be stated that there is litttle equipment on the market at

TABLE II

THE CREAMING OF MILK TESTING 4 PER CENT WHICH WAS PASTEURIZED AND COOLED IN A RAPIDLY REVOLVING COIL PASTEURIZER EMPLOYING BRINE AT 15° F.

Temperature Treatment of Milk	Average Time	Cream Layer Volumes 2 Hour	24 Hour
°F.	m. s.	%	%
62-143	12- 1	20.4	16.2
143	30– 0	20.4	16.3
143–100	6– 5	20.6	16.3
100– 80	5–15	20.3	16.1
80–60	5–29	20.3	16.2
60–40	8– 0	19.8	16.1

the present time by which it is possible to secure the results shown in Table 2 but it is clearly evident that vat pasteurizers can be so altered in construction that similar results can be secured.

DISTRIBUTION OF THE FAT IN CREAMED MILK

Why is the skimmilk layer on ordinary pasteurized creamed milk so blue as compared with the old-fashioned raw milk of many years ago or of our raw milk supply of today? The answer to this question lies more in proper pasteurization than in marked reductions in the total fat content of milk. I have summarized data illustrating the fat content of cream and skimmilk in milk which has been creamed at 40° after being subjected to the various treatments indicated in Table 3. It is interesting to note that the percentage of fat in the skimmilk of milk which has been held for some time at 50 or 60° prior to bottling is above 1 per cent whereas the fat content of the skimmilk from the same milk pasteurized at temperatures varying from 140 to 144° is less than

TABLE III

INFLUENCE STORAGE TEMPERATURE AND PASTEURIZATION ON DISTRIBUTION OF FAT AFTER 24 HOURS CREAM RISING AT 40° F.—4% MILK

Treatment of Milk	Cream Layer Volume, %	Percentage Fat in Cream	Shimmilk
Fresh milk	16.8	24.5	0.6
Aged at 40° F.	16.4	17.7	1.7
Aged at 50° F.	17.2	18.0	1.3
Aged at 60° F.	17.6	18.5	0.9
Past., 140° F.	16.9	31.0	0.1
Past., 144° F.	16.4	28.0	0.5
Past., 150° F.	10.0	23.7	2.0

one-half that amount. The blue color of the skimmilk is due largely to the more thorough creaming of properly pasteurized milk although it should be stated that this creaming is not superior to that secured on fresh milk as it is drawn from the cow.

We stress the thinness of the skimmilk but fail to recognize the extra richness of the cream which is secured on the pasteurized milk. The data show that the cream on pasteurized milk contains 8 to 10 per cent more fat than that which is present on raw aged milk. Variations in the percentage of fat in both the cream and the skimmilk must be considered when one attempts to explain the varying cream layer volumes.

It is certain that I have omitted much practical and interesting information on this subject but I trust that our studies will have given you a clearer conception of the creaming properties of milk.

THE INFLUENCE OF ALKALINITY UPON THE EFFICIENCY OF HYPOCHLORITE

C. K. JOHNS

Central Experimental Farm, Ottawa, Ontario

Although the greater germicidal speed of hypochlorite solutions of approximately neutral or mildly alkaline reaction has been reported by a number of workers (2, 3, 4, 7, 8, 10, 12) the fact that such solutions are much more corrosive than the strongly alkaline type has been urged as an objection to their employment (11). Since there appeared to be quite a wide difference between the alkalinity of the latter type and that of the ordinary liquid sodium hypochlorite, some studies were made in the hope of developing a less corrosive solution which might still possess reasonably good germicidal speed. To this end, stock solutions of hypochlorite were made up from calcium hypochlorite (HTH) and washing soda, starting with a ratio of 1:1 and extending to 1:9. Corrosiveness was studied by half immersing 1″x3″ strips of tinned steel and tinned copper in rinsing solutions (containing 100 parts per million available chlorine) for 48 hours at 30° C. Parallel tests on germicidal speed were conducted with *Strept. lactis* as test organism, employing the plating and milk tube technique described in a previous paper (2).

It was found that the corrosiveness of such a solution for tinned steel declined quite rapidly between the ratios of 1:1 and 1:3, after which the diminution was more gradual. Tinned copper, however, was corroded more severely, particularly at the air-water line, and even at a ratio of 1:9 a significant amount of corrosion still took place. It might be noted in passing that these results are more in agreement with the findings of Hunziker, Cordes

Just to Remind You!–

8 years ago we made this statement:

To Boards of Health, Milk Plant Superintendents, *and All Others Responsible for Maintaining the Supply of*

CLEAN MILK

YOUR increasing opposition to the use of milking machines has resulted not only in our giving serious study to the real causes for that opposition, but in our making a sincere effort to correct them. A careful canvass of your inspectors showed that the failure to produce clean milk could be laid to three definite faults in the design of milking machines.

The Surge Milker is our solution of these three distinct problems which you set before us. Whether we have mastered them to your satisfaction is for you to decide.

Problem 1—

[illegible]

Problem 2—

[illegible] The Surge has no claws. That problem is solved.

Problem 3—

[illegible]

[illegible]

[illegible]

Can your own faith then be any more definite?

[illegible]

[illegible] The teat is NOT washed in the milk. On average quarters the teat will be found perfectly dry when the teat cup is removed.

That is our story, gentlemen. We do not ask you to believe anything. All we ask is that you investigate. And we offer to place at your disposal every possible facility for investigating from every angle.

We shall be glad to refer you to Certified Farms, Grade "A" Farms, and ordinary dairy farms, located conveniently near you, where the Surge is in daily use. You will be furnished with full descriptive printed matter on request. In addition we shall welcome an opportunity to submit a Surge unit for examination.

Backing up our own statements we refer you to Bulletin No. 524, issued by the Geneva Experiment Station, after a series of tests of the Surge extending over a long period.

Remember, we are asking you to investigate FACTS—not PROMISES.

Very sincerely yours,

PINE TREE MILKING MACHINE CO.

we repeat!

"In order to produce CLEAN MILK the milker must be taken all apart and washed CLEAN after every milking"....

GENTLEMEN! ......

Eight years ago we published an open letter addressed to all authorities charged with the responsibility for guarding the milk supplies of the nation. . . Above is a reproduction of that letter. You can't read it, of course, but we will be glad to send you a full size copy. We want you to know the policy we have always followed. The original letter will be sent to you on request. Will you send for it?

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"When Writing Mention This Report"

and Nissen (1) than with those of Prucha (5) in regard to the relative susceptibility to corrosion of tinned steel and tinned copper.

Turning now to the effect of increasing alkalinity upon germicidal speed, we were unable, with the tecnique employed, to detect any slowing down until ratios of 1:7 to 1:9 were employed. With these solutions, a small percentage of the test organism survived after contact periods of ten and fifteen seconds (See Tables 1 and 2).

TABLE I

PERCENTAGE SURVIVAL OF *Str. lactis* No. 248.

	Diversol	Solutions J 1:7	Solution K 1:8	Solution L 1:9
	6 Tests	9 Tests	9 Tests	9 Tests
After 10 sec.	—	0.0267	0.088	0.259
" 15 "	28.57	0.058	0.014	0.0003
" 20 "	—	0.0	0.002	0.0
" 30 "	13.38	0.0	0.0	0.0
" 45 "	12.62	0.0	0.0	0.0
" 60 "	10.35	0.0	0.0	0.0

TABLE II

SUMMARY OF MILK TUBE INOCULATIONS

Str. lactis No. 248.

	Diversol	Solution J	Solution K	Solution L
After 10 sec.	xxxxxxx	x–xxxxx	x–xxxx–	x–xxxx–
" 15 "	xxxxxxx	———	——x—	—x——
" 20 "	xxxxxxx	·———	·———	———
" 30 "	xxxxxxx	·———	——x—	——x—
" 45 "	xxxxxxx	———	———	———
" 60 "	–x—x—	———	———	———

x=typical fermentation in 48 hours at 30° C.

However, compared with the effect of a strongly alkaline solution (Diversol) it is obvious that these solutions have a considerable advantage, while the marked reduction in corrosiveness as compared with the low ratio solutions makes them a much more acceptable product.

Since at this time it was believed that a further increase in alkalinity would have a marked effect upon the germicidal speed, no studies were made upon ratios wider than those already referred to. Instead, a series of can rinsing tests was conducted, employing solutions of mild, intermediate and strong alkalinity. For the former, Solution X (ratio 4:3) was chosen; Solution K (ratio 1:8) represented the intermediate type, while Diversol represented the strongly alkaline type. Sterilized cans were rinsed with a suspension of *Strept. lactis,* drained, then rinsed with one of the hypochlorite solutions (100 p.p.m.) for ten seconds, drained for five minutes, then rinsed with a 0.01% solution of sodium thiosulphate. This rinse was then plated out, using purple lactose agar (Difco) and incubating at room temperature for five days. In all, 103 cans were thus studied, the summarized data appearing in Tables 3 and 4. (These are depicted graphically in Chart 1.)

TABLE III

SUMMARY OF RESULTS OF CAN RINSING TESTS

	Diversol	Solution K (1:8)	Solution X (4:3)	Control
Number of cans examined	32	32	31	8
Average count from 1 cc. thio rinse	581	74	41	55,463
Median count	395	66	38	49,500
Average % survival	1.05%	0.133%	0.074%	

TABLE IV

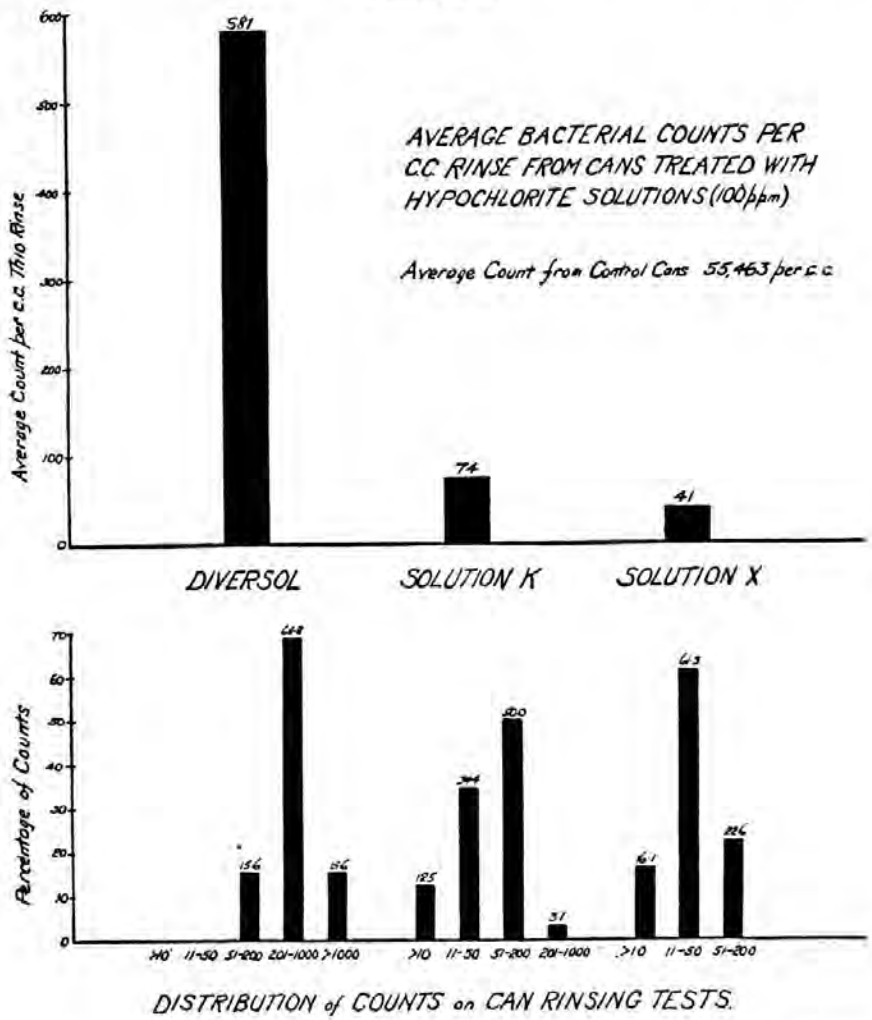
DISTRIBUTION OF BACTERIAL COUNTS ON CAN RINSING TESTS

	10		11–50		51–200		201–1000		1000	
	No.	%	No.	%	No.	%	No.	%	No.	%
Diversol	0	0.0	0	0.0	5	15.6	22	68.8	5	15.6
Solution K	4	12.5	11	34.4	16	50.0	1	3.1	0	0.0
Solution K	5	16.1	19	61.3	7	22.6	0	0.0	0	0.0

• Probably on account of the five minute interval between rinsings with the hypochlorite and thiosulphate, the difference between the strongly alkaline solution

(Diversol) and the other two is much less marked than in the laboratory tests. Nevertheless, it is evident that this solution is considerably less effective than the intermediate type (Solution K) which closely approaches the strongly corrosive neutral solution (X). Further

CHART I



corrosion tests were also made on Diversol and Solution K, with Solution C replacing Solution X as the more nearly neutral representative. In these tests, weighed duplicate strips were half immersed in 100 p.p.m. solutions in jelly jars, one set (I) being covered while the other (II) remained uncovered. The solutions were renewed every forty-eight hours. At the end of ten days at 30° C., the strips were removed, washed, dried and reweighed. Table 5 shows the changes in weight of the

TABLE V

LOSSES IN WEIGHT OF TINNED METAL STRIPS HALF IMMERSED IN HYPOCHLORITE SOLUTION[1] FOR 10 DAYS AT ±30° F.

	Tinned Steel		Tinned Copper	
	Covered	Uncovered	Covered	Uncovered
Diversol	1.4[x] mgm.	0.1[x] mgm.	0.1[x] mgm.	0.0 mgm.
Solution K	0.0 mgm.	0.7[2] mgm.	2.8 mgm.	1.8 mgm.
Solution C	2.8 mgm.	9.2 mgm.	8.0 mgm.	11.6 mgm.

[1] Strengths of Solutions 100 p.p.m. Av. Cl.
[2] Corner eaten away.
[x] Gain in weight.

strips. It is interesting to note that, in general, the tinned steel strips in the covered jars show a greater degree of corrosion than those in the open jars, while with tinned copper the reverse appears to hold true. However, in spite of variations in loss of weight resulting from weak spots in the tinning, etc., it is evident that Solution K shows much less corrosiveness than Solution C (which again is decidedly less corrosive than Solution X), although under this more severe test tinned copper was attacked quite strongly at the air-water line. Diversol, as usual shows little or no corrosiveness.

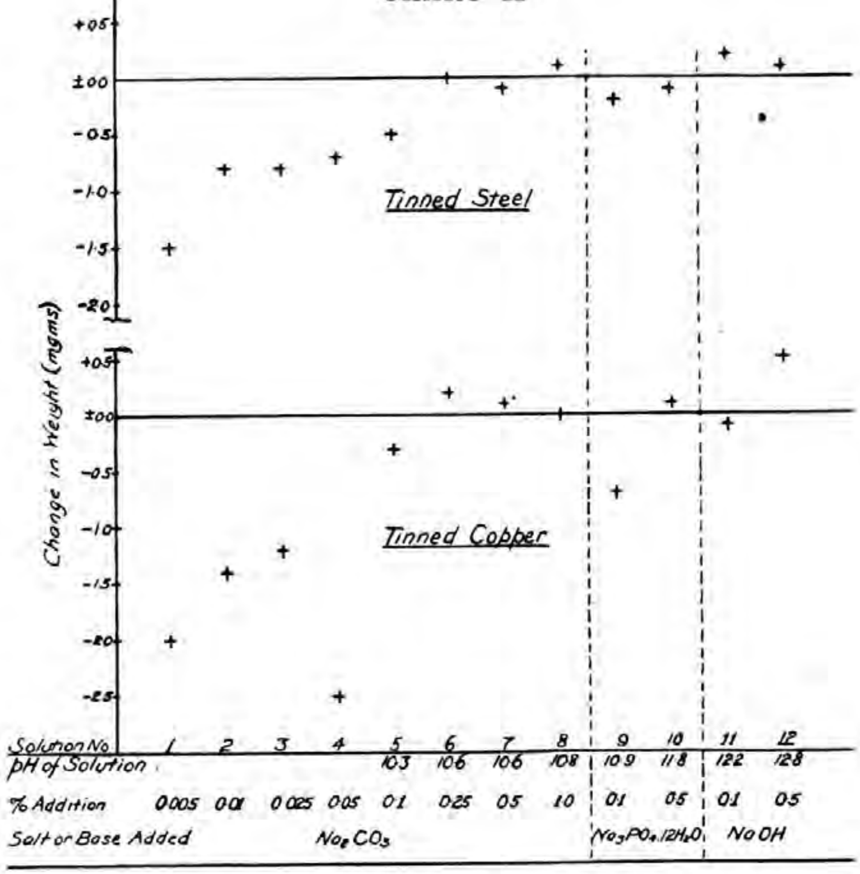
In view of the advantages of Solution K, it was decided to adopt this product for any sterilizing where corrosion would be an important factor, and, due to pressure of other work, this project was allowed to stand. However, a short time ago a paper by Quam (6) came to my attention. Quam reports the effectiveness of small additions (0.1% to 0.5%) of bases and salts to sodium hypochlorite in reducing corrosion and increasing stability, and also suggests that the germicidal power is not impaired thereby. In view of our previous results (2, 3), together with those reported by other workers (4, 7, 8, 9, 10, 12) it was felt desirable to extend our studies into the range more alkaline than that previously studied. Accordingly a further series of stock solutions having ratios of 1:12, 1:15, 1:18 and 1:24 were made up and tested out in the same manner as before. While the results obtained were more irregular than in the previous work it appeared that even at a ratio of 1:24 the germicidal action was still reasonably rapid. While the corrosiveness was further reduced, tinned copper was still attacked to an appreciable degree.

As stock solutions containing such large amounts of washing soda are inconvenient to prepare, in the next series of tests varying amounts of sodium carbonate (soda ash) were added to definite quantities of 100 p.p.m. solution prepared from calcium hypochlorite (HTH). Due to an error in calculation, the amounts added in the first series (Solutions 1-5) were only one-tenth of the required amounts; these solutions were therefore strongly corrosive and showed good germicidal speed. In the next series (Solutions 6-10) the range for sodium carbonate was extended up to 1.0%, while two solutions were prepared containing 0.1 and 0.5% of tri-sodium phosphate as recommended by Quam. Finally, a third series was conducted in which three solutions (5, 6 and 9) were repeated, while two new solutions (11 and 12), containing 0.1 and 0.5% of sodium hydroxide respectively, were also tested. Corrosiveness was studied by half immersing tinned strips in covered jelly jars for 48 hours at 30° C. The results of the germicidal tests appear in Table 6, while Chart 2 records the changes in weight of the metal strips.

In connection with the data summarized in the left-hand portion of Table 6, spreader and mould contamination on the poured plates has introduced a certain amount of irregularity into the results. Likewise, in the case of

Solution 12 the test organism failed to grow at all on account of the alkalinity of the medium. Consequently the results obtained with the milk tube technique afford a better indication of the relative germicidal speeds of the various solutions. It will be noticed that concentra-

CHART II



Changes in Weight of Tinned Metal Strips Half Immersed in Hypochlorite Solutions (100 ppm Available Chlorine) for 48 Hours at 30° C.

tions of sodium carbonate as great as 1.0% may be employed without any marked decrease in germicidal speed, while at 0.25% or higher the corrosiveness is practically negligible; 0.1% however does not afford sufficient protection against corrosion.

In the case of tri-sodium phosphate, although a 0.1% addition gives a slightly higher pH than that of a 1.0%

TABLE 6.—EFFECT OF ADDITION OF VARYING QUANTITIES OF SALTS AND BASES UPON THE GERMICIDAL SPEED OF A HYPOCHLORITE SOLUTION

				Percentage of Organisms Surviving						Milk Tube Inoculations					
				Period of Contact with NaOCl (seconds)						Period of Contact with NaOCl (seconds)					
No.	Salt or Base added	pH	No. of Tests	10	15	20	30	45	60	10	15	20	30	45	60
1	0.005% Na_2CO_3		3	0.0	0.0	0.0	0.0	0.0	0.0	---	---	---	---	---	---
2	0.01% "		3	0.0	0.0	0.0	0.0	0.0	0.0	---	---	---	---	---	---
3	0.025% "		3	0.009	0.0	0.0	0.0	0.0	0.0	---	---	---	---	---	---
4	0.05% "		3	0.054	0.05	0.036	0.0	0.0	0.0	--x	---	---	---	---	---
5	0.1% "	10.3	6	0.068	0.051	0.0	0.0	0.0	0.0	-x- ---	--- ---	--- ---	--- ---	--- ---	--- ---
6	0.25% "	10.6	6	0.025?	0.0	0.0	0.0	0.0	0.0	xx- xx-	--- ---	--- ---	--- ---	--- ---	--- ---
7	0.5% "	10.6	3	0.0?	0.0?	0.0	0.0	0.0	0.0	xx-	---	---	---	---	---
8	1.0% "	10.8	3	0.0?	0.0?	0.0	0.0	0.0	0.0	xx-	x--	---	---	---	---
9	0.1% $Na_3PO_4.12H_2O$	10.9	6	7.37	0.68	0.24	0.0	0.0	0.0	xxx xxx	xx- xxx	x-- x--	--- ---	--- ---	--- ---
10	0.5% "	11.8	3	58.9	48.9	31.7	21.3	10.7	3.56	xxx	xxx	xxx	xxx	xxx	xxx
11	0.1% NaOH	12.2	3	65.0?	81.5	49.1	28.4	22.8	16.0	xxx	xxx	xxx	xxx	xxx	xxx
12	0.5% "	12.8	3	?	?	?	?	?	?	xxx	xxx	xxx	xxx	xxx	xxx
	Diversol		6	—	28.6	—	13.4	12.6	10.4	xxx xxx	xxx xxx	xxx xxx	xxx xxx	xxx xx-	xxx -x-

N.B. x = typical *S. lactis* fermentation after 48 hours at 30° C.

addition of sodium carbonate, the corrosiveness is decidedly more marked. In addition the solution containing 0.1% of tri-sodium phosphate shows a reduction in germicidal speed as compared with 1.0% of sodium carbonate. Consequently, the phosphate cannot be considered as satisfactory as the carbonate in either respect. In the case of 0.5% of phosphate, germicidal speed is impaired so greatly as to render this solution unsuited to general use for rinsing or spraying. Sodium hydroxide, added in the quantities reported by Quam, has an even more strongly depressing effect upon germicidal action.

In all the tests reported so far small percentages of salt or base were added to 100 p.p.m. rinsing solutions made up from calcium hypochlorite stock solution. Quam, however, has apparently been interested mainly in spraying solutions, having employed a basic solution of sodium hypochlorite containing 255 p.p.m. available chlorine. In order to check his results more directly, a basic solution of sodium hypochlorite having a chlorine

TABLE VII

CORROSION OF TINNED METAL STRIPS HALF IMMERSED IN HYPOCHLORITE SOLUTIONS (225 P.P.M. AV. Cl.) FOR 48 HOURS AT ±30° C.

No.	Salt or Base Added	Change in Weight Tinned Steel	Tinned Copper
13	0.1% Na_2CO_3	−0.3	−1.1
14	0.5% "	−0.1	−0.2
15	0.1% $Na_3PO_4.12H_2O$	−0.8	−1.4
16	0.5% " "	±0.0	±0.0
17	0.1% NaOH	−0.1	−0.6
18	0.5% "	−0.2	+3.0(?)

concentration of 255 p.p.m. was prepared from Solution C (ratio 1:2). The results of the corrosion tests appear in Table 7. As one would expect, the increased chlorine content has resulted in an increase in corrosiveness where only 0.1% additions of salt or base have been made; where 0.5% was added, corrosion is practically the same with 255 p.p.m. as with 100 p.p.m. available chlorine.

TABLE VIII

RESULTS OF MILK TUBE INOCULATIONS FROM HYPOCHLORITE SOLUTIONS[a]

Solution No.	Addition	Period of Contract of Test Organism[3] with Hypochlorite Solutions (seconds)					
		10	15	20	30	45	60
13	0.1% Na_2CO_3	——	——	——	——	——	——
14	0.5% "	——	——	——	——	——	——
15	0.1% Na_3PO_4 12 H_2O	xxx–	——	——	——	——	——
16	0.5% "	xxxx	xxxx	x–xx	x——	——	——
17	0.1% NaOH	xxxx	xxxx	xxxx	xxxx	xxxx	xxxx
18	0.5% "	xxxx	xxxx	xxxx	xxxx	xxxx	xxxx

Four series of milk tube inoculation tests were conducted on the above solutions, the result of which appear in Table 8. Here again the effect is exactly what one would expect, the stronger concentration of chlorine increasing the germicidal speed to a measurable degree. This is particularly noticeable in the case of the solution containing 0.5% of tri-sodium phosphate. The solutions to which sodium hydroxide was added are still too slow for any effect to be observed within one minute, so no direct evidence of increased germicidal speed was obtained.

Since there are so many other phases of this problem upon which no work has been done, it would be unsafe to draw too sweeping conclusions. It does seem, however, that Quam is in error in recommending the employment of tri-sodium phosphate and sodium hydroxide in the concentrations reported. Sodium carbonate, on the other hand, may be employed in concentrations as high as 1.0% without interfering too seriously with germicidal speed, while corrosiveness is practically eliminated. Apparently too, there are other factors in addition to pH which influence the corrosiveness and germicidal speed, while these two characteristics of a hypochlorite solution do not always show a parallel decrease with increasing pH.

Summary

It would appear that hypochlorite solutions for rinsing and spraying purposes may carry considerably higher alkalinity than is customary. The proper degree of alkalinity diminishes corrosion without interfering too seriously with germicidal speed. This desirable combination may be achieved by the addition of sodium carbonate to the rinsing or spraying solution to give a concentration of 0.25 to 0.5 per cent.

Acknowledgement

The writer wishes to acknowledge the assistance of Mr. D. G. Hewer, B. S. A., in connection with the germicidal tests reported in this paper.

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REPORT OF COMMITTEE ON LABORATORY METHODS

GEORGE E. BOLLING, *Chairman*

At the 1930 convention of the Association a paper by Dr. H. G. Harding presented a method for estimating the keeping quality of milk that was considered well worth investigation by this committee.

The method proposed was described by the author, as follows:

> "PROPOSED METHOD OF MEASURING KEEPING QUALITY.
>
> "For the estimation of keeping quality of milk the following test is proposed: The sample of milk is placed in air at a temperature of 68° F. and the time determined for an increase in titratable acidity of 0.06 of one per cent acid, calculated as lactic acid. The temperature of 68° F. has been selected as standard as it is approximately the average temperature to which milk is exposed under customer conditions. By experiment it is found that with an increased acidity of 0.06 per cent milk begins to have a slight acid taste. However, many people do not detect by taste an increase in acidity until it is much greater. Changes other than souring may be observed by noting the odor of the samples.
>
> "This test has the advantage that it measures approximately the length of time that the milk will remain usable under customer conditions. Very little apparatus is required for the test; merely a supply of standard alkali (preferably tenth normal sodium hydroxide), a burette, a titration dish and stirring rod, a supply of phenolphthalein indicator solution, a pipette for measuring the milk for titration, and an incubator at 68° F. However, an initial sample of 100 cc. is required, and a half-pint sample is better. The holding time required varies with the grade of milk examined but will practically always be 48 hours or less. Under laboratory conditions the samples may be tested for acidity at the start of the holding period and at the beginning and end of the day's work until soured. From these data the approximate time of souring may be calculated."

Later that year in a bulletin of the Dairy Research Bureau of the Mathews Company, Dr. H. A. Harding strongly endorsed the method and stressed its applicability to official supervision of milk supplies. He made the point that many supervising officials who lacked sufficient funds to provide for bacterial plate counts could substitute the increase in titratable acidity method at less expense.

In undertaking the work your committee soon found themselves unable to agree with the assertion that the temperature of 68° F. represented "approximately the average temperature to which milk is exposed under customer conditions," this being given as the reason for selecting that temperature. The manufacturers of electric refrigerators state that there are upwards of a million such in use at the present time and that they regard the market as but 10% saturated; and about every one must have been impressed with the activity of the manufacturers to reach the point of saturation for this article.

Moreover, the number of ice chests in home use must run into the millions. An interesting feature in this connection is that certain dealers in ice have stated that the advertising campaign of the electric refrigerator concerns in stressing the necessity of keeping food at a low temperature has, to a certain extent, reacted to their benefit; many families who for one reason or another did not invest in an electric refrigerator began to take ice the entire year.

Our feeling in this respect is that a lower temperature than 68° more truly represents average customer conditions and that as time elapses this difference will become more general.

Our next difficulty was in reconciling the market prices for a 68° incubator with the idea that such equipment could be had more cheaply than the apparatus required for bacterial plate counts. Prices quoted for a guaranteed 68° incubator varied from $800 for a size which appeared of rather inadequate capacity to $1200 for one that seemed more suitable. We have been given to understand, however, that one of the larger electric refrigerator concerns is interested in the matter of supplying a cabinet that can be maintained at 68°, which may render it available at a figure more compatible with the means of the average milk inspection laboratory.

No member of the committee had available a 68° incubator but several were desirous of ascertaining the applicability of the proposed test at a temperature of 50° F. which we felt more nearly approximated customer or household conditions.

But a few tests were necessary to show that the method was inapplicable both for keeping the samples at room temperatures of about 80° F. or in the regular laboratory incubator at 37° C. as all such samples, regardless of the initial bacterial count, or whether raw or pasteurized, soured much in excess of .06 acidity during the first 24 hours.

Such work as was done with holding at 50° in the refrigerator, indicated that the time necessary to effect an increase in titratable acidity, both in raw and pasteurized milk to be not less than 96 hours and in many instances 120 hours did not suffice.

The numerous titrations required, two daily on each sample, for five days in some cases, required considerable time in the aggregate. Also the volume necessary for so many titrations requires at least a 10 oz. sample. It became obvious that if many samples per day were run, considerable storage capacity would be required.

In the original article by Dr. H. G. Harding and also cited by Dr. H. A. Harding instances are given of numerous samples of high count milk acquiring the .06 increase in acidity in a 10 hour period. This period of time has been objected to by some as impossible of incorporation in the work of the average municipal or state laboratory which average a shorter working day, even without taking into account the time involved in titrating a large number of samples.

The authors quoted, may state, with entire justification, that we have proved nothing as to the merits of the proposed test by such work as we have done. The universal absence of 68° incubators, however, suggested trying the test by such means as were at our disposal. If such a cabinet becomes available at a reasonable price more work at the particular temperature specified should certainly be done by this committee, if the test is seriously proposed as a substitute for the plate count.

Several members of the committee after trying the method felt that the time and labor consumed in the repeated titrations and consequent calculations so much exceeded that involved in plate counts as to create an unfavorable impression. These observations are based on the method as given by the authors. It has been suggested by one of this committee, however, the tedious calculations could be eliminated by the use of a nine gram pipette, in that it would be possible to read the percentage of acidity directly from the burette.

To illustrate how the method may consume an impossible amount of time:

If a laboratory receives fifty samples one morning and titrates each, an allowance of three minutes per sample for measuring and titration would require two and one-half hours at both beginning and close of the first day. If these samples all required two more titrations the second day another five hours would be required.

If a second set of fifty samples were received the second day a total of ten hours would be spent in titrations that day. If, as the authors state, the titrations are to be done at "the beginning and end of each day's work until soured," the services of several technicians in both day and night shifts would soon be devoted exclusively to titrations in laboratories receiving any considerable number of samples each day.

The committee believes that application of increase in titratable acidity data to official milk supervision could be fraught with as many difficulties as there now are in the application and interpretation of bacteria count control. Moreover, the length of time which a bottle of milk will keep will give us little information in those cases where milk keeps a short time.

We request that this report be considered and accepted as one of progress rather than as final.

As empowered by this Association in 1923, we have continued to examine dehydrated media intended for use in plate counts of milk. Our approval was given to the product of the Digestive Ferments Company.

Friday, September 11
2.00 P.M.

USE OF A PHOTOGRAPHIC STANDARD IN THE MICROSCOPIC EXAMINATION OF RAW MILK

KENNETH M. ROYER

Pure Milk Association, Chicago, Ill.

In order to make the work herein outlined entirely clear to all, it is necessary to outline briefly, first, the type of organization in which it is used, second, the personnel or force available to do the work and third, the condition which made the work necessary.

The Pure Milk Association is a co-operatively operated farmers' organization delivering milk direct from its producers to the distributors in the Chicago area. It operates entirely on a bargaining basis, owning no plants, buying or distributing no milk. It consists of approximately 20,000 farmer members. One of the divisions of this organization has been named the Laboratory Field Service Department. It is the duty of this division to render such service as the members need and call for in connection with the laboratory work involved in the marketing of raw milk. The work consists of the following:

(1) The checking of butterfat tests and weights of milk delivered by members of various plants.

(2) An insurance involving payment for milk shut off from market due to contagious disease in the producer's family.

(3) Quality work for the protection and help of members.

Including:

(a) Assisting buyers to locate special troubles when producers are involved.

(b) Assisting members to comply with Health Department requirements in regard to bacteria count of raw milk.

(c) Aiding members to meet demands of buyers in all phases of quality.

(d) Helping members, as a group, to deliver a quality product that will insure them of a market for their milk.

The organization available to handle this work includes 25 men, 16 of whom are located in country territories and 9 operating in the city plants and central laboratory which is located at the head office of the Association.

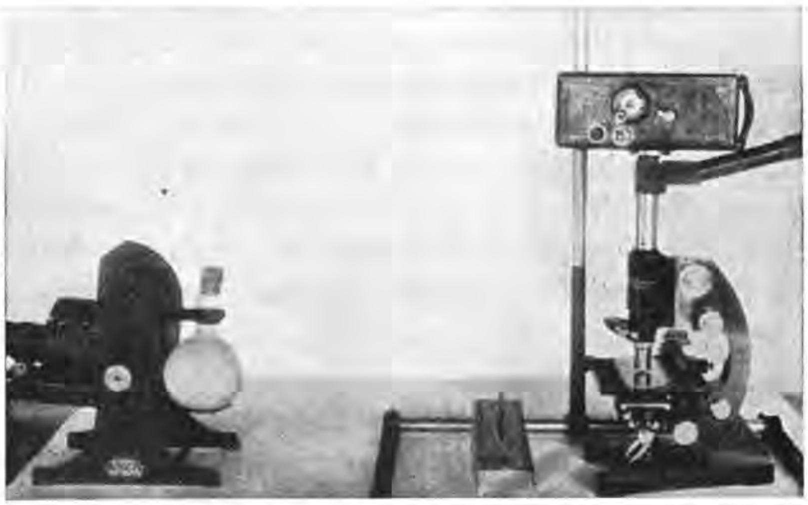
Being a farmers' organization, it is supported entirely by funds coming direct from the farmers. Considerable demand developed which necessitated a definite program of service with reference to quality problems. This program is designed along purely educational lines, there being no power in the hands of the fieldmen of the Association to shut off or discriminate against milk of undesirable quality. The problem being to show the members where the trouble was and advising them as to how it could be eliminated. In many cases the members were found already shut off from the market; in other cases threatened shut-offs were existing which made the problem of the Association to either help the member to produce milk of low count so he could be put back on the market, or rectify present conditions and forestall a shut-off.

After considerable experience in field work in an effort to handle these problems, the Breed direct microscopic method of examining milk was adopted. The general technique involved is completely and thoroughly explained in bulletin No. 566 of the New York State Agricultural Experiment Station, Geneva, New York and circular No. 58 of the same station. The fieldmen either in the country territory plants or city plants are not trained technicians in all cases; all of their work must be done under milk plant receiving room conditions, which necessitated a change from the regular methods of technique in that a platinum loop holding approximately .01 cc. is used in place of a pipette and the smears are made in the form of a circle of one square centimeter area instead of the usual squares. This deviation from the standard method speeded up work sufficiently so that samples could be obtained without difficulty of all milk received by one operator in the receiving room. The inaccuracies introduced by this variation in technical methods were found not to be of serious consequence, due to the fact that greatest emphasis is placed on types of bacteria rather than exact numbers present.

The quantitative determinations were arranged to compare with the standard classifications used in the operation of the Methylene Blue Test. A code was worked out on this basis including capital letters for the quantitative determination and numbers for the qualitative determination. The smears taken in the country are mailed to the central laboratory for staining and examining. The smears taken in the city, of course, are stained and examined as soon as they are brought in by the fieldman who made them. Due to the fact that the types of organisms present in the milk were of greatest importance, considerable work was done in taking smears and immediately following up conditions in the country confirming the judgment of the technicians who examined the slides. The results of the examination are mailed to the country fieldmen the same day the slides are received so that immediate follow up can be made by the fieldman in the territory.

It became necessary after the preliminary work in this connection to train the fieldmen regarding the interpretation of the information sent back to him from the head laboratory. It then followed that the fieldman himself, through educational means must explain to the producer the condition of his milk and just exactly why he was to do the things that were asked of him. For example, the man examining the smears quite often finds evidence of udder trouble of serious nature. The fieldman, not a technician, would not know what was meant by a report of this type except that the trouble was found in the cows themselves. In turn, if the farmer was informed that certain cows in his herd were causing trouble, he must be convinced, in order to obtain the necessary co-operation in eliminating the trouble. It was quite evident that no ordinary amount of explaining would get it straight either to the fieldman or to the producer in a way that would get the results that were desired. This condition brought up the possibility of photograph work which would give the fieldman a rather clear conception of what the sample of milk actually looked like and at the same time give him something he could show the producer when explaining the condition. The visual method is undoubtedly superior in getting a definite idea across to the farmer. It was possible with this method to show bacteria which are commonly found, also the appearance of milk of high bacteria count, as compared to a low count. Few producers realize the actual significance of bacteria in milk and, of course, it being impossible to show each one through a microscope, the following methods were adopted to bring this information to the fieldman and producer in a way that could be easily grasped by both.

During the process of examining smears in the laboratory, smears of the most typical bacteria groups were saved for photograph work. The arrangement made for photographing these was finally arrived at by using standard 35 millimeter movie film in any "Still" camera designed to handle it. The Leica camera manufactured by the Leitz Company and the DeVry "Still" camera were both used.



Equipment used to take photographs for photographic standard, using 35 mm. movie film.

Each camera holds sufficient film to take in the neighborhood of 40 photographs of 35x70 mm. frame size. The Leica camera was used with lens by placing it directly over the microscope supported by a stand provided. By the use of the demonstration extension arm directly connected with the ocular and the camera being placed directly over the microscope, the operator could look in from one side and do the necessary focusing, picking out desired fields before the photographs were taken. A special light was provided as well as the proper filters necessary with the Methylene Blue Stain in order to obtain definition and contrast in the photograph. Pancromatic film was found to give the best results. The film, after exposure, was developed in the usual way with equipment provided for tank developing, using slow, non-grain developers. The negative film thus obtained was used for making prints which were enlarged sufficiently to give the necessary effect. From these negative films, positive films were produced which were used for projection purposes where possible.

The equipment necessary to do this work is of comparatively small cost considering the value of the visual methods. Although the best results were obtained by the Leica camera, very fine photographs were made by using a DeVry film camera by removing the lens and using an adapter made of sponge rubber which was cut out to fit the ocular of the demonstration arm to exclude the light from the film of the camera. Focus correction, of course, must be made to allow for the space intervening between the ocular and the plane of the film exposed. This can be obtained by adjusting the eyepiece on the demonstration side arm. The actual equipment, therefore, in addition to the microscope consists of only a light for photographic work, the necessary filters for photographing Methylene Blue Stained preparations and demonstration side arm ocular for the microscope. If the film is to be developed by a commercial house, the above equipment is all that is needed. If, however, the developing and printing is to be done in the laboratory, an enlarger, developing tank and chemicals, as well as a printing apparatus for making positive film is needed in addition to the above equipment.

With this equipment available in the laboratory, it is possible to take samples from a group of producers' milk and examine the smears, take necessary photographs of the most outstanding difficulties apparent from the microscope examination and prepare positive film strips for project purposes used in meetings of these same shippers a few days later. It has been found that this rapid and definite work along educational lines brings a new and greater realization to the producer as to what the production of quality milk actually means from the bacteriological standpoint.

The results of this work at the present writing are very outstanding. Although the greatest feature in the accomplishment is the fact that by the use of the microscope, various types of bacteria can be identified, the photographic standard aids materially in speeding up results purely due to the fact that the producer himself sees what the technician in the laboratory finds when the samples of milk are examined. Where it has been noted that unusually large quantities of milk were being returned by buyers on a basis of bad odor or flavor, samples have been taken and examined at once, following which a meeting of the producers involved was called and by careful explanation accompanying the projection on the screen of conditions found, immediate improvement has been evident. From the standpoint of the fieldmen operating under this plan, it has been noted that increased confidence is being placed in the men themselves by the producers which has been due to the fact, very largely, that all fieldmen have a set of photographs showing the general type of organisms present in their milk which was the cause of the impaired quality. This increased confidence enables the fieldmen working along educational lines to get results, which undoubtedly would not be possible were it not for this definite system.

BANG'S DISEASE IN RELATION TO MILK

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Bang's Disease or Bovine Infectious Abortion has for many years been a source of trouble to the Livestock Industry. Since the discovery in quite recent years that Undulant Fever in man is also caused by *Brucella abortus*, this organism has assumed importance from the Public Health standpoint. The first reported case of this infection in man appears to have been that recorded by Keefer (1) in 1924.

Without entering into controversial detail it may be said that the evidence is quite clear that Undulant Fever occurs in man through the ingestion of milk of infected cows and by contact with infected material. Most strains of *Brucella abortus* of bovine origin are of low virulence for man under ordinary circumstances, and either do not produce the disease or give rise to an infection of such a mild type that it is not recognized. On the other hand, some strains from cattle, whether or not primarily of bovine origin, are capable of producing the disease. For this reason any infected milk supply is a potential danger.

Result of infection on milk yield. When a cow aborts the quantity of milk she gives is less than she would have given had she carried her calf to full time. McAuliff (2) reported that in reply to a questionnaire, ninety breeders estimated their milk losses due to abortions at from 0 to 75%. Many milk producers have told us that their losses from this cause have ranged from 25% to 50%. In one herd of twelve animals five aborted within two months and the owner's income from the sale of cream dropped from an average of \$20 to \$25 a week to \$10 and less. It is more difficult, however, to obtain figures on the reduction in milk yield of infected animals that do not abort. White *et al* (3) reported that the non-reactors in the Station herd returned \$28.41 more in milk value than the reacting cows. Sims and Miller (4) found that the milk production per cow in the infected group was 35% less than the clean group. Sims *et al* (5) later found over a three year period that the infected cows gave 28% less milk. A reduction in butter fat was observed in six of eight half-sisters that became infected. The two uninfected animals exceeded their estimated average. In one of the herds we have recently taken over under an area eradication plan the owner reported that four of his best cows had dropped from 25% to 50% in their milk yield and gave less butter fat, a reduction from 3.5% to 2.9% in the worst case. These four animals were positive to the agglutination test and the remainder of the herd were negative. There was no clinical evidence of mastitis. Birch and Gilman (6) produced a transient inflammation of the udder by feeding *Br. abortus*. Runnels and Huddleson (7) and Sholl and Torrey (8) have shown the presence of interstitial mastitis due to infection with this organism. Sims and other workers have shown that mastitis is more prevalent among positive than negative animals. Such changes in the mammary gland would account for a decreased efficiency in those cases where abortion has not taken place.

Importance of the udder as a reservoir of infection. In the course of routine and experimental work we have examined the milk of 89 cows by guinea-pig inoculation, which method in our hands has proved more satisfactory than cultures. Composite samples or individual samples of each quarter were employed according to the object of the examination. Thirty-six cows had a serum titre of 1:000 at the time the milk was collected. *Br. abortus* was recovered from twenty-four (66.6%). Nine animals had a titre of 1:500. *Br. abortus* was recovered from four (44.4%). Six had a titre of 1:250 and the organism was present in five of the six (83.3%). Twenty-two cows had a titre of 1:100. *Br. abortus* was recovered from the milk of four (18.1%). Ten animals had a serum titre of 1:50, which we class as suspicious. These ten samples all proved negative for *Br. abortus*. Six samples were from negative cows in infected herds and were all negative for this organism. Cooledge (9), King (10) and Fitch and Lubbehusen (11) have reported the isolation of *Br. abortus* from negative cows. The writer has encountered a few infected guinea-pigs that were negative to the agglutination test. It is evident that infection may exist without agglutinin production, but such cases are probably few in number.

In the seventy-three positive cows (1:100 and higher) the highest percentage of infected udders occurred among the cows with a titre higher than 1:100. However, eighteen per cent of the animals with a titre of 1:100 had infected udders. Gilman (12) reported that he was unable to recover *Br. abortus* from the udders of cows with a blood titre lower than 1:320. Thirty-seven, or 50.6% of our positive animals were shown to harbour *Br. abortus* in the udder. Repeated tests would doubtless have given a higher percentage. In this connection it is interesting to note that in some recent work with full-term, positive cows the writer recovered *Br. abortus* from the placental membranes of five out of thirty-four cases (14.7%), whereas the organism was recovered from the milk of eighteen out of thirty-two of the same animals (56.2%).

It is evident from these figures that the udder is the most important reservoir of infection. The animal that aborts is probably the most dangerous disseminator of infection, but apart from this, milk may well be a more dangerous agent than the placental membranes and discharges of full-term, positive cows.

Certified milk. Since *Br. abortus* has been added to the list of organisms pathogenic for man it is obvious that to meet the requirements of certified milk production a herd must be free from Bang's Disease. About eighteen months ago the writer purchased a pint of certified milk from a local dairy. Cultures were made and guinea-pigs were inoculated with 5 cc. and 10 cc. of cream by the intra-abdominal route. *Br. abortus* was isolated from this bottle by animal inoculation, and well-marked lesions of tuberculosis also developed in those animals that were held longer than our regular forty day period.

A pint of certified milk was purchased from another dairy. *Staph. aureus* predominated on culture, and inoculated guinea-pigs died from peritonitis due to this organism. A second bottle of certified milk from this dairy did not yield *Br. abortus* but this organism was recovered from the third pint. The strains isolated were of low virulence for guinea-pigs and fell into the bovine group under Huddleson's dye plate classification (13). Meyer *et al* (14) and other workers have referred to the isolation of *Br. abortus* from certified milk.

These results emphasize the danger of certified milk. A product which offers, as it does, a feeling of security to the purchaser, lays a heavy obligation upon those responsible for its production.

Pasteurized milk. This year Carpenter and Boak (15) reported that 205 samples of pasteurized milk and cream, collected in thirty-eight cities and twelve villages, were negative for *Br. abortus* by guinea-pig inoculation. They also found that temperatures of 142° F. and 145° F., for twenty and thirty minutes, on the most virulent strains of *Br. abortus,* were found satisfactory for pasteurization.

The writer has examined samples of pasteurized milk from badly infected herds with negative results. Our strains have been destroyed by ten to fifteen minutes exposure at 140° F. in sealed ampoules.

As milk is not the only source of infection to man, pasteurization, while safeguarding the milk, does not remove the danger from other sources. We must, therefore, look to eradication of this disease as our final goal, in the interests of both Public Health and the Livestock Industry.

The agglutinin titre of milk compared to the serum titre and guinea-pig inoculation results. Cooledge (16) demonstrated the presence of agglutinins in the milk of cows with infected udders. Mitchell and Humphreys (17) found that where the milk was negative for agglutinins and complement-fixing bodies animal inoculation was also negative; but where animal inoculation proved positive, the milk of that quarter reacted to the agglutination or complement-fixation test. They found in several instances that the milk reacted to both tests but *Br. abortus* was not demonstrated by animal inoculation. Fitch and Lubbehusen (18) did not find evidence of correlation between milk agglutinins and infection of the udder. Gilman (19) did not recover *Br. abortus* from milk with a titre below 1:80 but did recover the organism from 53.7% of the samples with a titre of 1:80 or higher.

The writer examined samples of milk from the individual quarters of the udders of twelve positive or suspicious cows. Subcutaneous injections of 5 cc. of cream were made in guinea-pigs. The milk was coagulated by the addition of commercial Rennet and the blood serum and whey were tested for agglutinins in dilutions of from 1:25 to 1:10,000. The inoculated guinea-pigs were chloroformed forty-five days later, their serum was tested for agglutinins and cultures were made from the spleen and liver, and other organs showing lesions. The results are given in Table 1.

A few guinea-pigs died from intercurrent infections, but in those cases where results are available they agree

TABLE I

SERUM AND MILK TITRES AND GUINEA-PIG INOCULATIONS

No. of cow	Serum Titre	Whey Titre R.F.	R.H.	L.F.	L.H.	Guinea-pig inoculations R.F.	R.H.	L.F.	L.H.
67	1:250	1:250	1:100	1:1000	1:100	+	+	+	died
68	1:1000	1:50	1:100	1:100	1:50	+	+	+	+
69	1:100	—	—	—	—	—	—	—	—
76	1:100	—	—	—	—	—	—	—	—
78	1:50	—	—	—	—	died	—	—	—
84	1:500	—	—	—	1:50	—	—	—	—
90	1:1000	1:1000	1:500	1:250	1:250	—	+	+	+
95	1:500	1:100	1:25	1:100	1:25	—	—	—	—
99	1:1000	1:250	1:50	1:100	1:100	+	+	+	+
105	1:1000	1:500	1:500	1:250	1:250	+	+	died	+
107	1:1000	1:250	1:50	1:100	1:100	+	—	+	+
108	1:50	—	—	—	—	—	—	died	—

with those of Mitchell and Humphreys. The number is too small to draw conclusions from, but the indications are that the examination of milk serum offers a means of detecting cows with infected udders. *Br. abortus* was not recovered from two udders in which one or more quarters reacted. Experience, however, has shown that the organism cannot be regularly isolated from all infected udders. The value of this method, if it proved satisfactory, might be considerable, as it is not possible to detect udder infection from the blood serum titre. Frequent examinations would probably be necessary because there is nothing to suggest that a clean udder in a reacting cow might not become infected at any time.

It is interesting to note that the left front quarter of No. 67 had a titre of 1:1000. The serum titre was only 1:250 and the other quarters were 1:250, 1:100 and 1:100. Gilman (19) records a similar observation, which taken in conjunction with the fact that cows with positive blood serum may have negative milk, supports the contention of Smith, Little and Orcutt (20) that the udder is responsible for the production of agglutinins in milk.

Summary

Cows that abort give less milk than those that carry to full term. The results of many workers suggest that infected cows, that do not necessarily abort, give a lowered milk flow.

The udder appears to be the most important reservoir of infection. It is suggested that milk may well be a more dangerous source of infection than the placental membranes of full-time, positive cows.

Br. abortus was recovered from the milk of two herds producing certified milk. Tubercle bacilli were also present in one sample.

Pasteurization, properly carried out, destroys *Br. abortus,* but as milk is not the only source of infection to man eradication of the infection should be the ultimate goal.

The agglutinin titre of milk may prove to be of value in the detection of infected udders. The serum titre in positive cows (1:100 and higher) is not of value for this purpose. The percentage of infection was greater in the higher titres but *Br. abortus* was recovered from 18% of the cows with a titre of 1:100.

Milk with a higher titre than serum in the same cow, and negative milk from cows with a positive blood reaction support the contention of Smith, Little and Orcutt and Gilman that agglutinins in milk are produced by the mammary gland.

Acknowledgements

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BRUCELLA ABORTUS INFECTION OF THE UDDER

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Following the discovery by Schroeder (1) and Smith and Faybean (2) that the *Brucella abortus* was contained in the milk of animals, Schroeder drew attention to the possible harmful effects of this organism upon human beings. He had no experimental evidence to support his views but he pointed out that the organism was pathogenic for various experimental animals and might possibly be pathogenic for man. Since the organism is excreted in the milk of many infected animals he drew attention to the ease by which man might be infected if he were susceptible. He believed that the milk consumer should be protected against this organism on account of its potential pathogenic properties. Considerable attention was aroused at that time but interest gradually waned and soon the problem was almost forgotten. In 1918 when Miss Alice Evans (3) discovered the relationship between the *Brucella abortus* and *Micrococcus melitensis,* interest was again stimulated in the possible pathogenic properties of the *Brucella abortus* with the result that its etiological relationship to certain human febrile infections was brought to light. Thus we see that the deduction made by Schroeder has been amply justified in the course of time.

Few organisms cause such varied clinical conditions as the *Brucella abortus.* In the bovine, porcine and caprine hosts it causes no marked clinical manifestations of infection save the act of abortion and the pathological lesion resulting from its presence are few indeed. In fact with the exception of the pathological changes brought about in the placentae of pregnant animals scarcely a lesion of note has been found. In small laboratory animals, such as the guinea-pig and the rabbit, the organism causes very gross pathological changes which frequently result in a septicaemia and death. The liver, spleen, lymphatic glands and even the joint and bones may be attacked. In the horse the organism appears to occasionally localize in the ligamentum nuchae and causes necrotic changes. With this exception the horse is relatively immune. In man the organism occasionally colonizes producing clinical symptoms often marked by a prolonged undulant fever accompanied by prostration. Thus we see that the various manners in which the various species of animals react to this invading organism is unusual.

In cattle the infection has many interesting aspects. As an illustration it is interesting to note that even today after thirty-five years of intensive investigation we are unaware of all the tissues in which the organism permanently colonizes. You are, of course, familiar with the uterine infection but it must be remembered that this is only a temporary infection and a few weeks after the emptying of the uterine cavity the *Brucella abortus* disappears from it. In spite of this disappearance the animal usually continues as an infected individual and capable of transmitting the disease to other susceptible animals. In our Institute we have attempted to discover in what tissues of the cow's body the organism permanently colonizes and I believe that a knowledge of this point should be of importance in the epidemiology of this infection.

This brings me to the question of considering one of the tissues which has been shown to be an important factor in permanently harboring the *Brucella abortus*. For reasons which are self-evident the importance of

Brucella abortus infection of the udder not only in transmitting the infection from animal to animal but from animal to man is easily realized.

Mammary Gland Infection

We have no accurate data concerning the number of infected animals which harbor the *Brucella abortus* in their mammary glands since in order to obtain this data it would be necessary to study thousands of animals and many different herds. Doubtless the pathogenicity of the organism and the resistance of the host play a part in this particular type of infection. It is, therefore, altogether likely that different herds show different percentages of infection of the mammary gland. The question, however, has been superficially studied and several different workers have contributed valuable information in regard to this subject. Cooledge (4), Fitch (5), Gilman (6), Gwatkin (7), Mitchell and Humphreys (8), have all contributed information bearing on this subject. These authors and others are in agreement that a number of animals in an infected herd harbor the *Brucella abortus* in the udders.

The question of how long the udder continues as an infected organ is one that at present must be left unanswered. From our studies we know that many animals excrete the *Brucella abortus* from the mammary gland from the time of infection to the death of the animal. The organism is not given off constantly but may appear in the milk intermittently. The question of mammary gland infection is being intensively studied in our Institute at the present time and data has been collected which we believe will be of interest and value.

The Diagnosis of Udder Infection

It is remarkable that this organism may colonize in the udder and remain present for so many years without causing marked physical disturbances. It is true that the udder has apparently a lowered resistance against pathogenic micro-organisms but generally speaking no clinical evidence of udder infection is present.

By guinea-pig inoculations, especially if these animals are allowed to live for a considerable period of time we can discover the animals with infected udders but this method is impractical and no use can be made of it for practical purposes.

Cooledge (4) pointed out the presence of agglutinins in the milk of infected animals. Smith, Orcutt and Little (9) showed that by introducing killed organisms into the mammary gland the formation of agglutinins was stimulated locally. This suggested to us that in some instances *Brucella abortus* infection was altogether an udder infection and that the blood titre was dependent upon the local formation of agglutinins in the udder or at least upon the stimulation brought about by the local focus of infection. To study this point Mitchell and Duthie (10) removed the udders from two high reacting animals and the following tables will show the decline of agglutinin titre.

TABLE I

AGGLUTINATION TITRES (COW No. 132)

Date	Remarks	Agglutination end point	Days after removal of udder
July 24, 1928		1 : 10	
Oct. 2, 1928		1 : 10	
Nov. 3, 1928		1 : 10	
Dec. 10, 1928		1 : 100	
Feb. 4, 1929		1 : 400	
Apr. 24, 1929		1 : 600	
Apr. 29, 1929	Udder removed		
May 8, 1929		1 : 600	9 days
May 14, 1929	Aborted		15 days
May 15, 1929		1 : 600	16 days
May 21, 1929		1 : 400	22 days
June 10, 1929		1 : 400	42 days
June 26, 1929		1 : 400	58 days
July 8, 1929		1 : 400	70 days
July 29, 1929		1 : 200	91 days
Aug. 6, 1929		1 : 100	99 days
Aug. 14, 1929		1 : 100	107 days

TABLE I—(Continued)

AGGLUTINATION TITRES (COW NO. 132)

Date	Remarks	Agglutination end point	Days after removal of udder
Sept. 17, 1929		1 : 50	141 days
Oct. 23, 1929		1 : 50	177 days
Dec. 11, 1929		1 : 50	226 days
Dec. 26, 1929		1 : 25	241 days
Jan. 21, 1930		1 : 25	267 days
Mar. 18, 1930		1 : 25	323 days

TABLE II

AGGLUTINATION TITRES (COW NO. 227)

Date	Remarks	Agglutination end point	Days after removal of udder
June 6, 1929	Udder removed	1 : 28000	
June 14, 1929		1 : 26000	8 days
June 27, 1929		1 : 2560	21 days
July 3, 1929		1 : 1200	27 days
July 14, 1929		1 : 800	38 days
July 29, 1929		1 : 400	53 days
Aug. 7, 1929		1 : 200	62 days
Aug. 27, 1929		1 : 100	82 days
Sept. 24, 1929		1 : 100	110 days
Nov. 8, 1929		1 : 100	155 days
Jan. 31, 1930		1 : 100	229 days
Mar. 19, 1930		1 : 100	286 days

From this it is apparent that in at least some animals the presence of infection in the udder stimulates the formation of antibodies.

As one point in an excellently conducted experimental study, Gilman states tentatively it may be assumed that quarters showing agglutinins at 1.80 or above are actively affected with the Bang's bacillus and may eliminate the organism at any time. Quarters showing agglutinins under 1.80 only in rare instances eliminate the organism.

Mitchell and Humphreys (8) studying each quarter of 16 reacting animals by means of the agglutination and complement fixation tests in addition to guinea-pig inoculations concluded that in each case the milk from the infected udders reacted to the agglutination or complement test usually to both and where agglutinins and complement fixing substances were absent guinea-pig inoculations were negative. The following tables will give the details of the experiment.

TABLE I. BLOOD REACTIONS

				Ever infected with		Slow agglutination									Rapid agglutination				Complement fixation		
Animal	Age	Pregnancy	Aborted	Metritis	Mammitis	1:10	1:25	1:50	1:100	1:200	1:500	1:1000	1:-2000	1:-4000	0.08	0.04	0.02	0.01	0.1	0.025	S.C.
A	4	1st	No	No	No	++++	++++	++++	++++	++++	++++	+	–	–	++	+++	++++	++++	–	++++	–
B	5	3rd	No	No	No	++++	++++	++++	++++	++++	++++	+++	–	–	++	++	++++	++++	–?	++++	–
C	5	3rd	No	No	No	++++	++++	++++	++++	–	–	–	–	–	++++	++++	++++	++++	++++	++++	–
D	4	2nd	No	No	No	++++	++++	++++	++++	–	–	–	–	–	+++	+++	+++	+++	++++	++++	–
E	10	7th	No	No	No	++++	++++	++++	++++	++++	+++	+++	–	–	++++	++++	++++	++++	++++	++++	–
F	9	5th	No	Yes	Yes	++++	++++	++++	++++	++++	+	–	–	–	+	++	+++	+++	++++	++++	–
G	7	5th	No	No	No	++++	++++	++++	–	–	–	–	–	–	+++	+++	+++	+++	–	?	–
H	8	6th	No	No	No	++++	–	–	–	–	–	–	–	–	+	+	+	+	–	++++	–
I	8	6th	No	Yes	No	++++	–	–	–	–	–	–	–	–	–	–	–	–	?	–	–
J	4	2nd	No	No	No	++++	++++	++++	++++	–	–	–	–	–	+	++	+++	++	++++	++++	–
K	9	7th	Once	Yes	Yes	++++	++++	++++	–	–	–	–	–	–	++	+	+	+	++++	++++	–
L	13	10th	No	No	No	++++	++++	++++	+++	++	–	–	–	–	++++	++++	++++	++++	++++	++++	–
M	5	3rd	No	No	No	++++	++++	++++	++++	++++	++++	–	–	–	+	+++	+++	+	++++	++++	–
N	5	3rd	Once	Yes	No	++++	++++	++++	++++	++++	++	–	–	–	+	++++	+++	+	++++	++++	–
O	11	7th	Once	Yes	No	++++	–	–	–	–	–	–	–	–	+	++	++++	++++	++++	++++	–
P	6	3rd	Three times	No	Yes	++++	++++	++++	+	–	–	–	–	–	+	++	++++	++++	++++	++++	–
Q	3	1st	No	No	No	++++	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

TABLE II. MILK—ITS REACTIONS AND INFECTIVITY FOR GUINEA PIGS

Milk from		Reactions of milk															G.P. Inoculations			Tests of G.P.'s serum		
Ani-mal	Quar-ter	Slow agglutination								Rapid agglutination				Complement fixation			No.	Date Inocula-tion		DATE		
		1:10	1:25	1:50	1:100	1:200	1:500	1:1000	1:-2000	.08	.04	.02	.01	0.1	0.025	Con-trol	G.P.	1st	2nd	1st Oct. 22/29	2nd Nov. 21/29	3rd Jan. 2/30
	R.F.	+++	–	–	+++	+++	+++	–	–	++++	++++	++++	++++	++++	++++	–	310	Oct. 2/29	Oct. 30/29	Agg. 1:100 ++++ C.F.++++	Agg. 1:2000 C.F.++++	Agg. 1:5000 C.F.++++
A	R.R.	++++	++++	++++	++++	++++	–	–	–	++++	+++	+++	++	++++	++++	–	311	"	"	Agg. 1:50 ++++ C.F.++++	Agg. 1:2000 C.F.++++	Died Dec. 21/29
	L.R.	++++	++++	++++	++++	++++	++++	++++	–	++++	++++	++++	++++	++++	++++	–	312	"	"	Agg. 1:100 ++++ C.F.++++	Agg. 1:2000 C.F.++++	Died Dec. 17/29
	L.F.	++++	++++	++++	++++	+++	–	–	–	++++	+++	++	+	++++	++++	–	313	"	"	Agg. – C.F. –	Agg. – C.F. –	Agg. – C.F. –
Blood		++++	++++	++++	++++	++++	++++	+	–	++	+++	++++	++++	–	++++	–						
	R.F.	++++	++++	++++	+	+	–	–	–	+++	+++	++	–	++++	++++	–	302	"	"	Agg. – C.F. –	Agg. – C.F. –	Agg. C.F.
B	R.R.	++++	++++	++++	++++	++++	+++	+	–	++++	++++	++++	+++	++++	++++	–	303	"	"	Agg. 1:100 C.F.++++	Died Oct. 22/29 after bleeding	
	L.R.	++++	++++	++++	++++	++++	+++	–	–	++++	++++	++++	++++	++++	++++	–	304	"	"	Agg. 1:100 C.F.++++	Agg. 1:100 C.F.++++	Agg. 1:100 C.F.++++
	L.F.	++++	++++	++++	++++	++++	?	–	–	++++	++++	++++	+	++++	++++	–	305	"	"	Agg. 1:100 C.F.++++	Agg. 1:500 C.F.++++	Agg. 1:500 C.F.++++
Blood		++++	++++	++++	++++	++++	++++	+++	–	++	++	++++	++++	–?	++++	–						
	R.F.	++++	++++	++++	++++	++++	–	–	–	++++	++++	++++	+	+++	++++	–	294	"	"	Agg. 1:10 C.F.++++	Agg. 1:1000 C.F.++++	Agg. 1:200 C.F.++++
C	R.R.	++++	++++	+++	+++	+++	+	–	–	+++	+++	+++	+++	++++	++++	–	295	"	"	Agg. 1:100 C.F.++++	Agg. 1:1000 C.F.++++	Agg. 1:9000 C.F.++++
	L.R.	++++	++++	++	+	+	–	–	–	+++	+++	+++	+++	+++	+++	–	296	"	"	Agg. 1:100 C.F.++++	Agg. 1:2000 C.F.++++	Agg. 1:4000 C.F.++++
	L.F.	++++	+++	+	++	++	–	–	–	+++	+++	+++	+++	+++	+++	–	297	"	"	Agg. 1:100 C.F.++++	Agg. 1:2000 C.F.++++	Agg. 1:1000 C.F.++++
Blood		++++	++++	++++	++++	–	–	–	–	++++	++++	++++	++++	++++	++++	–						
	R.F.	–	–	–	–	–	–	–	–	–	–	–	–	+	–	–	306	"	"	Agg. – C.F. –	Agg. – C.F. –	Agg. – C.F. –
D	R.R.	–	–	–	–	–	–	–	–	+	–	–	–	++	+++	–	307	"	"	Agg. 1:400 C.F.++++	Agg. 1:2000 C.F.++++	Agg. 1:4000 C.F.++++
	L.R.	–	–	–	–	–	–	–	–	+	?	–	–	++	+	–	308	"	"	Agg. 1:100 C.F.++++	Agg. 1:2000 C.F.++++	Died Jan. 1/30
	L.F.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	309	Oct. 2/29	Oct. 30/29	Agg. – C.F. –	Agg. – C.F. –	Agg. – C.F. – Died Nov. 21 (bleeding)
Blood		++++	++++	++++	++++	–	–	–	–	++++	++++	++++	++++	++++	++++	–						

TABLE II. MILK—ITS REACTIONS AND INFECTIVITY FOR GUINEA PIGS—CONTINUED

Milk from		Reactions of milk															G.P. Inoculations			Tests of G.P. s serum		
Animal	Quarter	Slow agglutination								Rapid agglutination				Complement fixation			No.	Date Inoculation		DATE		
		1:10	1:25	1:50	1:100	1:200	1:500	1:1000	1:2000	.08	.04	.02	.01	0.1	0.025	Control	G.P.	1st	2nd	1st Oct. 22/29	2nd Nov. 21/29	3rd Jan. 2/30
	R.F.	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	286	"	"	Agg. − C.F. −	Agg. − C.F. −	Agg. − C.F. −
I	R.R.	−	−	∓	−	−	−	−	−	−	−	−	−	−	−	−	287	"	"	Agg. − C.F. −	Agg. − C.F. −	Agg. − C.F. −
	L.R.	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	288	"	"	Agg. − C.F. −	Agg. − C.F. −	Agg. − C.F. −
	L.F.	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	289	"	"	Agg. − C.F. −	Agg. − C.F. −	Agg. − C.F. −
Blood		++++	−	−	−	−	−	−	−	−	−	−	−	?	−	−						
	R.F.	−	−	−	−	−	−	−	−	−	−	−	−	+++	++	−	314	"	"	Agg. − C.F. −	Agg. − C.F. −	Agg. − C.F. − Died Dec. 30/29
J	R.R.	−	−	−	−	−	−	−	−	−	−	−	−	++	+	−	315	"	"	Agg. − C.F. −	Agg. − C.F. −	Agg. − C.F. −
	L.R.	+	+	+	+	−	−	−	−	++	+	−	−	++++	++++	−	316	"	"	Agg. − * C.F. ++++	Agg. 1:2000 C.F. ++++	Agg. − C.F. − Died Dec. 23/29
	L.F.	−	−	−	−	−	−	−	−	−	−	−	−	++++	++++	−	317	"	"	Agg. − C.F.	Agg. − C.F. −	Agg. − C.F. −
Blood		++++	++++	++++	++++	−	−	−	−	+	++	+++	++	++++	++++	−						
	R.F.	+++	+	−	−	−	−	−	−	+	−	−	−	−	−	−	326	"	"	Agg. − C.F. −	Agg. − C.F. −	Agg. − C.F. −
K	R.R.	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	327	"	"	Agg. − C.F. −	Agg. − C.F. −	Agg. − C.F. −
	L.R.	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	328	"	"	Agg. − C.F. −	Agg. − C.F. −	Agg. − C.F. −
	L.F.	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	329	"	"	Agg. − C.F. −	Agg. − C.F. −	Agg. − C.F. −
Blood		++++	++++	++++	−	−	−	−	−	++	+	+	+	++++	++++	−						
	R.F.	++	++	++	−	−	−	−	−	+	−	−	−	−	−	−	322	Oct. 2/29	Oct. 30/29	Agg. − C.F. −	Agg. − C.F. −	Agg. − C.F. −
L	R.R.	++	++	++	−	−	−	−	−	++	+	−	−	−	−	−	323	"	"	Agg. − C.F. −	Agg. − C.F. −	Agg. − C.F. −
	L.R.	+	+	+	−	−	−	−	−	++	++	−	−	−	−	−	324	"	"	Agg. − C.F. −	Agg. − C.F. −	Agg. − C.F. −
	L.F.	+	+	+	−	−	−	−	−	++	∓	−	−	−	−	−	325	"	"	Agg. − C.F. −	Agg. − C.F. −	Agg. − C.F. −
Blood		++++	++++	++++	+++	++	−	−	−	++++	++++	++++	++++	++++	++++	−						

TABLE II. MILK—ITS REACTIONS AND INFECTIVITY FOR GUINEA PIGS—CONTINUED

Milk from		Reactions of milk															G.P. Inoculations			Tests of G.P.'s serum		
Animal	Quarter	Slow agglutination								Rapid agglutination				Complement fixation			No.	Date Inoculation		DATE		
		1:10	1:25	1:50	1:100	1:200	1:500	1:1000	1:2000	.08	.04	.02	.01	0.1	0.025	Control	G.P.	1st	2nd	1st Oct. 22/29	2nd Nov. 21/29	3rd Jan. 2/30
	R.F.	–	–	–	–	–	–	–	–	+	+	+	–	++++	++++	–	270	"	"	Agg. – C.F. –	Agg. – C.F. –	Agg. – C.F. –
M	R.R.	+	+	+	+++	+++	–	–	–	++++	+++	+++	+	++++	+++	–	271	"	"	Agg. – C.F. –	Agg. – C.F. –	Agg. – CF.. –
	L.R.	–	–	–	++++	–	–	–	–	++++	+++	+	–	++++	+++	–	272	"	"	Agg. – C.F. ++++	Agg. 1:1000 C.F. ++++	Agg. – C.F. – Died Dec. 23/29
	L.F.	–	–	–	–	–	–	–	–	++++	+++	++	+	++++	++	–	273	"	"	Agg. – C.F. ++++	Agg. 1:500 C.F. ++++	Agg. 1:9000 C.F. ++++
Blood		++++	++++	++++	++++	++++	++++	–	–	+	+++	+++	+	++++	++++	–						
	R.F.	++++	++++	++++	++++	++++	++++	–	–	++++	++++	++++	++++	++++	+	–	290	"	"	Agg. 1:100 C.F. ++++	Agg. 1:2000 C.F. ++++	Agg. 1:12000 C.F. ++++
N	R.R.	++++	++++	++++	++++	+	–	–	–	+++	++	+	–	++++	+	–	291	"	"	Agg. – C.F. –	Agg. – C.F. –	Agg. 1:11000 C.F. ++++
	L.R.	++++	+	+	++++	+++	–	–	–	+++	++	–	–	++++	++	–	292	"	"	Agg. – C.F. –	Agg. – C.F. –	Agg. – C.F. –
	L.F.	+	+	+	++++	+++	+++	–	–	+++	+++	–	–	++++	++	–	293	"	"	Agg. – C.F. ++	Agg. 1:500 C.F. ++++	Agg. 1:2000 C.F. ++++
Blood		++++	++++	++++	++++	++++	++	–	–	+	++++	+++	+	++++	++++	–						
	R.F.	–	–	–	++	–	–	–	–	+++	++	+	–	++++	++	–	278	"	"	Agg. – C.F. –	Agg. – C.F. –	Agg. 1:5000 C.F. ++++
O	R.R.	+	+	+	+	–	–	–	–	+++	++	+	–	++++	+++	–	279	"	"	Agg. – C.F. ++++	Agg. 1:2000 C.F. ++++	Agg. 1:4000 C.F. ++++
	L.R.	+	+	+	+	–	–	–	–	++++	++	+	–	++++	++++	–	280	Oct. 2/29	Oct. 30/29	Agg. – C.F. –	Agg. – C.F. –	Agg. – C.F. –
	L.F.	++	++	++	+++	–	–	–	–	+++	+	–	–	++++	+++	–	281	"	"	Agg. – C.F. –	Agg. – C.F. –	Agg. – C.F. –
Blood		++++	–	–	–	–	–	–	–	+	++	++++	++++	++++	++++	–						
	R.F.	++	++	++	++++	+++	–	–	–	+++	+++	++	+	++++	+++	–	298	"	"	Agg. 1:100 C.F. ++++	Agg. 1:2000 C.F. ++++	Agg. – C.F. – Died Nov. 21/29
P	R.R.	+	+	+	+++	+++	–	–	–	+++	+++	+++	+	++++	++++	–	299	"	"	Agg. – C.F. –	Agg. – C.F. –	Agg. – C.F. –
	L.R.	+	+	+	+++	+	–	–	–	+++	+++	+	–	++++	+++	–	300	"	"	Agg. – C.F. ++++	Agg. 1:2000 C.F. ++++	Agg. – C.F. – Died Dec. 13/29
	L.F.	++++	++++	+++	++++	++++	–	–	–	+++	+++	++	–	++++	+++	–	301	"	"	Agg. 1:100 C.F. ++++	Agg. 1:2000 C.F. ++++	Agg. – C.F. – Died Dec. 26/29
Blood		++++	++++	++++	+	–	–	–	–	+	++	++++	++++	++++	++++	–						

TABLE II. MILK—ITS REACTIONS AND INFECTIVITY FOR GUINEA PIGS—CONTINUED

Milk from: Animal	Milk from: Quarter	Reactions of milk: Slow agglutination 1:10	1:25	1:50	1:100	1:200	5:100	1:1000	1:2000	Rapid agglutination .08	.04	.02	.01	Complement fixation 0.1	0.025	Control	G.P. Inoculations No. G.P.	Date Inoculation 1st	2nd	Tests of G.P.'s serum DATE 1st Oct. 22/29	2nd Nov. 21/29	3rd Jan. 2/30
	R.F.	++++	++++	++++	++++	++++	+	−	−	++++	++++	++++	++++	++++	++++	−	266	"	"	Agg. − C.F. −	Agg. − C.F. −	Died Dec. 30/29 (pneumonia)
E	R.R.	++++	++++	++++	++++	++++	−	−	−	++++	+++	++++	++	++++	++++	−	267	"	"	Agg. − C.F. ++++	Agg. 1:1000 C.F. ++++	Agg. 1:6000 C.F. ++++
	L.R.	++++	++++	++++	++++	++++	−	−	−	+++	+++	+++	−	++++	++++	−	268	"	"	Agg. 1:50 C.F. ++++	Agg. 1:2000 C.F. ++++	Agg. 1:2000 C.F. ++++
	L.F	+	+	+	+++	−	−	−	−	+++	+++	+	+	++++	++++	−	269	"	"	Agg. − C.F. −	Agg. − C.F. −	Agg. − C.F. −
Blood		++++	++++	++++	++++	++++	+++	+++	−	++++	++++	++++	++++	++++	++++	−						
	R.F.	++++	++++	++++	++++	+++	−	−	−	+++	+++	+++	+	++++	++++	−	274	"	"	Agg. 1:100 C.F. −	Agg. 1:2000 C.F. ++++	Agg. 1:2000 C.F. ++++
F	R.R.	++++	++++	++++	++++	+++	−	−	−	+++	+++	+++	+	++++	++++	−	275	"	"	Agg. 1:100 C.F. ++++	Agg. 1:2000 C.F. ++++	Agg. 1:2000 C.F. ++++
	L.R.	++++	++++	++++	−	−	−	−	−	+++	+++	+++	+++	++++	++++	−	276	"	"	Agg. 1:100 C.F. ++++	Agg. 1:500 C.F. ++++	Agg. 1:200 C.F. ++++
	L.F.	++++	++++	++++	++++	++++	−	−	−	+++	+++	+++	++	++++	++++	−	277	"	"	Agg. 1:100 C.F. +++	Agg. 1:200 C.F. ++++	Agg. 1:200 C.F. ++++
Blood		++++	++++	++++	++++	++++	+	−	−	+	++	+++	+++	++++	++++	−						
	R.F.	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	318	"	"	Agg. − C.F. −	Agg. − C.F. −	Agg. − C.F. −
G	R.R.	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	319	"	"	Agg. − C.F. −	Agg. − C.F. −	Agg. − C.F. −
	L.R.	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	320	"	"	Agg. − C.F. −	Died Oct. 23/29 hemorrhage	
	L.F.	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	321	"	"	Agg. − C.F. −	Agg. − C.F. −	Agg. − C.F. −
Blood		++++	++++	++++	+	−	−	−	−	+++	+++	+++	+++	−	?	−						
	R.F.	+	−	−	−	−	−	−	−	++++	++++	+++	++	++++	++++	−	282	"	"	Agg. − C.F. −	Agg. − C.F. −	Agg. − C.F. −
H	R.R.	+	−	−	−	−	−	−	−	+++	+++	+++	+	++++	++++	−	283	Oct. 2/29	Oct. 30/29	Agg. − C.F. ++++	Agg. 1:200 C.F. ++++	Agg. 1:1000 C.F. ++++
	L.R.	−	−	−	−	−	−	−	−	+++	+++	++	+	++++	++++	−	284	"	"	Agg. − C.F. ++++	Agg. 1:1000 C.F. ++++	Paralysed Killed Nov. 21/29
	L.F.	+	−	−	−	−	−	−	−	++++	++++	++++	++++	++++	++++	−	285	"	"	Agg. − C.F. −	Agg. − C.F. −	Died Nov. 20/29
Blood		++++	−	−	−	−	−	−	−	+	+	+	+	−	++++	−						

The Possibility of Detecting Animals Infected in the Udder

From the work shown above and from the work reported by authors already mentioned we have evidence that where agglutinins or complement fixing substances are found in quarters of the udder those quarters are potential excretors of the *Brucella abortus*. We are intensively studying this question at present and believe if this relationship does exist that these tests may be used for indicating a focal infection of the mammary gland.

In communities where it is impractical to pasteurize the milk this method would surely be useful since by it the animals potentially dangerous to man would be discovered.

I would, however, emphasize that this should only be looked upon as a temporary expedient and that the ultimate objective should be the control and eradication of *Brucella abortus* infection from animals since until the reservoirs of infection are dried up in lower animal cases of human infection will doubtless occur from time to time.

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THE EXCRETION OF TUBERCLE BACILLI FROM THE UDDER *

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It will perhaps appear to you as quite unnecessary that a paper dealing with tuberculous infection in one phase or another and presented to an audience familiar with the subject of tuberculosis from a "public health standpoint" should open with a statement of one or two facts so well known and generally accepted that it will seem idle to call attention to them. Nevertheless, and though it might sound like a paradox, it is no less true that our very familiarity with certain facts and observations cause them, quite frequently, to be disregarded or given inadequate attention and application. The facts which I have particularly in mind are:

1. That tuberculosis is a communicable and preventable disease,
2. That bovine tuberculosis is communicable to the human family, especially to children,
3. That it is transmitted through the milk,
4. That the tubercle bacillus (*Mycobacterium* tuberculosis) is the cause of it.

These are the indisputable facts which constitute the basis on which preventive means against tuberculosis rest and are established, including tuberculin testing of cattle and pasteurization of milk. Accordingly, it is the sources of the tubercle bacillus and the channels through which these bacilli flow and are passed from one host to another that are or should be of chief importance and concern;

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for the prevention of tuberculosis is neither more nor less than preventing the passage of living tubercle bacilli from a tuberculous to a non-tuberculous animal or person.

While the sources of infection have been fairly well explored and made known, there has been and there still is a great deal of hesitancy or seeming reluctance to give them full recognition and to apply the knowledge gained to the extent that it should be applied in preventive measures against tuberculosis, and especially in regard to drying up or closing the known reservoirs of tubercle bacilli and the avenues of escape. This is particularly true of one great source of infection, namely, the udder and the milk of the tuberculous cow.

While there is an obvious and readily recognized danger in the tuberculous udder and in the milk drawn from it, it is often asserted that, as a rule, the milk of tuberculous cows which do not have active tuberculosis of the udder is free from tubercle bacilli and harmless, and that milk is not dangerous until the udder itself becomes diseased. That itself is a fallacy and a dangerous one. A tuberculous udder liberates masses of tubercle bacilli into the milk stream and such a highly dangerous source of infection is, of course, beyond question. Fortunately, this condition can usually be detected by clinical examination; and in some countries veterinary inspection, particularly for tuberculous mastitis, and the removal and condemnation of all such animals found in dairy herds is a compulsory measure. There neither is nor can be any need or excuse for maintaining a cow with manifest tuberculosis of the udder and it should be made an indictable offense to allow any such animal in a dairy herd or the use of its milk for human consumption. But the removal and condemnation of cattle affected with udder tuberculosis, though greatly reducing the amount of tuberculous infection in milk, would by no means afford an adequate safeguard or assure a milk supply free from tubercle bacilli. It has been proved, over and over again, that tubercle bacilli may be excreted with the milk from an udder in which neither manifest tuberculosis nor microscopical evidence of tuberculous lesions are present. It is, in fact, known that in tuberculous cows with no evidence of tuberculous udder lesions virulent tubercle bacilli may pass into the milk stream and be excreted by that route. Many such cases have been recorded in the literature and in some of these the tuberculous lesions discoverable at post mortem examination proved to be very slight in extent and limited to one or more of the lymphatic glands.

In the course of studies made at our Animal Diseases Research Institute, carried over a period of years, we have become familiar with animals excreting tubercle bacilli in their milk while free from tuberculous lesions of the udder. We have determined that cattle may harbour and excrete virulent tubercle bacilli for long periods of time and, at post mortem examination, show but little evidence of tuberculosis. Some of our cases have been young heifers in their first lactation period. To ascertain the extent of the disease in such cases, post mortem examinations have been carefully conducted at the laboratory; and cases have been recorded in which the only lesions found were confined to the retropharyngeal lymph glands. However, it frequently happens that virulent tubercle bacilli are present in groups of lymph glands which appear to be quite normal—so-called N.V.L. (No visible lesion) glands—their presence being determined by biological tests on guinea pigs. The observations and experimental data that are being accumulated point to considerable resistance to active disease in this category of cases. It may be remarked here that a tuberculin test reaction indicates tuberculous infection but not necessarily tuberculous disease in the sense of visible and active lesions. In tuberculosis work and in preventive means we have to distinguish, sometimes sharply, and keep in mind the difference between tuberculous infection and tuberculous disease. This is really very important because, for variable periods, long or short, an animal which may be highly resistant to tuberculous disease may at the same time be highly infective.

In cattle and, no doubt, in human beings, degrees of natural susceptibility and degrees of natural resistance vary within a wide range and from time to time, changing, increasing or diminishing according to the environment, physical stress and strain, and the many factors which enter therein. But we have to recognize and stress the fact that in bovine tuberculosis, as in bovine infectious abortion, human typhoid and diphtheria and other diseases, there is a *"Carrier State"* and that the carriers of tubercle bacilli which find their way into the milk stream are a potential danger and not infrequently are active sources and spreaders of infection.

This Carrier State, represented by a latent, occult, or apparently benign infection is now styled by certain French writers defending anti-tuberculosis vaccination by means of BCG as "a state of simple parasitism"—a state in which tubercle bacilli live at the expense of their host but without causing material damage or disease. But, and as we have seen in the course of our own experiments, these carriers do themselves lose resistance and sooner or later, or when physical and chemical factors and changing environment give favourable opportunities, are apt to develop typical tuberculosis. We believe and, in fact, are quite convinced that cattle, particularly dairy cattle, "parasitized" with tubercle bacilli are a danger and a menace. The excretion of virulent tubercle bacilli in the milk is the important thing to remember; and it is of very secondary importance, from a preventive and public health viewpoint, whether the animal that is excreting virulent tubercle bacilli has or has not tuberculosis of the udder, whether it has only slight or very extensive lesions of the internal organs, or whether its individual resistance is high or low. The fact that it is intermittently excreting virulent tubercle bacilli in the milk is an all-sufficient reason for condemning it; and it is surely in the interests of the cattle breeder, in raising tuberculosis free herds, of the dairyman and of the milk consumer, and from a public health standpoint, to eliminate such animals.

It is not within the scope of this paper to discuss the effects of BCG vaccination of cattle. This question has aroused a world-wide controversy and there is at present more disagreement than agreement in respect to its safety and efficacy. The results of the trials and experimental studies which I have had the privilege of directing do not substantiate the claims made for BCG vaccination and have furnished much evidence to the contrary. At this time and place I need to refer to but one of the reasons for which I am opposed to BCG vaccination, and that is the excretion of virulent tubercle bacilli in the milk of some of the vaccinated and revaccinated animals which have cohabited with tuberculous cattle and reached their first lactation period.

Biological tests on guinea pigs with milk drawn from young vaccinated cows have proved the presence of virulent tubercle bacilli in some of those samples. In an experiment just concluded, a calf, isolated from the time of birth from all contact with tuberculous animals but reared on the milk of a young cow which had been vaccinated as a new born calf, and revaccinated annually, developed tuberculosis. The conditions of maintenance in this experiment were such that the milk was the only possible source of infection.

BCG vaccination does not prevent infection, and vaccinated cattle, when brought into contact with tuberculous infection, are just as liable as unvaccinated cattle to absorb into their sysytems virulent tubercle bacilli. They may, in a greater percentage than in the unvaccinated, show a somewhat greater degree of resistance, transient though it may be, to active tuberculous disease, developing that so-called state of parasitism, harbouring and excreting virulent organisms. In fact, we have found a much greater percentage of carriers among the vaccinated than in the unvaccinated: 25% as compared with 8%. The question whether the vaccinating bacilli themselves may revert to their original virulence after a long sojourn in the animal tissues has not been settled. In the laboratory, a dissociation of BCG strains into virulent and non-virulent organisms can be brought about by cultural means. There would seem to be no valid reason why BCG in the animal tissues should not, in the course of time, revert to virulence even though this may be exceptional and dependent upon certain physical and bio-chemical factors beyond our ken and control. We have, in fact, seen it revert to high virulence in the tissues of guinea-pigs exceptional, as it may be. There are other grounds for opposing BCG vaccination as a method of controlling bovine tuberculosis in this country but I only wish to point out at this time that it would tend to complicate and render more difficult the production and maintenance of a milk supply free from tubercle bacilli.

Since bovine tuberculosis is a communicable milk-borne disease, preventive measures must aim at securing a pure milk supply, milk free from tubercle bacilli and, as an additional and essential safeguard, milk that is sterile and harmless. Effective pasteurization will assure the latter, that is, a relatively sterile milk, and render tubercle bacilli that may be present in it harmless. But milk pasteurization is mainly employed in the larger cities. In many of the smaller urban centers and in rural districts it is applied, if at all, on a relatively small scale. I am sure that we are all very strong advocates of milk pasteurization and would like to see it more generally adopted. The enlightened public will, no doubt, insist more and more upon compulsory pasteurization of milk as they realize that effective pasteurization prevents the transmission not only of bovine tuberculosis but of other diseases and infections affecting Man. But is pasteurization sufficient? The procedure is not fool-proof. There are loop holes in it. The time or the degree of heat may be insufficient. There may be a temporary breakdown in the machinery, and so forth. While pasteurization is usually carried out efficiently, there are occasional exceptions and, at times, unavoidable accidents. Pasteurization, moreover, plays little part in controlling or preventing the transmission of tuberculosis among cattle. The elimination of bovine tuberculosis in cattle and the prevention of its transmission to human beings should be a single objective and go hand in hand. We cannot achieve this object by pasteurization alone or by tuberculin testing of cattle alone. All available effective means and measures should be employed and these include first, a systematic, periodic veterinary inspection of all dairy cattle and the immediate isolation and removal of any animal which may be suspected of harbouring a disease or giving off impure milk; second, systematic and periodic tuberculin testing of all milk producing and breeding cattle; and third, effective pasteurization of milk.

In Canada and in the United States we are in a much more fortunate position in respect to bovine tuberculosis than in Europe and the older countries, in which the disease is so wide-spread and prevalent that the cost and the losses that would ensue in enforcing effective means of eradication would seem prohibitive. In our cattle the incidence of the disease is low, probably less than 5% for the whole country, and there is no doubt that the measures that are being taken are reducing it annually. But there are still people—and many of them—who refuse to accept the plain fact that T.B. is a contagious, preventible, milk-borne disease, people who say that the tubercle bacillus exists only in our distorted imaginations; and people who insist that to maintain a goat in the herds is more effective in keeping away diseases than the pasteurization of milk. The fine progress that has been made in this campaign in the past ten years will, it is hoped, be continued, as it surely will be if supported by the intelligent will of the public; and North America, Canada and the United States, will show the way, as I believe they are doing, in developing and maintaining a dairy industry second to none in its freedom from tuberculosis and infective disease and in the purity of its milk supply.

May I conclude with a thought which might be expressed in some such way as this:

Animal tuberculosis preceded human tuberculosis. At one period of time, far back in history, only animals were affected with tuberculosis, beginning with a single species. Subsequently, tuberculosis of other animal species and of man has been evolved. Even now, in the laboratory and in the experimental animal, we may witness changes, transitions and mutations in those properties and characteristics of tubercle bacilli which are arbitrarily used to classify them as human, bovine, avian and intermediate types of tubercle bacilli. Let us hold to the view that tuberculosis of animals and of man is, to a variable, lesser or greater degree, transmissable, between different species of animals and man. In transitions of the properties and pathogenicity of tubercle bacilli themselves and in the transmission of infection the all-important factors are the hosts and the environments—which are always changing. Knowing that animal tuberculosis is the immediate origin and source of a considerable amount of human tuberculosis can anything be more logical and more effective as a preventive means than to attack and eliminate the origin and source: the tuberculous infected animal? We should work to eliminate tuberculosis of animals, especially of the food producing animals, cattle, swine and poultry, and especially of dairy or milk producing cattle; and with the guiding principle that, in the prevention of tuberculosis the main attack should be made on the source of infection itself.

A MILK-BORNE EPIDEMIC OF SEPTIC SORE THROAT

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A severe epidemic of septic sore throat involving 450 cases, resulting in four deaths, occurred in Kirkland Lake, Ontario, in December, 1930.

Kirkland Lake is a recently developed Northern Ontario mining town, with a population of 8,000. The town is built on the rocky surface of gold mines, has a good sewage system and chlorinated water supply. The populace consists of Canadian born, with a very considerable admixture of Finns, Scandinavians and Central Europeans. Many of the families live in well-built frame homes. Some of the less fortunate ones resided in two room flats.

The medical services of the town are supplied by six physicians. Dr. R. H. Armstrong is part time Medical Officer of Health, a school nurse is employed, and a Victorian Order nurse is a resident of the town. A Red Cross Hospital has a capacity of thirty beds.

Scarlet fever had been prevalent during the fall term, necessitating some teachers and pupils to absent themselves from school. Twenty cases were reported in October and November and probably other cases occurred.

During the latter part of November occasional cases of severe sore throat, followed by glandular enlargement, were noted. The number of cases increased so that by the first of December the physician identified the malady as a distinct clinical entity. The situation was regarded as serious. The physician also noted that the affected households used milk from one dairy, namely Dairy B.

On December 9th, Dr. Armstrong, Medical Officer of Health, shipped a pooled sample of milk from each dairy to the Laboratory of the Department of Health. At the same time six throat swabs were sent from milkers and milk handlers of Dairy B, already suspected as the source of the epidemic, with the request that these be examined for streptococci. These were examined for B. diphtheriae as well as Streptococci. The throat cultures from Mrs. B, Miss B, and one of the milkers showed the presence of beta type haemolytic streptococci. The sample of milk from Dairy B showed the presence of beta haemolytic streptococci, those from the other dairies did not. These results were wired to the Medical Officer of Health at whose order the distribution of milk of Dairy B was discontinued on December 12th.

During the period that scarlet fever was prevalent, one of the producer's (Dairy B) family contracted scarlet fever. A second member of the family became ill with scarlet fever a short time later, while a third developed a condition that was diagnosed as a cold, with an otitis media. The patients—all females—were said to have been isolated in a separate room, with nursing care, for a period of five weeks, and the family were released from quarantine in November. The other members of the family were not ill, and included the producer and his two sons, the one son being employed by the dairy to deliver the milk. The mother worked in the dairy as a bottler, and stated that she was not at any time ill during the previous months. However, it was learned that she had a sore throat and the culture taken of her throat on December 9th showed the presence of a beta type haemolytic streptococci.

On December 12th I had the privilege of accompanying to Kirkland Lake Dr. George, District Officer of Health, No. 6 District, and Dr. A. L. McKay, Provincial Epidemiologist. On December 13th a list of patients under the doctor's care was supplied by Dr. Armstrong, also the dairy from which the patients had taken milk was noted in each case. In view of the fact that there had been much interchanging of both milk bottles and milk between the dairies, a conference was held with the local Board of Health. Following the conference an order was issued prohibiting the sale of raw milk.

Epidemiological Investigation

The epidemiological investigation was begun on December 16th. It soon became apparent to the physicians investigating that in some of the families affected there had been earlier cases of sickness, with sore thoat as the predominate symptom. It was often found impossible to decide whether or not the previous illness was septic sore throat or not.

As to the time, however, at which the cases assumed definite epidemic proportions there is no doubt. Tables I and II show the onset of 445 cases as accurately as it was possible to determine. As stated above, the earlier cases were accepted as such when all available evidence supported that procedure. One case occurred apparently in September, 4 in October and 55 in November, 312 in the first half of December, 65 in the latter half and 9 in

January. January 15th is the onset of the last case reported. In 11 cases the date of onset could not be obtained. Altogether, data have been collected in 457 cases. There was probably a small number of other cases, no records of which were obtained.

TABLE I

Weekly Incident of Cases	Cases
Week ending October 31st	4
" " November 7th	3
" " November 14th	9
" " November 21st	18
" " November 28th	15
" " December 5th	59
" " December 12th	184
" " December 19th	112
" " December 26th	28
" " January 2nd	6
" " January 9th	5
" " January 16th	2

The explosive character of the outbreak as it occurred in December is well illustrated in Diagram I. The irregularity of the peaks in the line representing the incidence suggests repeated infections of varying intensity.

Age Incidence

The age incidence of the 457 cases is shown in Table III. The proportion of cases in adults is striking, the age group of 20 years and over supplying 62 per cent. The group of 15-19 supplied 9 per cent, school children of 5-14 but 14 per cent, and the group of 0-4, 15 per cent.

The incidence by sex, is also shown in Table III. Males outnumber females in all age groups except the 15-19 group. In adult groups this is possibly accounted for by the preponderance of males in the population and especially in those exposed, through the milk, as in large boarding-houses, bunk houses, etc.

TABLE II

Daily Incidence of Cases

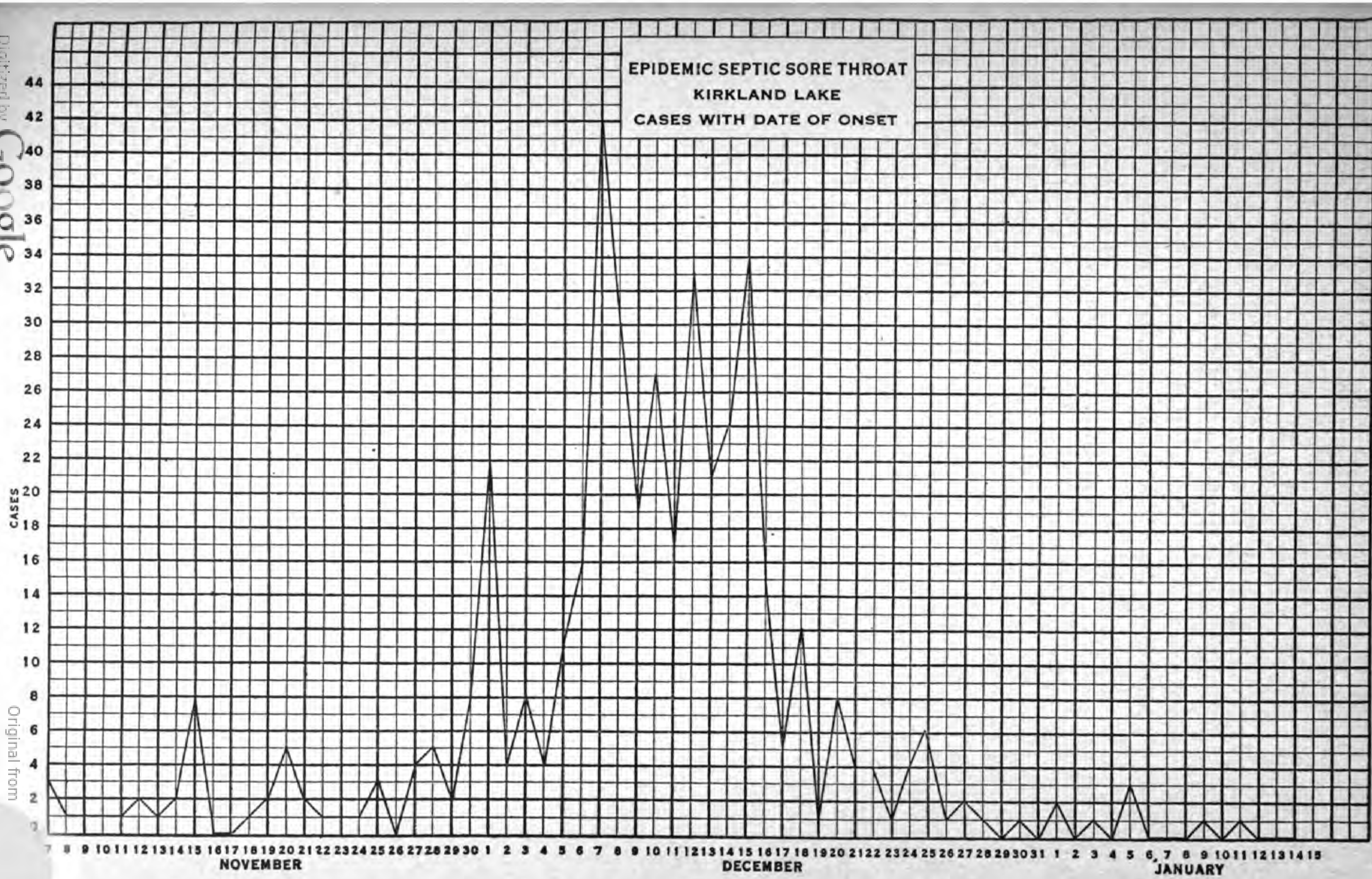
Cases

Day of Month	September	October	November	December	January
1				22	2
2				4	
3				8	1
4				4	
5				11	3
6				16	
7			3	42	
8			1	30	
9			1	19	1
10			1	27	1
11			1	17	
12			2	33	
13			1	21	
14			2	24	
15			8	34	1
16				15	
17				5	
18			1	2	
19			2	1	
20			5	8	
21			2	4	
22			1	4	
23			1	1	
24			1	4	
25			3	6	
26				1	
27			4	2	
28		2	5	1	
29		1	2		
30					
31		1	8	1	
Totals	1	4	55	377	9

TABLE III

Distribution by Age and Sex

Age Groups	Male	Per Cent	Female	Per Cent	Total	Per Cent
0–4	39	15.	28	14.	67	14.6
5–9	26	10.	14	7.1	40	8.8
10–14	15	5.2	9	4.5	24	5.3
15–19	12	4.6	29	14.6	41	8.9
20–24	31	12.	24	12.	55	12.
25–29	41	16.	38	19.6	79	17.3
30–34	39	15.	16	8.2	55	12.
35–39	18	7.	14	7.1	32	7.
40–44	14	5.3	12	6.2	26	5.6
45–49	12	4.6	10	5.2	22	4.9
50 and over	11	4.3	5	2.5	16	3.6
Totals	258	100.	199	100.	457	100.


EPIDEMIC SEPTIC SORE THROAT
KIRKLAND LAKE
CASES WITH DATE OF ONSET
CASES
44
42
40
38
36
34
32
30
28
26
24
22
20
18
16
14
12
10
8
6
4
2
0
7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15
NOVEMBER
DECEMBER
JANUARY

The data of those exposed in all the households involved are not available but Table IV shows the number and percentage distribution of those exposed and of cases in households for which the data were obtained.

TABLE IV

EXPOSED PERSONS AND CASES WITH PERCENTAGE DISTRIBUTION BY AGE AND ATTACK RATE

	Exposed		Cases		Attack Rate
	No.	Per Cent	No.	Per Cent	Per Cent
0– 4	109	15.	62	14.6	57
5– 9	61	8.4	35	8.8	52
10–14	63	8.7	24	5.3	38
15–19	64	8.8	38	8.9	59
20–24	75	10.3	50	12.	61
25–29	107	14.7	71	17.3	66
30–34	91	12.5	48	12.	53
35–39	54	7.4	27	7.	50
40–44	47	6.4	22	5.6	47
45–49	35	4.7	20	4.9	57
50 and over	23	3.1	15	3.6	65
Totals	729	100.	412	100.	57

MULTIPLE CASES IN FAMILIES

The frequency of multiple cases in families is shown, in Table V, for 310 cases in 130 families. Eighty-five per cent of these cases occurred in association with one or more other cases in the same family and 43 per cent in households with two or more addition-cases. This high frequency of multiple cases and exceptionally high attack rates in affected families, is possibly explained on the following bases: Milk from two, three or four cows was placed in a can and there was but little mixing of the contents of different cans during the bottling. Usually one or two cans were withheld at the regular bottling time and bottled later in the day as required. Heavily infected milk would thus be delivered to certain houses while other houses would get non-infected milk or milk infected only by contamination with utensils, bottles, etc. This distribution would give a greater concentration of massive infection in the unfortunate households.

TABLE V

FAMILY ASSOCIATION OF 310 CASES WITH OTHER CASES

36	Families with 1 Member of Family ill—	36	cases
48	" " 2 " " " "	96	"
24	" " 3 " " " "	72	"
10	" " 4 " " " "	40	"
7	" " 5 " " " "	35	"
4	" " 6 " " " "	24	"
1	" " 7 " " " "	7	"
130	Families	310	cases

DEATHS

Four deaths occurred as follows:

Female: age 10 months, died December 8th. The duration of illness was 48 hours. The cause of death was given as convulsions with septic sore throat as contributory.

Male: age 41, died December 15. The duration of illness was eight days. The cause of death was given as septic sore throat.

Female: age 58, died December 15th. The duration of illness was 8 days. The cause of death was given as septic sore throat with jaundice.

Female: age 18, died December 24th. The duration of illness was 9 days. The cause of death was given as septic sore throat with six months miscarriage as a contributory cause.

RELATIONSHIP TO MILK

Dairy B supplied 36 per cent of all households in the town, but it supplied 84 per cent of the affected families. Dairy A and C supplied 38 and 19 per cent of the general distribution but only 7 per cent of each of the affected families. During the early part of December when there was suspicion regarding infection being present in Dairy B, a number of their customers changed to Dairy A and C. Dairy A and C were not prepared for the increased demand so therefore obtained a certain amount of milk during the first 10 days of December from Dairy B. The milk they purchased from Dairy B was bottled and distributed without mixing with their own supply so several families were using Dairy B's milk unknown to them. This accounts for some families having the infection who were using milk from Dairies A and C.

TABLE VI

DISTRIBUTION OF MILK BY DAIRY AND BY FAMILY

Dealer	Number of Households Supplied	Percentage of all Households	Number of Families with Septic Sore Throat	Percentage of all Families with Septic Sore Throat
A	275	38.1	11	7.1
B	256	35.7	130	83.9
C	143	19.5	11	7.1
D	50	6.7	3	1.9
Totals	724	100.	155	100.

There was much more evidence incriminating Dairy B's milk. In one bunk-house accomodating 150 men, all using canned milk, only one case occurred and this patient gave a definite history of drinking Dairy B's milk two days before the onset of his illness occurred. A family of two who had been using canned milk were influenced by the attractive wagon of Dairy B and purchased some milk on December 5th. Both husband and wife drank the milk and in two days were suffering from septic sore throat. Boarding-houses using canned milk were free from the infection with the exception of a few boarders who gave a history of drinking Dairy B's milk outside their regular boarding-house. In one section of the town which was more or less isolated the majority of the households used canned milk and the sickness in this section was entirely confined to the users of Dairy B's milk.

Incubation Period

In a few cases where Dairy B had not been used regularly, but was used on one occasion the onset of illness was the second day after using the milk.

Contact Cases

In 450 cases investigated, 59 cases occurred on and after December 16th. It is therefore probable these cases were not due to infected milk as the distribution was stopped on December 12th. Five other cases used canned milk, therefore, these 64 cases would probably be considered as receiving their infection from contact. Therefore, per cent of contact cases in this epidemic was 14 per cent. This high per cent is probably due to the close contact in crowded quarters during the winter season.

Relation to Scarlet Fever

Of the 450 patients, 54 or 11.8 gave a history of a previous attack of scarlet fever. In a few of the affected families where there were patients convalescing from scarlet fever at the time of the septic sore throat epidemic the scarlet fever convalescents developed septic sore throat as readily as those who did not have scarlet fever. Two children with onset of fever on October 26th and November 1st, respectively, developed septic sore throat on December 1st. Another child with onset of scarlet fever November 18th developed septic sore throat December 11th.

Inspection of Dairies and Cattle

The milk supply of the municipality was derived from five producers and one distributor. A physical inspection was made of each cow supplying milk with the exception of cows of Dairy F and Distributing Station E. Altogether 83 cows were examined of which 18 showed pathological conditions. The salient physical characteristics of the dairies are briefly indicated.

Dairy A—The herd consisted of 39 cows, 28 of which were milking. This dairyman had a bottling machine; the washing was done by hand. Three cows showed abnormalities; one with palpable gland in tensor fascia lata, one with left front quarter caked, one with injury on two front teats. The latter was removed from the herd. Three hundred and fifty quarts of milk per day were distributed to 275 customers.

Dairy B—The herd consisted of 39 head, 28 of which were milking at the time of the epidemic; 11 of these showed some abnormality of the udder. These abnormalities included pendulous and congested udders and "three teaters." The milk-house adjoined the stable. The milk was strained into eight gallon cans, from whence it was put into a bottling machine. The filled milk bottles were placed in a wooden tank and tap water run into the tank. This producer used no ice. There were no facilities for the sterilization of bottles or milk cans. Utensils were rinsed in lukewarm water. All work was done by hand. The milk bottles, after being rinsed, were placed on a wooden rack to drain. This dairyman distributed 400 quarts per day, to 246 customers.

Dairy C—This was a model dairy as far as cleanliness is concerned. The cattle were kept in a scrupulously clean condition; the milk-house was separated from the stables; the bottles and cans were immersed in scalding water in a boiler placed over a box stove. The bottling was done by hand. The herd consisted of 24 members, 22 of which were milking. One member of this herd which had recently freshened had a slightly caked udder. No other abnormalities were discovered. This dairy was situated in close proximity to Dairy B. Between December 1st and December 15th, 160 quarts of milk were purchased from Dairy B and distributed to customers. This additional supply was not mixed with the milk of Dairy C. This dairy supplied 200 quarts to 143 customers.

Dairy D—This dairy consisted of 9 milking cows, one of which was a "three teater." The owner stated that a fourth teat had never been active. No other abnormalities were found. The cattle were kept in a clean hygienic condition. The milk-house adjoined the kitchen. The supply of hot water for washing pails and pans was procured by means of a hot water tank piped to the kitchen stove. The bottles were washed by hand. This dairyman distributed 70 to 80 quarts per day to 50 customers.

Dairy F—This dairyman owns 7 cows. This dairy was closed December 15th. Though none of its customers were infected, it was not considered satisfactory.

Bacteriological Investigation

On December 15th and 16th samples of milk were taken from each producing cow. One hundred and one samples were taken from 85 producing cows. In a few instances a sample was taken from each quarter, in others from the fore and hind quarters, whilst in 65 others a pooled sample was taken from the four quarters. A portion of the sediment obtained by centrifugalizing each sample was smeared and stained by Pappenheim's Gram stain.

A loop full of the sediment was streaked on rabbit blood agar plates. Poured plates were also made. Further culture work included plating 1 cc. of the sediment in beef infusion broth, incubating over night and streaking on blood agar plates.

Of 85 producing cows, hemolytic streptococci of the beta type were found in 17 samples.

From Dairy A, of 28 cows, eight showed the presence of hemolytic streptococci. Of these eight none were found to have pathological conditions on inspection. In Dairy B, of 28 cows, six showed hemolytic streptococci. Of these five showed pathological conditions evident on inspection. One was apparently normal. In Dairy C, of seven cows, none yielded hemolytic streptococci. Hemolytic colonies were fished to blood agar slants and tested in the following manner: (a) hydrolyzation of sodium hippurate; (b) pH determination in glucose broth; (c) carbohydrate reaction; (d) determination of hemolytic titre; (e) examination for the presence of capsules by the moist india ink method; (f) pathogenicity.

Cases and Convalescents

Throat swabs were taken from 20 patients. These swabs were received at the laboratory 24 hours later. We found the most satisfactory method was placing the swab in serum broth culture and incubating for 18 hours and then streaking a blood plate. Beta hemolytic streptococci were isolated from each of the 20 patients' cultures. They were tested out in a manner similar to the cultures isolated from the milk.

Sodium Hippurate

On examination of 17 milk cultures for their ability to produce hydrolysis of sodium hippurate, 15 of the hemolytic streptococcus cultures isolated from the milk were found to produce hydrolysis. Two of the cultures, namely from cow 98 and cow 264, both members of Dairy B herd, failed to hydrolyze sodium hippurate. The streptococcus cultures isolated from the patients also failed to hydrolyze sodium hippurate. The medium used for this test was the pork muscle broth, as described by Ayerst and Rupp, and later by Robinson and Beckler. We also found that the medium described by Hardenbergh yielded satisfactory results. The composition of this latter media is as follows:

10 grams Parke Davis Peptone
5 grams Pepsin
.03 grams Calcium Chloride (Eastman Kodak Co.)
10 grams Sodium Hippurate.
1 drop 1% Ferric Chloride
1000 cc. Distilled Water.

In mixing the media, all the ingredients were dissolved in the distilled water. The solution was adjusted to pH 7.1 with normal NaOH solution. The mixture was then dispensed in 5 cc. quantities, sterilized in the autoclave for 15 minutes at 15 pounds. The media was inoculated with the culture to be tested and incubated for 48 hours. To the 48 hour culture, 1.25 cc. of 7% Ferric Chloride was added. Should sodium hippurate be split into benzoic acid and glycocyll when the Ferric Chloride reagent is added, a precipitate was formed. On adding the reagent to the cultures, we found that all the patents' cultures and the cultures from the 2 cows remained unchanged, or no precipitate was formed, while the 14 cultures isolated from the milk all showed precipitate. As a control tube in this test, a 1 cc. of a 1% solution of benzoic acid was added to a tube of the media and incubated for 48 hours. On adding the Ferric Chloride to this tube, a precipitate was formed similar to the tubes inoculated with the cultures of bovine origin, while a negative control tube, uninoculated and incubated for 48 hours, after having added to it the Ferric Chloride solution, showed no change.

Carbohydrate Reactions

The cultures from cow 98 and cow 264 produced acid when grown in sugar-free serum broth containing 1% of the following: dextrose, lactose, saccharose and salicin but did not produce acid in broth containing inulin, mannite or raffinose (*i.e.*, pyogenes group). The other 15 strains varied in their utilization of these carbohydrates; some falling in the pyogenes group and others not.

pH Determination

Cultures were grown in dextrose broth, pH 7.4, and incubated for 48 hours. The final hydrogenion concentration was determined by the Colorimetric Method. The cultures isolated from 20 patients and the 2 cows all had a pH of 4.8 and above, while the cultures isolated from 14 other cows had a pH of 4.6 and below. Control tubes were incubated, uninoculated. It was found after 48 hours incubation that the pH of the control tube changed only .1.

Haemolytic Titre

Typical colonies were fished into serum broth, made by adding a few drops of sterile horse serum to beef infusion broth. After 24 hours incubation, ½ cc. of the culture was mixed with an equal amount of a 5% suspension and washed rabbit corpuscles, in normal saline solution. The set-up was then placed in a water bath at 37° for 2 hours. The results were read after 2 hours incubation. The set-up was then placed in the ice-box over night and a reading made again the following morning.

Pathogenicity

The growth from a blood slant, cultured from cow No. 98, when injected intravenously into a rabbit, killed the rabbit in 24 hrs. The organism was recovered from the heart's blood. Cultures from 20 patients and from cow No. 98 were inoculated into 5% horse serum dextrose broth and incubated for 24 hrs. Mice were given 0.5 cc. of the 24 hr. culture intraperitoneally at 4.30 P.M., January 30th. All mice were found dead at 9 A.M., January 31st. The culture isolated from cow No. 264 has not proven to be as virulent, in as much as a mouse lived for 3 days after injection. Four of the milk strains injected into mice proved to be non-pathogenic.

Thermol Death Point

The cultures were grown in broth for 48 hrs. On immersing the cultures in the water bath, all the patients' cultures and the 2 cows' cultures failed to survive after having been exposed to 140° F. for 10 minutes.

Capsule Formation

The examination of moist india-ink preparation was carried out.

Clinical Findings

The onset of the disease was remarkably abrupt, so much so that some of the patients expressed the opinion that they had been poisoned. The swelling of the throat included the pillars of the pharynx, soft palate, uvula and tonsils. There was a marked oedema of the uvula in each case. Many cases developed swelling of the lymph glands. Dr. Armstrong states that a conservative estimate would be that 5% of those infected in the epidemic are now suffering from permanent heart damage. In children it was not common for the glands to suppurate. Of the fatal cases, 4 in number, all presented a typical septic appearance with undisturbed consciousness to the end.

A Milk-Borne Epidemic of Septic Sore Throat

(Summary)

1. A milk-borne septic sore throat epidemic occurred at Kirkland Lake in early December, 1930.

2. The epidemic involved 457 cases and resulted in 4 deaths.

3. The incubation period appeared to be 2 days.

4. The high percentage of contact cases, 14 per cent, is probably accounted for by the close contact in crowded quarters during the winter season.

5. The milk supply of the town was supplied by 5 dairies, 4 producers and one vendor.

6. Dairy B supplied 36 per cent of all households in the town, but supplied 84 per cent of the affected households.

7. Milk samples taken from 85 producing cows, yielded 17 strains of beta haemolytic streptococci. Two of these, isolated from cow No. 98 and No. 264, respectively, and members of Dairy B herd, proved to be of human origin.

8. Throat cultures obtained from 20 cases of septic sore throat all showed the presence of beta haemolytic streptococci.

9. Twenty strains isolated from 20 patients appeared indistinguishable from the strain isolated from cow No. 98. The comparison was based upon non-utilization of sodium hippurate, acid production and utilization of carbohydrates. No serological study has as yet been carried out.

10. The epidemic was controlled by prohibiting the sale of unpasteurized milk.

Acknowledgements

I wish to express my sincere thanks to Dr. A. L. McKay, Director of Division of Communicable Diseases for granting me the privilege of using the Epidemiological data used in this paper.

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Saturday, Sept. 12
9.00 A.M.

RELATION OF THE STREPTOCOCCUS TO MILK-BORNE INFECTION

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All market milk contains streptococci. They are the organisms chiefly concerned in the natural souring of milk. In ordinary grades of milk *Streptococcus lacticus* is the species chiefly responsible for this fermentation. This organism differs from most other streptococci in that (1) it grows rapidly in milk at fairly low temperatures, (2) it produces a higher acidity and (3) it is more resistant to heat (60° C. for 30 minutes). According to Ayers, Johnson and Mudd it is not found in the mouth, udder or feces of the cow and probably gains entrance to the milk from dairy utensils. According to these authors and others *Strep. lacticus* is indistinguishable from *Strep. fecalis* of the human intestine and it may be that this is its ultimate source. In Certified milk Jones found the principal source of streptococci to be the cow's udder. This is not surprising since in the production of such milk there is little opportunity for contamination after the milk leaves the udder. This is confirmed by the fact that Jones found neither fecal nor skin streptococci in bottled Certified milk with any great frequency.

For all practical purposes streptococci may be considered inhabitants of the normal udder. From some young cows, in milk for the first time, one may obtain almost sterile milk but eventually there becomes established in the lower milk passages a bacterial flora which, in many cases, is composed largely of streptococci. The milk drawn from some animals may contain relatively few organisms and that from others may contain several thousands per cubic centimeter. The bacteria found in Certified milk are commonly almost exclusively udder organisms and a most important and effective means of keeping down the total bacterial count of such milk is the elimination from the herd of "high counters," animals with udders which harbor large numbers of bacteria but which may show no evidence of mastitis.

The streptococci found in the normal udder are often indistinguishable from those found in cases of mastitis. That they do not produce mastitis in all cows infected may be due to the absence of predisposing causes such as mechanical injury to the udder, chilling, improper feeding or lowered resistance due to other causes. On the other hand, there is abundant evidence that mastitis is contagious and may be carried from cow to cow by the hands of the milker. Such being the case, I suppose we must postulate an increase in virulence on the part of the streptococcus which otherwise may resemble bacteriologically those found in normal animals.

Mastitis is very prevalent. It appears in all herds from time to time and is present in most herds of more than a few cows at all times. Because of the lowering of milk production and, in many instances, the destruction of one or more quarters of the cow's udder, the control of bovine mastitis is at the present time probably a problem of greater economic importance to the dairyman than is any other disease of cattle. From the public health standpoint it is of less importance. Mastitis streptococci may be found in practically all market milk, raw or pasteurized. Some are hemolytic and some are non-hemolytic in the blood agar plate. There is no conclusive evidence that they may cause disease in the human consumer of milk unless possibly certain forms of intestinal disturbance may result from the drinking of very heavily infected milk from diseased cows.

There are two well recognized milk-borne human streptococcal infections; septic sore throat, with its many clinical variations, and scarlet fever. As will be described later, the streptococci found in milk-borne epidemics of septic sore throat and scarlet fever are much alike bacteriologically and some of the earlier reports of these epidemics indicate that both forms of disease were encountered. In later epidemics erysipelas is sometimes mentioned as a concomitant disease. The earliest of these epidemics in which milk was recognized as the mode of spread were reported in England beginning in 1875. Needless to say, at first the evidence was wholly clinical and epidemiological. As early as 1881 Watson suspected mastitis in a cow as the source of such an epidemic. Attention began to be fixed upon various pathological conditions in cows from herds epidemiologically associated with these epidemics; *e.g.* aphthous fever (Robinson, 1884), teat and udder eruptions (Kenwood, 1895), cows which gave abnormal milk but without gross clinical evidence of mastitis (Grey-Edwards and Severn, 1897; Kenwood, 1904; Pierce, 1904), cows with eruption or ulcers on teats (Chalmers, 1904; Robertson, 1904), cowpox and mastitis (Robb, 1905), mastitis (Savage, 1905). In most of these epidemics the evidence was wholly epidemiological and no bacteriological work was done. However, in the epidemics reported by Grey-Edwards and Severn (1897) and by Pierce (1904) streptococci said to resemble *Strep. pyogenes* were isolated from the milk of suspected cows. In 1905 Savage isolated a streptococcus from a suspected cow with mastitis. Bacteriological methods in use at that time were not adequate to differentiate the streptococci pathogenic for man from some of the bovine strepotococci which are found in mastitis.

In 1906 to 1908 Savage made a thorough comparative study of streptococci from bovine mastitis and sore throat in man. Although his cultural methods were not adequate to differentiate one group from the other he noted a difference in pathogenicity for experimental animals (mice and goats). He found a bovine streptococcus harmless when massively inoculated into his own throat. He found one or two strains of streptococci from mastitis which resembled the sore throat strains in pathogenicity. In 1911 he reviewed his work up to that date and announced the following hypothesis: *"I regard the bovine udder and teat lesions, as commonly met with, as of purely bovine origin and, as such, harmless to man. Occasionally, either as an invasion superadded upon the original bovine lesions or as a primary infection of the milk organs, there is a local infection with organisms of human origin. In such cases the conditions present may be decidedly prejudicial to man. In other words, the cow, in this class of infections, is only potentially pathogenic to man when it acts as an active or passive carrier of organisms of human origin."* Savage credits the first suggestion that cows may become infected with streptococci of human origin to Pierce (1904).

It was in 1908 (Cambridge, Mass.) that milk-borne epidemics of septic sore throat began to be reported in the United States. The first bacteriological studies were made in connection with the Chicago epidemic (1912) by Davis, Capps and Rosenow. Davis introduced the name *Streptococcus epidemicus* to indicate the hemolytic encapsulated streptococcus isolated from human cases in this epidemic. Most of this audience is familiar with the many epidemics which have been reported since that time and it is not necessary to mention them. In many instances the bacteriological study of these epidemics has not been complete and in such cases the incrimination of the milk supply has been solely epidemiological.

Often the probable means of infection is "not stated," "undetermined," "attributed to a dairy employee," "streptococci reported in the milk" or "mastitis reported in one or more cows." From what has been stated above it is evident that the mere finding of streptococci in milk or finding of mastitis in a cow is of no significance even though the streptococci found may be hemolytic. In nearly every epidemic in which suitable material could be promptly obtained and thoroughly studied bacteriologically *Strep. epidemicus* has been isolated from human patients and from the udder of one or, at most, a few cows. Brown, Frost and Shaw (1926) made comparative studies of the streptococci from various epidemics and hemolytic bovine streptococci. They found the streptococci from different epidemics to be similar and indicated methods for differentiating them from bovine strains. These methods are described in original publications and are summarized briefly in the Methods and Standards of the American Association of Medical Milk Commissions for the Production of Certified Milk.

In 1928 Brown and Kindwall reported that the encapsulated *Strep. epidemicus* is probably the S-type dissociate of the non-encapsulated *Strep. pyogenes.* It is known that growth in serous exudates of the animal body or in milk containing blood or serum favors the appearance of the encapsulated form. It may be for this reason that the human hemolytic streptococci found in diseased udders are so persistently encapsulated and it may be that failure to look for capsules resulted in the reporting of *Strep. pyogenes* from some of the earlier epidemics.

With grants from the Research Committee of the American Association of Medical Milk Commissions these and other problems are being studied. Davis and Pilot are studying the incidence of *Strep. epidemicus* in human carriers and sporadic throat infections. Frost, Hadley and others have found a fair number of cows harboring *Strep. epidemicus* (usually of low virulence) in inter-epidemic periods. They have found that not all but a fair number of cows may be infected with this organism by smearing it onto the unabraded teat opening. The fate of non-encapsulated human streptococci when injected into the udder is being studied. More rapid methods for the detection of encapsulated streptococci in the human throat and in milk are being discovered.

Much is yet to be done on the cultural study of streptococci from cases of scarlet fever. The organisms isolated are sometimes described as encapsulated and sometimes as non-encapsulated; some strains as fermenting mannitol and some not fermenting this substance. From a bacteriological standpoint this is not a satisfactory state of affairs. The only means of recognizing scarlet fever streptococci seem to be by the opsonic test and by toxin neutralization, and the latter seems to be none too specific. Otherwise some of these strains are indistinguishable from *Strep. epidemicus.* From a strain of non-encapsulated scarlet fever streptococcus, Brown and Kindwall (1928) were able to induce the appearance of the encapsulated form. Evidence is accumulating that in milk-borne epidemics of scarlet fever the route of infection may be the same as with septic sore throat, *i.e.,* through the udder of the cow. Of the forty milk-borne epidemics of scarlet fever reported between 1907 and 1927 in the United States not one was traced to an infected udder. In every case the source of the epidemic was attributed to a milker, milk handler or contaminated milk bottles although Savage (1911) and the earlier English observers drew no distinction between the possible means of transmission of scarlet fever and septic sore throat through the infected cow. This was probably because the streptococcal etiology of scarlet fever gained earlier and wider acceptance in England than it did in America. In 1928 Jones reported the isolation of a scarlet fever toxin-producing hemolytic encapsulated streptococcus from an infected udder. Culturally this organism resembled *Strep. epidemicus* but could be differentiated by means of the precipitin reaction. It was also found that fresh milk, unheated or heated at 58° C. for 20 minutes, possessed considerable bactericidal property for the scarlet fever streptococcus but that cows could be infected by the injection of cultures into the udder. Jones (personal communication) has also found that milk has little or no bactericidal power for *Strep. epidemicus.* This phenomenon has an important bearing on the laboratory technique for the isolation of scarlet fever streptococci from milk. The milk should be cultured as soon as possible after withdrawal from the udder. Since amounts of more than 0.1 cc. of milk in 10 cc. of blood agar may either partially or completely inhibit the growth of colonies of the scarlet fever streptococci, less than 0.1 cc. of milk should be inoculated into the primary blood agar plate. It should be borne in mind that the colonies in the primary plate may be quite small and with small zones of hemolysis because of the inhibitory action of the milk. After isolation the organism may be differentiated from bovine streptococci by the same methods employed for *Strep. epidemicus* and other human streptococci.

The data at hand indicate that the same measures which are employed to prevent the occurrence of milk-borne epidemics of septic sore throat should be effective for scarlet fever; (1) The elimination of carriers of hemolytic streptococci from the dairy personnel, especially the milkers; bacteriological study of throat cultures of each new employee before he is permitted to work; periodic cultures from all employees; and the early culture of each case of sore throat. (2) The culturing of the milk of each cow purchased or added to the milking line and periodic cultures from all cows. (3) The elimination from the milking line of every cow which shows any evidence of udder infection and bacteriological study of the milk of such animals. If human streptococci are found the animal should be disposed of immediately. I realize that these measures can be carried out only in the production of high-priced milk such as Certified milk. When they can not be carried out, the milk should be pasteurized whenever possible. If they are carried out, I regard such raw milk as safer from human streptococcal infection than ordinary grades of commercially pasteurized milk for it must be realized that in ordinary grades of milk coming to the pasteurizer from a large milk shed human pathogenic streptococci must often be present as demonstrated by the work of Frost, Thomas, Gumm and Hadley (1930). If there is failure in the effectiveness of pasteurization (and we know that there often are failures) we have no means of knowing how many so-called sporadic cases of septic sore throat or scarlet fever may be due to the consumption of this milk. No doubt dilution is a safety factor in keeping down the number of such cases but, since the source of infection may not persist or the failure in pasteurization may not be expected to occur continuously, there may be no recognizable epidemic and the collection of epidemiological data may be extremely difficult or impossible. I would not recommend the wholesale condemnation of milk containing bovine mastitis streptococci but I would recommend the ferreting-out of milk deliveries showing leucocytes or mastitis streptococci in large numbers and the effort to eradicate bovine mastitis for economic reasons.

DIAGNOSIS AND CONTROL OF MASTITIS

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In considering any disease, our first object is to obtain a clear mental conception of its clinical and anatomical characteristics, and to know what changes have taken place in the diseased tissues. In defining mastitis we will disregard unusual types and consider the form that is of so much interest to the farmer, the distributor, the dairy inspector, and to some extent to the health officer. Mastitis is a chronic inflammation of the udder caused for the most part by a special form of streptococcus that attacks only the udder of the cow. This inflammatory disease leads to a destruction of the secreting glandular tissue which is replaced by connective or scar tissue; this gives to badly affected quarters their firm indurated condition. From time to time the inflammation becomes more active, the milk becomes flaky or contains clumps —"garget," while the affected quarter may swell and show heat and pain. According to Skar, of Oslo, Norway, nearly all acute mastitis is a flare-up of the chronic form. This was expressed by a farmer as a tendency on a part of his cows to have mastitis. The tendency for certain cows to have mastitis means that they have it continuously, and between active attacks it is chronic, or as Dr. Hucker calls it, sub-clinical. Thus it is a chronic disease, progressive in character, marked by recurrent acute attacks, and finally leading to a condition where the glandular secreting tissue is largely replaced by connective tissue. By this time an abundant secretion of milk is impossible and the animal becomes badly damaged or worthless for dairy purposes.

Cows with mastitis present various problems according to the parties who are interested. From the standpoint of the owner, mastitis means a diminished milk flow; it causes an economic loss. Such individuals may give plenty of milk for two or three months after freshening and then they begin to dry off; they are low producers. Many cows that are poor producers are really good cows with damaged udders.

Milk dealers are interested in the quality of the milk; they want a product that is neither damaged nor spoiled. When the disease becomes sufficiently severe, or when there is a flare-up of a chronic form, the milk usually carries large numbers of bacteria, its flavor is changed and it is a damaged product. It cannot possibly be restored to normal by any method of processing.

The health officer is chiefly interested because of the possible presence of bacteria that are dangerous to man and this is comparatively infrequent. There is also the possibility that small quantities of milk may contain large amounts of damaged liquid rich in toxinc products.

The dealer, the consumer, and the health officer are directly interested in the control of milk, and the producer is, in addition, also concerned with the control of mastitis. In the past the veterinarian has been chiefly consulted to treat individual or group attacks. But there is developing a changed conception of his relation to disease control. As in human medicine, the prevention of disease is receiving much greater attention. A dairyman who will employ a person skilled in the control of mastitis to help maintain the health of the herd will spend his money more effectively than if he merely hires some person to treat a sick cow. Today certain milk companies are employing veterinarians for this purpose, and I know of a number of herds under systematic examination and special sanitary methods of milking for the purpose of maintaining normal udders. The fundamental problem in milk production is the maintenance of mastitis-free cows.

In our brief study of this disease we have made an effort to become familiar with all information available by means of observation in the stable. The cows themselves, both normal and diseased, have been thoroughly examined. Bacteriological and chemical tests of the milk are of great value, but without knowledge of the udder that supplies the milk wrong conclusions may be drawn. Failure to observe this principle has resulted in the publication of much misinformation about mastitis. The common statement that milk came from an apparently normal udder means nothing.

Chief interest is in the cause, the manner of spread, and the methods of control. There is no debate over the question that the disease is caused by infection. With few exceptions the badly diseased udder carries large numbers of bacteria, and herds from which such udders have been eliminated show comparatively little fibrosis. Furthermore, the disposal of infected cows and the practice of sanitary milking have repeatedly checked the disease. It is sometimes stated that we know little of the spread of the disease for the reason that experimental transmission by means of close association of a diseased and a normal cow has failed. What we fail to accomplish under artificial conditions may readily occur under natural conditions. I have yet to read of an extensive effort to reproduce the disease experimentally under conditions maintained in the average stable. The mere fact that the promiscuous mixing of susceptible heifers and diseased adult cows is followed by a spread of the disease is sufficient proof that the infection passes directly or indirectly from cow to cow, either on the hands or milking machine, or on the floor. We know that if the milk of an infected udder is injected into the teat of a normal cow she will develop mastitis very promptly. It seems logical that in time some of the infection from naturally infected cows may, by the process of milking, enter the non-infected teat, and I believe this is the way in which the disease is usually carried.

In the control of diseases caused by specific infection, such as tuberculosis or Bang abortion disease, all that is necessary is to break the channel of infection. After all of the infected animals have been disposed of, the disease cannot possibly recur without again introducing the infectious agent. Unfortunately this principle does not hold true in mastitis. In this respect it resembles calf scours and calf pneumonia. If we eliminate every cow that has mastitis and begin with an entirely normal group of young animals, it is possible, sooner or later, to have a badly infected herd without the introduction of a diseased individual. In other words, the habitat of the mastitis streptococcus is somewhere in the stable; according to a number of bacteriologists it is in the udder of the normal cow. Dr. Rosell has tried to find it outside the cow and has failed. On this subject there is much to be learned from bacteriological studies in mastitis-free herds. Some are of the opinion that the normal udder is the habitat of the mastitis streptococcus, and that the disease appears whenever the resistance of the udder is lowered. It is quite certain that it appears when the end of the teat is badly bruised. It is apparent, then, from our present knowledge, that control depends on constant vigilence, and the practice of sanitary milking and care of the udder. But the infection spreads chiefly, and much more readily, from diseased cows. In our mastitis-free herds we have not been able to find any considerable number of streptococci in milk samples.

Recently I examined the cows in a herd where a new milking machine had been installed. Apparently the milk cups had injured the teats through improper adjustment. In two weeks time five cows were fitted for the butcher. Certain milkers are followed by a trail of mastitis cows. In these instances mechanical injury of the teat causes the trouble.

Most dairymen believe that mastitis may be caused by high protein feed. There is no doubt that cows already affected with the disease in the form of fibrous thickenings in the udder do develop a more active form under the influence of high protein feed. I doubt if it is possible to initiate mastitis in a normal cow by such feeding.

Cows aften develop trouble at the time of freshening. This may be explained by the presence of a slight mastitis that has previously existed, perhaps for a year, and under the strain of renewed lactation the condition becomes actively acute. Often the cow's udder is not properly cared for at the time of freshening. Perhaps this is left entirely to the calf. If the youngster is active and strong a sufficient amount of milk may be removed. But it frequently occurs that the calf is weak and unable to obtain sufficient nourishment; in this case the udder becomes overdistended with milk, and a normal udder is damaged, perhaps ruined. When a mastitis is already present it may become extremely active under these circumstances. Similar examples are observed at cattle sales and exhibitions. In order to show a large udder, the milk is not removed. This is a serious strain upon a healthy udder, and it is disastrous to one that is 10 to 20 per cent defective.

Regardless of the fact that we know little of the habitat of the mastitis streptococcus, and have been unable to follow its wanderings from cow to cow, we do know a great deal about the causes of mastitis and how to prevent their operation.

I have mentioned the two chief forms, acute and chronic, and it is with the latter that you are chiefly interested. When fibrosis of the udder becomes somewhat advanced the milk production is lowered; the cow is a short milker and a low producer. It is rare that a high-class Holstein with marked fibrosis of the udder will produce 10,000 pounds of milk in a year. One owner recently asked whether I thought he could afford to sell his mastitis cows; from the standpoint of milk production he cannot afford to keep them. Such cows damage the quality and increase the cost.

Another point of great importance, and one that the average person is slow to comprehend, is that mastitis is a recurrent disease. When a cow has mastitis and recovers the chances are she will have another attack within a year—possibly two or three of them. I once listened to an account of a treatment that had cured one cow eleven times. The difficulty in understanding the nature of the disease is explained by the human tendency to consider disease in cross sections; it seems almost impossible for some minds to comprehend that disease is like a moving picture. To accurately estimate the significance of mastitis, one must consider the past history and the probable future.

I am supposed to discuss the clinical diagnosis of this disease, to tell how it may be recognized, and to explain the symptoms. Keeping in mind that we are dealing with a group of individuals with lowered production and recurrent flare-ups, we are interested in how to identify such individuals. With the numerous laboratory methods for the examination of milk, and with our present knowledge of physical examination of the milk and udder, this is not difficult. Doctor Hucker has shown the uniformity of results obtained by means of the physical examination and the laboratory tests. With either or both of these methods there should be no difficulty in estimating the status of affected herds. Such surveys have not been considered a part of the milk industry. When the control of mastitis becomes a part of this industry an enormous saving will be made.

The Clinical Diagnosis.—In the routine examination of a herd, one begins with a strip cup shortly before the regular milking period. While this method fails to reveal any except the more active cases, it requires little time, and it indicates the quarters in which gargety or flaky milk is present at the time of the examination. When used by the milker at each milking period, it reveals these cases whenever they appear and thus becomes a highly useful part of the examination. The strip cup test is followed by a chemical examination of the milk—the color test, for which the most widely used chemical is a solution of bromthymol blue (thybromol). This is done by adding one-half of cubic centimeter of the solution (0.25% in 47.5% alcohol) to 5 cubic centimeters of milk. To normal milk this gives a yellowish or slightly greenish tinge. Milk from cows with mastitis usually turns green. This may be light green, green, or dark green according to the activity of the inflammatory process. Absence of a reaction may occur when the mastitis is inactive, but the presence of a definite color change always means mastitis. The change in color is brought about by the alkalinity of the milk. This test should not be applied to cows that are about dry, or that have just freshened, for their milk has a high normal alkaline reaction. It is unsafe to buy cows that are "springing," or that have recently freshened. Their udders are distended to such a degree that the recognition of mastitis is difficult.

The physical examination of the udder is preferably made directly after milking, when the tissues are relaxed and flaccid. It is then possible to recognize fibrous thickenings or indurations in the udder. When the fibrosis is marked, the condition may readily be found, even when the udder is distended. The question has been raised: What is the significance of indurations in the udder? After repeated examinations of the udders in a number of herds, we are of the opinion that the degree of induration is a measure of the degree of mastitis. According to this principle quarters of udders are classified as follows: (1) normal, (2) suspicious, (3) distinct, and (4) marked. A cow with distinct induration in one or two quarters may still be a good producer. It is probable that an acute attack of a single quarter, resulting in a fibrous indurative swelling, may not progress; the circumscribed firm mass may never enlarge. But in most cases, atrophy of the glandular tissue and replacement with connective tissue continues until the lesions are marked. There is a wide variation in the rate of development of this process, depending somewhat on the circumstances associated with the primary attack—injury, or mere contact without injury. This explains the higher percentage of advanced forms in old cows. Do not carry away the impression that these indurations are of no significance. Conclusions based on a physical examination have usually been confirmed by means of a bacteriological or chemical examination. And the findings of a bacteriological or chemical examination are usually confirmed by means of a physical examination. Once indurations are formed the condition is permanent; it can always be recognized. But observations with respect to clots in the milk, to colorimetric tests, and to bacteriological examinations are variable; these conditions vary according to the activity of the inflammatory process. Yet sufficient evidence usually remains to establish a laboratory diagnosis.

Control of Mastitis.—Knowledge of clinical diagnosis is of little value unless it can be applied to an effective control of the disease. I believe that control is not difficult in herds recruited from natural additions. It may seem difficult for the reason that little effort has been made in this direction. The first step is to learn the condition of the herd. There are two ways in which this information may be obtained: (1) Rely entirely upon an examination of the milk after it arrives at the factory; this implies an identification only of forms that are advanced or are acutely active. (2) Conduct a systematic examination of all cows, require that all marked or distinct forms be segregated or removed from the farm, and that the owner adopt methods of mastitis prevention. It is possible to make an adequate survey by means of a clinical examination conducted in the stable, though conditions that require laboratory assistance will arise. It is a short-sighted policy to merely eliminate cows that are producing damaged or spoiled milk, or inflammatory secretions, and do nothing to prevent the development of such a condition in the healthy individuals. While it seems improbable that mastitis can be entirely eradicated, as we eradicate tuberculosis, we may anticipate relative freedom from heavy loss. The fact that many herds do not contain distinct or marked forms is proof that others may be kept healthy. This may be accomplished by grouping the normal individuals in the same line and milking them first. This implies sanitary milking with respect to cleanliness of the udder and hands, and a properly bedded stall with sufficient room. From the infected group, the more advanced cases should go to the butcher. It is highly probable that the cow with marked mastitis, subject to frequent acute activity, is the chief source of infection of healthy cows. It may be necessary to wash the hands, or to disinfect the teat cups of milking machines, after each cow is milked. It is also advised that after milking the ends of the teats be dipped in a mild disinfectant; this removes bacteria that may be left by the milker.

We now have under observation several herds, some of which were 60 to 75 per cent infected, and without exception the spread of the disease has been checked. Replacement with heifers occurs rather rapidly on the average farm. And it is also possible to buy mastitis-free replacements if one examines each purchase carefully and keeps away from herds where the percentage of disease is high.

OBSERVATIONS ON BOVINE MASTITIS

H. B. Switzer

Milk Import Station

Rouses Point, N. Y.

The first and most important provision of the Federal Import Milk Act is the requirement that the milk offered for importation must be the product of healthy cows. The Federal Import Milk Act is enforced by the Rouses Point Station of the Federal Food and Drug Administration. As a result of this provision the first problem which confronted the regulatory officials in working out field inspection procedure was to devise means for excluding all cows suffering from disease. In order to have a basis for understanding the methods of control it will be necessary to briefly sketch the requirements for the issuance of permits under the Import Milk Act. The original inspections of farms and animals are made by veterinarians working under the direction of the Veterinary Director General of Canada who appoves these inspection records and transmits them to our office where they are made the basis of issuance of the annual permits. After the issuance of the permits the continual surveillance of the farms is carried on by veterinarians from our control office located at Rouses Point, New York.

Early inspections revealed the fact that mastitis was the most common disease encountered and that it was also the most difficult disease to detect and control. After co-operative study of this problem by the officials of both the Canadian and American control offices a plan was evolved which would exclude diseased animals as determined by physical examinations made at time of farm inspections. During the first year each dairyman was warned that before the next annual inspection he would be expected to dispose of all cows suffering from mastitis and all cows that had suffered from mastitis to the extent of the loss of any quarter of the udder. In accordance with this plan the Veterinary Director General issued a statement in October, 1929, that no farms would be approved for permit if they were found to retain cows having mastitis as determined by careful manual examination of the udder. Previous to the issuance of this order the field men from both control offices had worked to improve their ability to detect mastitis by physical examination of the udder. This technique was worked out by comparative udder examinations and finally by checking their ante mortem observations with the actual conditions found on post mortem examinations of a large number of individual udders. Experience has proven that a trained inspector can detect somewhat more than ninety per cent of the cases which upon post mortem sectioning would reveal evidence of diseased condition.

It is interesting to note that our observations and experience in developing physical examination technique has been identical with that of Dr. Udall and his assistants working independently in developing the diagnostic methods which he has just described.

After the issuance of the previously mentioned exclusion order a careful inspection was made of each herd and all diseased cows detected by physical examination were excluded before the dairyman was permitted to deliver his milk to the American market. Upon the completion of this survey it was found that approximately four per cent were infected animals. The percentage of infection varied in different localities and it was our observation that in those areas where the herds were being maintained by replacements with young animals raised on the farm the percentage of infection was lower than in herds where new animals were constantly being purchased from outside sources. This leads to the conclusion that one of the main factors in the general spread of mastitis has been the careless purchase of animals from infected herds. By comparison with the reports from European countries and from certain sections in the United States the percentage of infection in Canadian herds is comparatively low.

When we come to consider some of the economic phases of the problem of bovine mastitis we are confronted with some startling records of losses due to infected udders. We are continually finding farms where the infection has resulted in a very marked decrease in the average volume of milk production. Many cases are found where the production has dropped as much as fifty per cent in two years time. In one specific case the monthly cream check when the twenty-three cows were first assembled was approximatly two hundred dollars. Eighteen months later as a result of udder infection becoming general in the herd the monthly returns had fallen to twenty-five dollars and this is not the whole story since in this case most of the high grade cows had lost one or more quarters and had to be disposed of at beef prices. We have repeatedly found that milk from diseased quarters, although normal in physical appearance, often tested as low as 0.7% butter fat while milk from normal quarters in the same cow was testing as high as 4%. This failure in butter fat secretion usually occurs soon after the acute stage of the disease.

After extensive observation of the herds on about nine thousand farms which have delivered to the United States market we have come to believe that the main factors in the spread of udder infection are milking contacts, crowded stabling and insanitary barn practices. We have often observed cases of the spread of this infection down the milking line starting from one animal and spreading along in the order of milking. Particularly was this true where the milking was done by milking machines that were not handled properly and where the dairyman was not watching the cows for early evidence of udder disease.

Our observations indicate that in stables where cows are crowded together in close contact the infection has spread more rapidly than in stables where each cow has room enough to lie down without crowding the adjacent animal. The practice of milking out an infected quarter on the stable floor is a very dangerous procedure and may be the means of disseminating the infection to other animals, especially those next in line. There does not seem to be any more important argument for the maintenance of sanitary stables than the prevention of the spread of mastitis from one cow to another from contact with infected stall floors.

There is apparently a great variation in the virulence of the causal organism in various herds. Numerous cases have been observed where an infected cow apparently has not spread the disease even though her isolation from other animals was not complete. There are other cases where the infection has spread through the herd at such a rate that all other cows have become infected within the period of one year.

It is interesting to observe the practical effects of the elimination of infected cows and the gradual lowering of infection on the controlled farms. We have recently compiled data covering a block of one hundred farms located in one section of the milk shed. The first inspection on these one hundred farms necessitated the removal of approximately eighty cows. A year later the inspector only found thirty-five cows suffering from mastitis on these one hundred farms and it is particularly encouraging to note that as a result of the most recent inspection only fifteen animals were eliminated. This seems to us to illustrate very definitely the possibility of eventual control of this disease and the reduction of infected animals to a very low minimum. This data represents results secured on practical farms which are not using any special precautions other than the removal of infected cows as fast as they developed. These results are most encouraging in pointing the way to a workable control program for the elimination of mastitis.

We have been able to secure the best results through the education of the dairyman regarding this problem of mastitis. The dairymen on the farms under our control have come to realize that mastitis is an infectious disease and that it is transmissible from one cow to another by stable and milking contacts. They have been alert in detecting the first symptoms of the disease in any of their cows and on their own initiative have taken steps to isolate this animal from the herd. They have also learned that stable cleanliness is one of the important factors in preventing the spread of the infection and this fact has had a tendency to change their barn practices toward better sanitation. Another effect of this program of education which has perhaps more far reaching results is the tendency of the dairymen to be more critical in the purchase of cows from other herds. In the territory under our control it has become very difficult to sell an animal unless the seller can assure the buyer that the animal is free from udder infection. A healthy udder has, therefore, come to be a factor in the sale value of cows in those areas where this educational program has been featured.

To briefly summarize our experience in mastitis control as applied to those farms under inspection through the enforcement of the Federal Import Milk Act: Bovine mastitis causes very heavy economic losses to the dairymen through loss in volume of production, lowering of percentage of butter fat secreted and the eventual loss of the animal as a milk producer. The infection in a herd also causes an additional loss in lowering the value of the animal from a sales standpoint. Our experience has shown that the physical examination of the milked out udder is a practical and efficient method for the detection of mastitis and that the isolation of animals detected by this means will eventually curb the spread of the infection.

SOME RESULTS OF THREE YEARS OF MASTITIS STUDIES IN THE PROVINCE OF QUEBEC

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Abstract

The following is an abstract of the more important results I have obtained in nearly three years of mastitis studies in the Province of Quebec, under the auspices of the National Research Council of Canada and the Department of Agriculture of the Province of Quebec. I have arrived at the following conclusions:

1. That the mastitis of the native cows shows approximately the same character and also occurs with more or less the same frequency as the mastitis I have observed in several European countries in preceding years. The frequency gives an average of 34% of diseased cows from those herds that I have tested in Quebec, approximately 1,222, many repeatedly tested during this time.

2. That the ordinary form of mastitis is most exclusively of streptococcal etiology, other etiological forms of mastitis being found only very incidentally. The latter non-streptococcal forms have usually some different clinical aspects. The staphylococcus mastitis, on account of being less frequent and of shorter duration, is of less economical significance in comparison to the streptococcus mastitidis, actually found in dairy herds producing milk intensively.

3. That the streptococcus found in connection with this form of mastitis is to be considered in most cases as a variety of streptococci. They have some different

characteristics which differentiate them from the groups of human streptococci described as pyogenes, anginosus, and epidemicus, and do not have the characteristics of most of the known types of pathogenic animal streptococci. In their most common form, known as streptococcus mastitis, they are not Beta hemolytic in horse and sheep blood. (Sometimes they show partial hemolysis in cow's and human blood.) They are non-pathogenic for mice, guinea-pigs, rabbits, goats, pigs and cows, except when inoculated intra-mammary in which case they ordinarily produce mastitis. It has never been demonstrated that it is pathogenic for man; however, some believe that it may cause disturbance in infants. This streptococcus presents some cultural characteristics and biological reactions which are rather constant, and manifest a lack of pathogenic and toxogenic action which some hemolytic streptococci seem to have. It appears to be similar to the streptococci described by Noccard Mollereau (1884) as streptococcus agalactia/ chronica contagiosa and as streptococcus mastitis epidemica indurativa by Guillebeau, Kitt, Addamentz, Zozchkke, and by the name of streptococcus mastitidis Migula by Savage (1906). I consider this streptococcus to be more similar to the lactic acid type, especially to the streptococcus cremoris and to the streptococcus fecalis and salivarius type, than to the other better known types of strepococci.

4. In many cases of mastitis I have not been able to isolate the ordinary type of mastitis streptococci in repeated testing nor to see them in smear sediments of fresh or incubated milk samples aseptically taken from diseased udders. In most cases I have found in sediment smears and in the cultures, micrococci of a flattened shape with cultural characteristics similar to the saprophytic transparent white udder micrococci. In my first studies I did not consider those micrococci as having an etiological

connection with the disease, but after constantly finding in some diseased cows only micrococci and these in greater number than in ordinary milk samples, I am inclined to believe, as do some others, that saprophytic udder micrococci, under favorable circumstances, may be an etiological factor in mastitis. I have found that this type that could be named micrococcus mastitis are more benign in character than the streptococcic form.

Ordinarily, they appear to be found only in one quarter and may continue for years. The induration and atrophy of the udder appears to occur with less frequency than when caused by types of streptococcus mastitis. The affected quarter ordinarily terminates in atrophy and induration. In my trials on vaccination I found a noticeable difference in results obtained by vaccinal therapy. This therapy has had much less effect in this form of mastitis than in the ordinary streptococcic form. The micrococcus mastitis such as I have seen has a different aspect than the acute pyogenic staphylococcus mastitis which I have found only four times in three years, and clinically they differ markedly. These udder micrococci appear very often mixed with the streptococci and are separated in pure culture from the streptococci with great difficulty. This very frequent mixture of streptococci and micrococci in supposed pure culture obtained from mastitis udder, is a cause of the frequent variation of cultural characteristics in repeated subcultures from mastitis strains supposedly pure.

5. The biological testing of fresh milk from separate quarters in order to discover biological, chemical and microscopical anomalies of the milk with such tests as pH, catalase and chlorine tests and the microscopical sediment tests are the most efficient and practical means to diagnose the disease in its earlier stages. The bacteriological testing, though being the more valuable test

in order to identify the etiological agents, is perhaps of less practical value for the diagnostician than the biological test, because in many cases the causative germ cannot be found in a single examination. The palpatoric examination of the udders in order to find the first appearance of indurative inflammatory lobules is very important when made by an expert, as reported by Udall and Schwitzer, and may often give an earlier diagnosis by a thorough examination. Sometimes we find indurated gland parts in the udder that appear not to be accompanied or preceded by any forms of mastitis that are chemically, biologically or bacteriologically manifested in milk and other times infection is present without noted induration.

The following tests are considered the most valuable for the early and precise diagnosis of mastitis, which I give in their order of simplicity and diagnostical value.

Biological and Chemical Testings

(a) pH tests, especially with bromthymol blue, are to be made preferably at the stable or a few hours after taking the samples. We consider this test as the easiest and most practical test in order to rapidly discover the affected quarters. It is approximately 90% accurate. With this test it is possible for a person to test all quarters of 40 cows within an hour in the stable. Its easy technic and the diagnostical value, I have reported in the January number of the Cornell Veterinarian of 1931, also the technic of the other following tests. A pH more than 6.7 or below 6.4 in cows not in the first days or advanced period of lactation, is in approximately 90% of cases an indication of mastitis. The pH may vary to some extent on different days in diseased cows. It is very constant in the udder of healthy cows. The other tests of practical value are:

(b) Catalase test, as a laboratory test or as rapid catalase test to be performed in the stables.

(c) Chlorine test.

(d) Lactose test.

Next to these easy practical tests which are the most important for the diagnosis of mastitis in cases where the udder does not clearly show symptoms of inflammation, the following tests may be considered equally as important:

(e) The macro- and microscopical examination of the sediment of fresh milk and after 20 hours of incubation followed by the bacteriological study of the milk, if possible aseptically taken. Many other tests are proposed but the above mentioned are sufficient, being the most valuable and practical. The sieve or black cloth test for detecting flakes, fibrin, or clots in the earlier stage of cases is also useful when clots are present.

The Bacteriological Study of Milk

We study the bacteriological aspects of the milk according to the following plan:

(a) Taking samples as aseptically as possible in sterile test tubes after washing the udders of the cows with alcohol and fixing their tails to avoid dust before and during milking.

(b) Cultures on special Klimmer agar (sucrose serum alcalial albuminat agar with brom-cresol purple), blood agar and sugar proteose, liver serum agar from sediment of fresh milk and after 12-20 hours with the sediment of incubated whole milk.

(c) Study of the cultural and biological character of the isolated streptococci in convenient media.

The positive diagnosis of streptococcus mastitis can best be done by demonstrating the streptococci in the sediment and by the change produced in lactose broth, milk with 10% litmus, with no reduction of methylene blue milk, and with no hemolysis in horse or sheep blood agar plates. Some few strains of streptococci and also udder micrococci produce hemolysis in cows' blood agar. Other culture media as, sodium hippurate broth, sugar tests and pH in lactose broth after 48 hours and the lack of growth at temperatures less than 15° Centigrade, may help to differentiate diagnostically from other streptococci ordinarily emanating from external sources. The non-reduction of methylene blue milk is not always constant in results and the proper concentration of the solution to be used should be determined. This streptococcus ferments, in very few cases, raffinose, inulin and arabinose, most constantly sucrose, lactose, maltose, lucose and variably mannitol and salicin. In broth or liquid media this species of streptococci give a flocculent growth, the medium remaining clear and the flocculent masses collecting as a deposit or adhering to the tubes. Although this type of growth shows a characteristically high frequency when first isolated it is by no means constant, and the degree of flocculation may vary over a wide range. In some cases a granular deposit may be associated with varying degrees of turbidity of the medium; in other cases, the growth as a whole may be finely granular as produced by other varieties of streptococci, the granules remaining dispersed throughout the medium. Some strains undergo noted changes in this respect but often these changes may be due to contamination with micrococci which persist on subcultures. If a strain gives a markedly flocculent growth, when first isolated, if subjected to repeated subculturing, it often appears as a diffused growth within a number of generations. In all cases, type of growth in fluid media is closely associated with the characteristic of chain formation. It occurs with most other streptococci. A strain which is forming long chains gives a most typically flocculent growth. If the broth appears turbid (diffused growth) it will be found that the short chain and diplococci or that some micrococci are present. Most species fail to liquify gelatine but some liquify gelatine at 22° after two to four weeks and always in a stratiform aspect.

Though particular tests for the classification of streptococci show well-marked lines of cleavage and though there is no difficulty in recognizing certain well-differentiated groups within the genus as a whole, the lack of uniformity in the test technic or the working with mixed members of streptococci in supposed pure cultures, as pointed out by Holman, renders classification and nomenclature particularly difficult.

When particular strains have been tested repeatedly after intervals of time, or when several colonies have been tested after planting out supposedly pure cultures, the results of fermentative properties are not always constant. Very often, supposed colonies of mastitis streptococci are not pure when carried through many subcultures. Cultures of mastitis streptococci are not easy to keep without loss or attenuation.

Since bacteriological tests on mastitis milk are most carefully executed and cultures made only from aseptically drawn milk, the description of coli mastitis, staphylococcus mastitis, pyogenes streptococcus mastitis, are less frequently encountered in the literature on mastitis. I believe that many earlier cases reported as staphylococcus mastitis, would today be recognized as streptococcus mastitis cases, or as udder micrococci—perhaps most of those in which the diagnosis was made upon the morphological aspect of the bacteria seen in the sediment or taken from agar cultures. The streptococci in milk sediment, milk cultures, and especially in ordinary nutrient agar, very often present a morphological arrangement, as isolated cocci, diplococci, or as irregular mass forming cocci which if determinative studies are not made, cannot with certainty be differentiated from saprophytic udder micrococci, from other micrococci, or from staphylococci frequently occuring in milk. Tuberculosis or actinomyces mastitis are seldom found in good herds.

In our experience in Canada during the last three years where we have tested bacteriologically approximately 2,900 samples, nearly all taken from separate quarters and in as aseptical a manner as the working in the stable permits, in all cases, with the exception of a few, in which we have isolated germs, not belonging to the udder saprophytic pathogenic cocci, we have always found streptococci and very often streptococci and micrococci together.

Before issuing our reports on vaccination results we wish to ask the following questions:

Is this streptococcus really the true etiological agent of mastitis?

Is this streptococcus a specific or separate variety or type center of streptococci?

These two questions may perhaps be considered as not yet sufficiently investigated to allow a definite answer. Notwithstanding the investigations reported on these questions during the last ten years have been rather numerous, and I believe that an answer may be intended in the affirmative. We have tried to do this in another paper based on our experiences and those of other mastitis workers.

Essays on Curative and Preventive Vaccination Against "Streptococcus Mastitis"

Since September, 1930 I have made trials in order to prove the effect of vaccination upon the streptococcus mastitis. I chose for my first series of experiments 104 cows located on 7 farms situated in different sections within a distance of 40 miles from our school at Oka. Most of these cows I have had under observation for two years as mastitis cows, with a persistent chronic or unchanged character of mastitis. I chose cows upon which I could make the most constant observation during the first experimentation period.

Reports published to date upon the therapeutical results with vaccination in streptococcus mastitis are not abundant. Some gave vaccination as of no value for the treatment of mastitis while others reported good results. Methods of vaccination employed by different workers are not the same. The first communication, approximately 8-10 years ago, reported on the use of dead streptococci strains and generally at doses of 2-4 cc. of vaccine (number of germs in cc. are ordinarily not given.) Vaccinations were repeated two to three times. Others used as a vaccination 10-40 cc. of mastitis milk, raw or boiled. Lately some good results were shown in doses from 10-20 cc. repeated three or four times and also from living bacterial injections.

Autogenous vaccines or stable vaccines are generally considered to be of more value. In Germany the Bavarian Government recently advised vaccination for mastitis using stable specific vaccines. However, not enough comparative studies have been made on this point. After very extensive studies upon non-specific protein therapy, especially by heterologous vaccines, that in the past 20 years has been made in human medicine for treating and preventing all kinds of infections and inflammatory processes, it is still doubtful as to what extent the true specific reaction acts exclusively in vaccinal therapy.

An advantage in the use of autogenous vaccines, besides the possible specific action, may perhaps consist in the use of fresher isolated cultures, instead of those of commercial stock vaccines, and also gives the security of always using specific germs causing the disease.

I used in my first experiments, vaccines prepared with strains of streptococci isolated from the diseased udders of different cows in each stable. These specific stable vaccines, prepared immediately or only a few days before using, I have mixed with ¼ parts of bacterial suspensions of streptococci isolated from diseased cows of other herds.

Preparation of Vaccine

I have always paid particular attention to using only strains of streptococci actually cultivated from the interior of the diseased quarters.

It is frequently a fact that streptococci, especially of the pyogenic type, isolated from milk samples and cultivated from milk taken without aseptic precaution, very often do not come from the interior of the udder.

Many times I have isolated streptococci from milk samples sent for laboratory examination, and I have been unable to find it in milk taken with aseptical precautions from the same cows. Streptococci of different kinds are found in the vaginal and fecal discharges of cows and also on the articles and materials contaminated with the discharges. On the other hand mastitis streptococci of Nocar-Guillebeau type, are very seldom found outside the udder.

The isolated and characteristic strains were grown on horse meat glucose and lactose broth with heart brain infusion as the media which has yielded a larger quantity of bacteria per cc. Less germs are always yielded from solid media than from glucose broth. The broth from pH of 7.2-7.4 were incubated 44 hours at 37.6° in Erlenmeyer flasks of one litre, half filled with the medium.

The cultures were shaken two or three times during the incubation period in order to increase the growth, and often sterile calcium carbonate was added. This growth of germs stopped ordinarily after 20 or 30 hours. The yield is seldom greater than 1400 to 1800 millions per cc. counting the individual of each chain of well-shaken cultures. One may obtain concentrated suspension by letting the broth settle naturally one day and decanting off the quantity of supernatant clear broth that is not wanted.

I have ordinarily used the whole broth culture. The first time I heated this culture for 25 minutes at 58° Centigrade, adding 0.40% of phenol for dead vaccine. The last time I used only living bacterial suspensions, adding at times as an attenuating and as a preservative agent, 0.2-0.3% phenol for living or non-heated vaccines.

I have injected intra-muscularly at intervals from 5 to 8 days the following progressive doses: 15, 30, to 40 cc. of vaccine in the first two periods 40-80 cc. in latter vaccinations. In the first two injections, I have applied only heated vaccines and in the others sometimes heated and living and the last time only living vaccines at doses of 25-60 cc. These series of injections I have repeated after two months if the cows continued to show further symptoms of mastitis and also a third time, two months later, if necessary.

As I strongly believe in the therapeutical value of protein injection in all localized inflammatory processes and also in the plainly demonstrated action of the defensive processes through the parenteral injections of proteins, and four experiments were not so much for the purpose of proving the therapeutical effects of determined kinds of vaccines, but especially to find out how to obtain a greater therapeutical result, I have in all cases, together with the bacterial suspensions of vaccines, injected also 40 to 60 cc. of milk, pasteurized a half hour at 60° Centigrade. In others, mastitis milk was injected, to which I added 4 drops of commercial formalin in 1,000 cc. of milk, the formalin being first diluted in a few cc. of water. In this experiment I have taken no other therapeutical measure, not even adopting the good recommendation of frequently milking the diseased cow.

In only a few cases have I observed a local reaction lasting more than three or four days as an effect of the injection. Out of approximately 1,600 injections made to date, I have observed a tumor-like formation with local inflammatory reaction in only five cases, and in two cases the formation of a small abscess.

To prove the capacity of the vaccine to produce reactions of infection I have injected in some cows 100 cc. of living streptococci suspensions and in a cow and in a sheep 200 cc. of living bacterial vaccine. The general reaction was only of two or three days' duration and of little importance.

The possibility of udder infection through the injection of living or attenuated streptococci apparently is not very probable. Since the inoculation of 83 healthy cows in order to prove the prophylactic value of the vaccination, after two months, I have observed the appearance of biological mastitis symptoms in three of the injected cows and I have been able to secure streptococci of mastitis from four cows out of the total of 42 of these cows examined repeatedly during the four months following vaccination.

Milk, as a non-specific stimulant of defensive immunizing reactions may perhaps contribute in rendering infection more difficult.

These experiences with the use of therapeutic milk injections demonstrate a slight tendency of injected milk being infected.

Methods used for Controlling the Therapeutical Effects of the Vaccination

In all therapeutical experiments, the greatest objection arises from the fact that very great difficulty is found in ascertaining that the therapeutical effect of success is really due to the therapeutical agent employed. The logical fallacy of the reasoning from "post hoc ergo proter hoc" (after this in consequence of this) never is so applicable as in therapeutics. Diseases are cured in most cases by the natural healing tendency of the organism, rather than by the therapeutical intervention.

A great number of diseased udders recover without treatment and seldom may it be possible to assert with certainty that any mastitis is cured by the specific treatment employed.

I give also those results which I have obtained from those actual experiments made without parallel of non-treated cows. Only after many comparative and parallel experiments of cases treated and non-treated would it be possible to make definite conclusions. I wish to emphasize the above statement, because I have really obtained greater results from the treatment than I dared to expect.

In order to verify the improvement or the cure of the diseased udder after the vaccination, I have used the same testing that I used for the finding of the disease.

I have especially chosen the pH, chlorine and sediment tests which give a surer and easier indication of the existence of mastitis. These bacteriological tests I have taken more as an etiological confirmation of disease.

The palpatory symptoms of induration and external anomalies of the udders cannot be taken as a symptom of an exact measure of the disappearance of the disease as does the testing of milk from each quarter for its biological and microscopical changes.

In relation to my work, I have made the important observation that in many cows the level of chlorine keeps higher than normal for a longer time after the restoration of the udder.

It is to be noted that the percentage of chlorine apparently decreases a long time after the disappearance of the other pathological alterations, as for example, the pH, the abnormal sediment, the catalases and streptococci. You may perhaps find an explanation to this phenomenon in the difficulty of completely restoring the vascular lesions in all inflammatory processes.

General Discussion of the Results

A cow's udder is composed of four separate and independent quarters which can be infected and present mastitis separately, as actually happens in most cases. Some quarters may be restored by means of treatment or by healing processes, while others may not. A more exact measure of the therapeutical effects may be given by checking or by registering each quarter separately, together with individual cows. I have also registered the results of the individual quarter in order to better verify the results.

The number of cows taken in the first experiment was 104. These cows were registered as diseased, some nearly two years, others only a few months. They have been tested on all their quarters many times before beginning of vaccination, on the same quarters during the vaccination, and from many weeks to four months after the vaccination series. The total number of quarters found diseased before beginning experiments on these 104 diseased cows, was 265. The number of quarters, which 10-15 days after the first series of injection, have shown an improvement or restoration according to exposed symptomology, was 209. The same after a second period of vaccination—224. Some cows having been killed and others calved or gone dry, could not be tested after the second or third period of vaccination. Of the 104 cows treated, 64 were symptomatically restored from mastitis in all their quarters after one series of 3 vaccinations with a total dose of 60 cc. of heated and unheated germs plus 40 cc. of milk.

The same after a second series of vaccinations two months later—71. Of the total of 104 cows treated, 71 cows were considered as cured.

After the treatment for mastitis we report an increase in the production of milk in one of the herds of 55 cows in which a record of the daily production was kept. In fact, in many cows, where the milk production went down to nearly half the normal quantity the production, after vaccination, was approximately the same as the maximum recorded previously. On other cows no increase in the production of milk was found.

Interpretation of Results

Objectively deducting from the comparison between diseased udders before the application of streptococci vaccine at the explained doses, 78.86% of diseased quarters have been cured, 68.21% of the cows have been considered as cured some months after.

The number of natural or spontaneously restored mastitis udders or quarters appear very variable in the published opinions. The character of the disease is not always the same in each herd, but on an average we can expect from 10 to 20% of spontaneous cures of mastitis. Some believe, however, that no cows recover from mastitis.

I had observed a permanent increase of the disease with very little tendency to cure, in one of the largest herds I have treated for nearly two years. The results in that herd after the treatment were surprisingly good. After our strictly critical observations, we may believe that the vaccination as here explained: high doses of non-heated germs plus 40-60 cc. of milk per injection, is highly recommended for the treatment of mastitis. No other treatment has given such good results. Some of the restored cows (very few) have, after some months, contracted or relapsed into the malady again, but apparently of a very short duration if treated again with the same treatment. My results in the vaccination combined with protein therapy may perhaps have been especially fortunate.

Results with Preventive Vaccination

We have had occasion to make this test only in a very reduced scale and not enough time has elapsed to deduct fundamental conclusions.

We had on February 12th made a preventive vaccination of 83 cows, consisting of two injections of 15 to 25 cc. of heated vaccine and 10 cc. to 25 cc. of living germs, at an interval of 8 days. These cows showed no symptoms of mastitis one to two months before the vaccination experiment and were kept in herds with other infected cows. The examination on April 10th showed that 64 of 69 cows which were examined had no symptoms of mastitis and that 3 cows had 1 to 2 quarters with slight symptoms of mastitis. In August a new examination of 63 of these cows showed 4 presenting biological symptoms of mastitis in one or two quarters, but only from two of these cows could I cultivate the streptococci. In another herd of 10 healthy cows prophylactically vaccinated, two have shown mastitis after a short time. None of the vaccinated cows have presented important changes after vaccination with living germs.

The most important work to be done on mastitis should be an effort to prevent mastitis with convenient and prophylactic preventive measures, and a study made to determine how the propagation and the infection occurs and where the streptococcus mastitis comes from. Many researches are necessary in order to determine the ordinary mechanism of infection and the connection of the pre-disposing circumstances, as perhaps the excessive milk production; the importance of udder saprophytics, abortus infection and other diseases. The habitat of mastitis streptococci out of udders and its origin, the study of the causes of the different clinical aspects and the variations of streptococcus mastitis and the variable morbid qualities of mastitis streptococci are also problems to be studied. It would also be convenient to standardize the many culture media used for these biological characterizations of mastitis streptococci.

The exact composition of litmus milk, methylene blue milk, origin of blood for hemolysis testing and its proportion must be more strictly established. The just evaluation of the biological changes in milk in order to determine when mastitis begins and when it is finished, will also be desirable. More studies upon the mastitis streptococci carriers and micrococci carriers are necessary. Finally, the therapeutical and prophylactical experiments have to be extended.

DISCUSSION OF PAPERS ON MASTITIS

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There is little new that I can contribute to the very interesting and, indeed, important subject of mastitis. In the eight Selected Raw and Certified dairies supplying Baltimore, all cattle in the herds are examined every two weeks for evidence of mastitis. The udders are examined physically and where there is any suspicion of mastitis through conditions of hardness, lumpiness, or atrophy, samples are collected from each quarter. It has been a routine measure to examine such samples for numbers of bacteria by the plate count and also by the direct microscopic method, to enumerate the leucocytes, and also to examine the milk by means of the catalase test. Recently, we have put into use the bromthymol blue test as described by Udall and Johnson in the April, 1930, issue of the Cornell Veterinarian. It may be interesting, as a modest contribution to the use of these tests in routine practice, to point out some of our findings. Of particular interest, I believe, will be the relationship between the bacterial count by means of the plate method in milks which give every indication through the leucocyte count and the catalase test of being from mastitic udders.

In general, the bromthymol blue and catalase tests check or confirm the leucocyte count very acceptably. In special observations made so that the data could be fully relied upon in a total of 58 samples where the leucocyte count exceeded 500,000 the bromthymol blue was positive. In 14 positive samples the catalase test checked equally well. In those samples in which from the leucocyte count the judgment might be considered negative for mastitis, the bromthymol blue test gave reactions in more than 50% of the cases which were either suspicious or positive. It is not considered that sufficient work has been done by us to pass a weighty opinion upon the value of the bromthymol blue test, but the above indication is merely cited in support of the claims for this test as a field method for quickly differentiating cattle which are at least suspicious of mastitis. It may be stated, in passing, that this method will be used as a routine one in the field and also in the laboratory where it will aid in arriving at a diagnosis of the rather debatable condition termed mastitis.

Mastitis was first described from clinical observations by veterinarians. The difficulties inherent to the diagnosis on clinical, or physical, symptoms alone have promoted the development of a number of laboratory examinations. We, in Baltimore, use, or have used, in the past, those which were cited above. In order to compare the clinical observations of the veterinarian in the field, a series of observations were made and the milks from cattle selected because of their supposed mastitic condition, were correlated with the findings of the veterinarian. Fifty-five conditions were diagnosed with the result that in 44 cases described as mastitis by the veterinarian in the field, the diagnosis was confirmed by both the leucocyte and bromthymol blue tests. In six cases diagnosed as negative the bromthymol blue test showed 4 positive reactions and 2 suspicious; from the leucocyte count, 5 were termed positive and 1 negative. In 5 cases termed suspicious by the veterinarian the bromthymol blue gave 5 suspicious reactions, while the leucocyte count gave 4 negative findings and one positive. While limited in extent this survey indicated that the positive diagnoses of the veterinarian were invariably checked by the laboratory, but that in negative clinical findings the bromthymol blue test and the leucocyte count gave indications to the contrary. In the majority of cases these tests by the veterinarian were either suspicious or positive when the diagnosis was either negative or suspicious. In brief, the laboratory tests gave, in the majority of instances, reactions which would in the light of our knowledge indicate mastitis where the veterinarian in the field was unable to clinically diagnose the case as such.

The relationship between the bacterial plate count to mastitic milk has been a matter of inquiry to us for several years. There appears to be little, if any, data in literature upon this particular point. Furthermore, it seems to be a general understanding that milk from a mastitic cow usually, and some Inspectors believe invariably, contains a high bacterial count. In 150 samples taken from individual quarters of cattle definitely suffering with mastitis as disclosed by the leucocyte count and catalase test where these two examinations checked in every case, the bacterial plate counts may be analyzed as follows:

In the 150 samples:—

		% Under
1,000 or less	= 57 or 38.0%	38.0
1,000 or 10,000	= 55 or 36.7	74.7
10,000 or 100,000	= 25 or 16.7	91.4
100,000 —1,000,000	= 7 — 4.6	96.0
Above 1,000,000	= 6 — 4.0	
	100.0%	

Minimum = 100
Maximum = 7,200,000
Average = 116,444

It is interesting to point out that about 75% of all samples contained less than 10,000 bacteria per cc. Although normal udder inoculations should show bacterial counts averaging around 5,000 or 6,000 bacteria per cc. it is interesting not only to state that 75% of samples of milk from cows definitely suffering with mastitis contained less than 10,000 bacteria per cc. but also that more than 90% of such samples contained less than 100,000 bacteria per cc. It will be easy to picture the condition which is favorable for the discharge of large numbers of bacteria into the milk during the course of mastitis, but it is believed that the above tabulation indicates that milk from cows suffering from mastitis does not necessarily presuppose that the milk contains large numbers of living bacteria but, to the contrary, is much more apt to contain relatively low numbers and more in accordance with the numbers found in milk from cows with normal udders.

STATE-WIDE MILK SURVEY IN NEW YORK

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A discussion of the survey of the milk and cream supply of New York State was presented at the Cleveland meeting of this Association last year. The work had then been underway for only three months. The plans outlined at that time have since been carried out more or less completely and most of the results are now available.

The survey included a quantitative study of the sources of supply of milk and cream for household consumption and for manufacturing purposes, a laboratory study of the quality of milk and cream being delivered to consumers and of milk being delivered to pasteurizing plants for pasteurization, a field study of the efficiency of local milk inspection and a statistical study of the milk control activities of health officers based on their own reports. The survey has been continued during the early part of this year with a study of fluid cream supplies and of ice cream supplies within New York State. We are not ready to report on this ice cream and cream survey.

The results of the survey omitting this later work showed that practically all of the milk and much of the cream for household consumpttion, equivalent in amount to about one and one-quarter pints of milk per capita daily, was produced in the so-called "New York milk shed" under the inspection of health officers of New York State municipalities. About two-thirds of the market milk consumed in the state as a whole was pasteurized. The findings show that 94% of the milk consumed in cities is pasteurized, while only 26% of the total amount consumed in the villages and rural areas is pasteurized.

The findings also indicated that in general, milk sold in the cities was of safer sanitary quality as determined by the percentage of milk pasteurized than that sold in rural communities and that sanitary conditions in pasteurizing plants were more satisfactory than those in raw milk bottling plants. Dividing the state geographically into districts, conditions were noticeably better in some districts than in others. The archaic and inefficient system of milk control by more than eight hundred part time health officers is probably responsible for the relatively poor showing made by rural communities.

The survey results also showed that much of the cream used for manufacturing within the state is imported from the middle western states and is not subjected to the same inspection as that required for fluid cream. At the present time it does not appear to be necessary for the protection of public health to require that milk and cream for manufacturing purposes meet the same standards as milk and cream for household consumption. However, some effective means must be devised to prevent the diversion of cream for manufacturing purposes into "fluid" cream channels. Approximately one and one-third times the quantity of milk used for household purposes is required to produce the manufactured milk products consumed in the state. A large part of this is, of course, imported as finished products. Careful estimates show that New York State produces only 14 per cent of the milk used to manufacture the milk products consumed in the state.

Laboratory Work

The field and laboratory survey work was carried out with considerable dispatch by following a fixed schedule. Two parties of four men each were placed in the field. Each party was furnished with three automobiles and with a mobile laboratory completely equipped for making standard plate counts and direct microscopic counts. In making surveys the laboratory headquarters were established at main centers of populations and samples were brought in from municipalities within a radius of about twenty-five miles by members of the survey party. Samples of milk and cream were collected from dealers' wagons on the street for standard plate count and composite samples of individual producers' milk were collected and smears made, usually at the plant, for direct microscopic examination. The pasteurizing and bottling plants were inspected. In the smaller places inspections were made of all farms up to twenty-five and in the larger cities fifty or more farms were covered.

The milk and cream supplies of about 200 municipalities of all sizes were surveyed in this way during a three month period. More than twenty-three hundred bottles of milk and cream were collected from dealers' wagons on the street. The standard plate counts on 69% of the milk samples were within the rather stringent limits set by the sanitary code, which are 30,000 for Grade A pasteurized and for A and B raw; and 50,000 for B pasteurized. Standard plate counts on 60% of the cream samples were within the less stringent standards set for cream, which are 100,000 for Grade A pasteurized, 500,000 for pasteurized, and 200,000 for raw cream. Direct microscopic counts were made of samples of milk collected from nearly 10,000 producers as delivered at pasteurizing and bottling plants. Eighty-three per cent of all these samples gave counts under 300,000 which is the maximum allowed for Grade B milk before pasteurization. It is interesting to note that contrary to popular belief, the percentages of bacteria counts falling in each of the four numerical groups arbitrarily selected before the survey was undertaken were about the same for raw milk to be consumed as such and for raw milk to be pasteurized and consumed as pasteurized milk.

Direct microscopic counts made on about two thousand samples of milk collected as delivered to cream plants in the middle western states were relatively higher than corresponding counts made on samples collected at New York State plants.

Inspections

It is rather difficult to express the results of the inspections of plants and farms on any basis even if a numerical score card were used which is not the practice in New York State. Of more than 900 raw bottling plants inspected 13% were rated as "good" and 29% as "poor." The other 58% were rated "fair." Those rated "good" meet practically all sanitary code requirements. Those that were passable but in need of definite improvements were rated "fair." The plants rated "poor" lack essential equipment and follow unsatisfactory methods from the public health standpoint. Of 466 pasteurizing plants rated on the same basis, 55% were good, 20% fair and 25% poor. Supervision of the inspection of pasteurizing plants by the State Department of Health very likely accounts to some extent for this difference. Of more than 3,000 farms inspected, 9% were rated "good," 70% "fair" and 21% "poor."

Activities of Health Officers

A study and analysis of the reports of health officers on their milk control activities gave further interesting information. More than eight hundred health officers serve the 1,225 health districts in the state. The health districts enumerated include cities, villages, townships, consolidated health districts and counties. Only eight per cent of these districts employed full time milk inspectors. Many of these inspectors, however, had other duties. An additional 12 per cent of the districts employed part time inspectors and in the remaining 80% part time health officers usually poorly paid for the services demanded, did such inspecting as was done.

In more than 90% of the health districts having milk dealers the health officers were, according to their reports, issuing permits and making an inspection at least once a year of each milk plant and dairy farm. About three-quarters of the districts report the required annual physical examination of cows made. Observations made lead us to believe that the value of these examinations is questionable as ordinarily carried out. In about 60% of the health districts bacteria counts of all dealers' milk were made at least four times a year as required. In another 19% some counts were made and in 21% of the districts, no bacteria counts were made. This analysis, of course, deals only with the performance of specific duties prescribed by the sanitary code. It does not take into consideration how well or how poorly they may be performed. It is rather surprising, bearing in mind the circumstances under which milk control is done, that the showing is as good as it is.

Magnitude of Control Problem

These findings aroused our interest in the amount of milk control work necessary to give the milk and cream supply in the 1,225 health districts in the state which excludes New York City, only the minimum supervision required by sanitary code regulations. Careful estimates show that there are 4,200 plants and shipping stations to be inspected at least once during the year, 31,000 dairy farms to be inspected once a year and 420,000 cows to be examined physically once a year. In addition to this not less than 20,000 samples of bottled milk should be collected each year and standard plate counts made. Although the code does not specifically require that bacteria counts be made of producers' milk as delivered at plants, it does fix maximum counts for milk before pasteurization. For effective control, we would add to the present minimum code requirements the collection and examination of samples of producers' milk at least once each month and the inspection of plants monthly with an additional allowance for special inspections of plants and dairies and for the physical examination of cows when laboratory findings indicate the need thereof.

Cost

Careful estimates of the probable cost of carrying on effective supervision of the milk supplies of the state on a county basis indicate that this work can be done at a total cost of approximately $560,000, half of which would be paid by the various counties and half by the state. This represents a total cost of approximately 10 cents per capita per year. If the cities do not continue to maintain independent milk inspection forces but co-operate in the work of the full time county unit, a large part of the cost of the county work would be covered by the present expenditures of cities.

Progress to be Expected

To make further satisfactory progress in milk control work in New York State in the most economical method, both financially and administratively, it appears to be necessary to educate the public generally and milk control officials particularly, as to the necessity for this work and as to how efforts may best be directed to accomplish it. It is also important to pass regulations, the enforcement of which will make it possible to identify manufacturing cream and prevent its diversion to fluid cream channels. The drafting of such regulations is now under way. The ultimate need is, we believe, to replace the present system of milk control often times carried on by non-technically trained part time health officers by a system of full time milk control specialists. This is economically possible if the work is placed on a county unit basis.

RUNNING DOWN THE CAUSES OF HIGH BACTERIA COUNTS IN MILK

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The bacterial content—both as to numbers and kinds—is one of the most important problems in the marketing of whole milk. Our first aim is, as it always has been, to control this bacterial content, but in this we are confronted with certain difficulties which at times prove rather disconcerting. There is little doubt regarding the fact that the application of the principle of bacterial control has, in many respects, been reduced to an absurdity by the almost universal emphasis that is being placed upon insignificant differences in specific counts and by the establishing of grades based upon numerical limits that fall well within the range of experimental error. It is true that to publish counts in a newspaper yields information of no value to anyone except possibly to the technician experienced in the milk control laboratory. It may also be pointed out that certain types of micro-organisms do not grow on the media ordinarily used. Nevertheless, in spite of these or other defects which might be pointed out, it must be agreed that wherever an effort is being made to keep the number of bacteria in milk as close to an irreducible minimum as is practically possible, such milk is invariably, dependably high in quality. This is the justification for bacterial control and constitutes the reason why it shall probably always continue to play an important part in our efforts to improve milk quality.

Instead of spending time and energy in condemning the principle of bacteria count control and in pointing out the defects in laboratory technique, extreme variations in duplicate counts and the like, perhaps it would be well for us to check up the fallability of the prevailing notions as to how the principle of bacterial control should be applied. It may be that we have unwittingly allowed our enthusiasm to override our judgment. As a result, control officials, milk plant operators and others have been guilty of literally trying to make it appear that a more or less highly variable biological phenomenon (in this case micro-organisms in general) can be sufficiently controlled to meet arbitrarily fixed standards that reflect personal opinions which were not based upon a comprehensive knowledge of the underlying fundamental principles.

Just as the successful farmer will always be confronted with the job of reducing the weed content of his farm to the lowest practical minimum, so will the successful handler of milk always be confronted with the job of keeping the bacterial content of the milk at as low a point as is practical. It is from this point of view that this subject is discussed. It is safe to assume that milk control officials will continue to be called upon to lend their assistance in locating the causes of high counts. To render this service most satisfactorily, however, demands a constant searching for the fundamental truths and a willingness to have every decision or conclusion checked up against demonstrated facts.

Any given series of high counts may demand a different approach in attempting to locate the cause or causes. Therefore, all one can hope to do in this brief period is to indicate, aided by citing personal experiences, some principles that may be of assistance. It is difficult to outline fixed rules. Many causes of high counts are comparatively easy to locate; others are difficult.

It is never safe to dismiss the causes of any high count with a snap judgment and there is no better training in the field of applied dairy bacteriology than to follow persistently the principle of exhausting every possibility in an effort to actually prove causes. Sometimes final proof cannot be obtained: not infrequently will the high count disappear before the cause has been demonstrated. Proving one's point adds valuable information and makes future work progressively easier. Being content to "get away with" explanations or to guess, progressively weakens, and sooner or later makes effective progress impossible.

The laboratory method employed is an important factor in determining one's approach to the problem of locating causes of high counts. Therefore, a brief statement regarding the methods should be made at the outset.

The agar plate method reveals only those micro-organisms adapted to growth on standard media. It is safe to assume that, for the most part, most of the miscellaneous micro-organisms normally present in raw milk grow on the standard media. Marked discrepancies even then will occur at times, due to the fact that for some reason, a particular milk supply happens to contain a type of micro-organisms not adapted to growth. As applied to pasteurized milk, we are confronted with some disconcerting complexities in that many of the thermophilic types will not grow under ordinary laboratory procedures. Some demand temperatures as high as 140 to 150° F. and others appear to be so highly specialized in their growth requirements as to demand the addition to the regular standard media of some special food materials such as yeast extract, lactose, or tomato juice and the like. Then there are the obligate anaerobes which may not appear, as well as most of the pathogens.

The direct microscopic method, with proper magnification, reveals practically all of the micro-organisms present, including to some extent the dead cells which, however, tend to lose their capacity to absorb stains. Tiny organisms may be overlooked as well as those that do not stain well by methylene blue. A microscopic field may be so densely stained as to completely obscure the bacteria cells or a given sample of milk may contain so much fine dirt as to cause the microscopic field to be cloudy. Under such circumstances it is always difficult to detect micro-organisms.

By the direct microscopic method, it is possible to examine a large number of samples of milk on consecutive days and to trace causes on the same day that the count is made. It is also possible to note the types of organisms present and in this way obtain, oftentimes, irrefutable proof of causes of high counts.

Each method has its advantages and disadvantages and both yield counts that are more or less highly variable. Wherever possible, it is advisable to use both methods in duplicate—not so much to check accuracy of counts because when applied to individual samples, this is more apt to prove misleading than otherwise—

but to confirm conclusions regarding types and sources. One method is no more accurate than the other in ascertaining numbers of bacteria in milk.

At milk plants where there is being received from the farms an excessively high percentage of high bacteria count milk, the general cause is comparatively easy to locate. But after making the necessary corrections, there will very likely still exist a few persistently high cases or there will suddenly appear, even at high class dairies, a series of counts in excess of the limits, the cause of which is oftentimes not so easy to locate. If the counts are excessively high such as several million, it is usually an easy matter to locate the cause but usually the most disconcerting case is that one in which there are a series of counts ranging for example from 10,000 to 40,000 or more in a supply where every effort is being made to meet a 10,000 count limit, for example.

One count, whether high or low, is of interest but under most circumstances, is of little value. However, if a trained bacteriologist knows something of the past history of a given supply and especially if he knows something about the significance of the types of microorganisms present as revealed by the direct microscopic method, a single examination unquestionably has value. This demands a technician who thoroughly understands the inherent limitations in bacteria count methods and the difficulties involved in interpreting results.

A few personal experiences and observations will best illustrate some of the complexities to be encountered in locating causes. To be successful one should develop an epidemiological point of view, because ability to make the best use of a "bird's-eye" picture of the numerous factors involved in their possible relation to the high count is of very great value and saves much time. In other words, it is necessary to be able to successfully eliminate from consideration those factors which have little possible relationship, if any, and especially is it necessary to be able to properly evaluate seemingly plausible theories which are invariably advanced by others at the start.

The inspector, technician, or anyone else who seizes upon the first plausible theory suggested, conclusively demonstrates his own unfitness to render the service he is supposed to render. Who hasn't met those individuals who are quick to agree with a dairyman's suggestion that ropiness in milk is due for instance "to the eating of some weed in a pasture" or to the prevalence in the pasture of a white, foamy substance formed, by a certain insect, between the stem and blades of grass. A tactful and courteous doubt regarding all suggestions, together with a determination to approach the task from the point of view of ascertaining the truth so far as possible, is the only safe procedure.

In localities where there has been little or no sanitary supervision, especially where no bacterial control has been maintained, one may normally expect a relatively high percentage of the milk to be excessively high in bacteria counts. This is not always true, however. For example the percentage of high counts is lower in cold weather than during warm weather. Usually most of these high counts are the result of inefficient cooling. This fact is quite generally appreciated because it has been demonstrated many times that insistence upon better cooling will result at once in a marked reduction in the number of high counts.

Even under rigid supervision and with efficient cooling, a relatively small percentage of repeatedly high counts may persist. A few of these may come from dairies managed by operators who studiously evade requirements. They constitute a problem in themselves. Fortunately most of the persistently high counts occur where there is a willingness and desire to meet requirements but the individual concerned lacks knowledge of the principles of bacteriology. This is the inspector's opportunity to render a helpful service. To be on the safe side, however, his conclusions should be based upon a series of counts.

Should one be confronted with such a series of repeatedly high counts, special studies are often necessary before safe conclusions can be reached. The position of an inspector who goes out armed with the facts is greatly strengthened. In those cases of persistently high counts, it is best to sample each can delivered but this is not always possible. At least a composite of night's and morning's milk should be taken. If the counts on night's milk are high and morning's low, improper cooling is invariably the cause. This rule is not without its difficulties, however, because it is not always easy to distinguish morning's milk from night's milk; or because of the holding back of one milking, the milk may be older than it is supposed to be. Occasionally milk may be delivered on alternate days. The delivery of old milk, however, is the exception rather than the rule.

The prevalence of the typical, short chained, lactic acid producing streptococci is also indicative of improper cooling. Usually any extremely high count of several millions or more is invariably largely the result of inadequate cooling, rather than the result of excessive contamination from dirty equipment. Lower counts that are repeatedly in excess of the numerical count limit may be the result of inadequate cooling, but are more frequently the result of the addition of bacteria from poorly cleaned equipment.

If the counts in both morning's and night's milk as delivered by the producer are high and contain about the same numbers of bacteria in each, it is usually safe to conclude that the chief cause is due to the addition of bacteria in large numbers from the utensils. This conclusion is particularly justified if the types of microorganisms are alike in every can. Improperly cleaned milking machines may be the cause for high counts in such cases, but not always. The problem is not as simple as this. Dirty milk cans may play a part as well as the occasional case of mastitis. The more time an inspector spends in studying all cases of high counts from the point of view of ascertaining the truth, the more efficient he becomes in judging the significance of each possible factor.

Another safe assumption is that high counts in fresh milk delivered within 3 to 5 hours after being drawn from the cow is far more indicative of excessive contamination than of growth. But again, we must not lose sight of exceptions. There might be sufficient bacterial growth in an occasional lot of milk to be significant and a high udder content will occasionally play a part. In general, the so-called "germicidal properties" of mixed fresh milk is sufficient to control growth during this period which is lengthened by cooling. Fresh milk produced under clean conditions should be uniformly low in count during the first 3 to 5 hours, even though not cooled.

Before going further, I wish to again emphasize the fact that the above suggestions cannot be depended upon to solve one's problems in 100 per cent of the cases. The exceptional cases occur sometimes with disconcerting frequency and ability to recognize them, at least, with a reasonable degree of accuracy, is an index of a man's fitness to render the service which will win the confidence of all interested in milk control.

For example, one striking exception to the above statement that a high percentage of high counts in a given milk supply justifies the conclusion that the milk was being inadequately cooled, was brought out in one instance in central New York State.

The author was called upon to make a bacterial count by the microscopic method on the milk delivered to roadside platforms by 35 dairymen. The first examination revealed 28 delivering excessively high count milk. A second count was repeated the following morning and the same 28 were still delivering high count milk. This was an interesting observation in itself and naturally raised the question as to why the remaining 7 should deliver low count milk on both days. In attempting to answer this question, another more strikingly interesting observation was made that the same identical micro-organisms predominated in every can of high count milk delivered by the 28 producers. Experience had proven that this was unusual in many respects because normally the types of micro-organisms predominating, differ in the milk delivered by different producers. To find the same micro-organisms predominating indicates a common source of contamination. There was but one common source in this case: namely, the vat in which the cans were being washed. An examination of the cans revealed an ounce or more of milking water in each can and an examination of this milky water under the microscope revealed the same organism prevalent in the 28 cases in sufficient numbers to give an initial contamination of over 150,000 per cubic centimeter. Unfortunately, my schedule in extension work did not make it possible to follow up every case. But the fact that three of the seven who delivered low count milk on both days stated that they always washed their own cans before putting milk into them has considerable significance.

Under ordinary control, it would be customary to turn over to an inspector this list of high counts and it is quite certain that had this been done, the inspector would have gone out among the producers and discussed a different possible cause at each farm, when the truth was that a more efficient cleaning and sterilization of the cans would have resulted in a marked reduction of the number of persistently high counts. Special studies on the few remaining cases would have revealed the fact that in general the causes of the high counts differed on the different farms and each case might require a different approach.

To be able to go to a dairy and demonstrate that the cause of the high count was due to inadequate cooling or to a dirty milking machine moisture trap as we have actually done several times, or to some other utensil as was done specifically with an aërator in one case, or to udder troubles, is a most instructive procedure. Both the inspector and the producer learn more real applied bacteriology in the field of milk production than can be learned in a course of lectures on the subject.

If one follows the principle of ascertaining the facts and stands ready to demonstrate the facts wherever possible, the location of causes for counts in excess of the limits becomes progressively easier. With apologies to Koch, may I offer four postulates? First, study microscopically the types of micro-organisms predominating in the milk. Second, make a microscopic preparation of material scraped off or collected from the suspected source. Third, have the demonstrated cause removed—if it is an udder, have the milk kept out; or if a dirty utensil, have it cleaned. Fourth, re-examine the milk microscopically and wherever possible, recheck at intervals a few times in order to make sure that the desired results have been accomplished.

Sometimes one will find that he has missed the cause, but with experience, it is surprising how comparatively easy it becomes to locate it, even in a milk supply that is supposed to meet, for example, a 10,000 or 30,000 count limit, but in which the counts run repeatedly from 40,000 to 75,000 or 100,000 per cubic centimeter.

In one such case, the first examination of several bottles of milk revealed a small micrococcus organism, growing singly or in pairs. This was the only type to be found. A microscopic examination of the milk directly from the udders of the 20 cows revealed no micro-organisms in 100 fields. The milk was cooled at once after each milking, to below 40° F. The utensils, including the milking machines, were smooth, clean and dry. Sterilization was by means of a hypochlorite solution. On examining the detachable part of the milking machine moisture trap which, according to instructions from the salesman, was left attached to the stanchion hose, was found to be coated with a thin layer of thick milk. An examination of this under the microscope revealed the same miscrocci mentioned above. As a result, this moisture trap was cleaned daily, in the same way as the other utensils and of 17 successive counts on samples sent later for rechecking, all but two were below 10,000.

Another case occurred at a Farm Bureau-College demonstration meeting which was attended by 30 producers and held at a milk distributor's plant. The count averaged 48,000 and the source was shown beyond dispute, as shown by the types of micro-organisms present, to be due to contamination from streaks of yellow material in the creases between the pipes of a small surface cooler.

In two other cases the high counts were traced definitely, by means of noting type, to the filler valve and gaskets under the automatic bottle filler.

In general, whenever the surfaces of any milk equipment appear to the eye to be clean, dry and free from any visible evidences of accumulations, it is safe to assume that comparatively few bacteria will be added to the milk, especially where a reasonable degree of sterilization is practiced. I am confident that any inspector or milk plant man can train himself to locate by inspection only, a number of the sources of high counts. Some sources will escape detection, however, for a time.

In locating causes of counts repeatedly in excess of the limits, it is usually helpful to study, if available, a large number of previous counts arranged in sequence according to the date of sampling. In doing this, however, one must always keep in mind the efficiency of the laboratory technician. But even then, interesting possibilities may come to light.

In one instance we were asked to ascertain why it was impossible to produce on a certain dairy farm, milk with counts lower than 20,000. Everything was being done that could be expected to control the bacterial content. An arrangement of the counts in sequence as above indicated revealed an abnormal uniformity covering a period of seven months, in which 91 of 96 counts were between 20,000 and 35,000. Reasoning epidemiologically and from experiences in milk counts, such uniformity could reflect faulty laboratory procedures only and to one acquainted with laboratory methods it is natural to first suspect a faulty use of the dilutions, which was found to be true in this particular case. The technician had been instructed to count only the 10,000 dilution plates, even though the bacterial content of the milk averaged from 4,000 to 10,000 or 12,000 per cubic centimeter. With a dilution of 1-100, this would mean 40 to 120 colonies per plate; a 1-1000 dilution, 4 to 12 colonies; and a 1-10,000 dilution, less than one bacteria per plate. The one to two or three contaminating colonies that may fall into each place or the couple of specks in the media mistaken as colonies, would be multiplied by 10,000.

This shows that the technician may be at fault but sometimes this is far from easy to prove.

Large colony forming bacteria prevalent in milk as shown under the microscope oftentimes indicate utensil contamination. However, one must be cautious because large colonies oftentimes form in the thick cream layers and their increase in numbers and size may be due to growth. This fact always must be kept in mind in drawing conclusions as to utensil contaminations. Some technicians are too hasty in concluding that utensils are the cause, merely from the fact that large colony formers prevail.

It is generally safe to assume that the prevalence in any milk supply of excessive numbers of leucocytes with bacteria engulfed in them, is a fairly reliable index of abnormalities in udders. To locate the exact source sometimes demands special studies. I shall not undertake any extended discussion of the problem of udder trouble. It is clear that our knowledge is still meager and that there are many annoying complexities. For example, some cases of garget yield large numbers of micro-organisms and the numbers oftentimes reflect the stage of the disease. In other cases, udders are found with unmistakable evidences of mastitis, secreting fairly large numbers of leucocytes into the milk but showing so few organisms as to escape detection microscopically. To find the micro-organisms it is sometimes necessary to incubate the sample of milk at body temperature for 24 hours or more. Udders will also be found that appear normal, clinically. The milk may also appear normal, although containing large numbers of leucocytes with micro-organisms engulfed.

The locating of high counts in a mixed milk supply presents somewhat different problems. The complexities are greater and one must be guided by counts made upon process samples together with a microscopic study of the prevailing type. As applied to pasteurized milk, the agar plate and microscopic method supplement each other. When it comes to locating especially the thermophilic types, it is impossible to proceed intelligently by the use of one method alone. The agar plate count may be less than 5,000 and yet in the milk there may be several millions of living micro-organisms. These organisms are not disease producers but will cause a marked deterioration in flavor.

Some of the thermophilic organisms will grow if the plates are incubated at 140° or more. Others will not grow on the agar medium unless some special substance is added, such as lactose sugar, tomato juice or yeast extract.

The question of eliminating or of controlling these micro-organisms is a much discussed one. Some are sure that they cannot even be controlled. Our experience has been, however, that they can be controlled, but to do so demands a supervision of the milk as received prior to pasteurization and above all, there is demanded daily, unfailingly, a careful and thorough cleaning of all equipment and prolonged sterilization by the use of hot water at least above 180° F. or by steam.

These instances are sufficient to indicate the valuable part that a trained technician or inspector can play in the bacterial control of any milk supply and to give some notion of the numerous complicating factors that exist, but the knowledge of which is imperative. Of one thing we may be sure—any sanitary supervision of milk supplies that directs the attention to the essential factors that determine the bacterial content of the milk is progressively building up a more intelligent group of milk handlers. The dairyman becomes a more efficient dairyman, and the distributor a more efficient distributor.

REPORT OF COMMITTEE ON DAIRY FARM METHODS

T. J. Strauch, *Chairman*

In order to produce quality dairy products, milk must be produced at its source by methods which will insure cleanliness and purity.

There are a number of different factors governing the production and handling of milk on the farm which have an influence on the sanitary quality of milk. Your committee therefore recommends the following requirements for the production of clean milk.

1. The entire body of the cow should be kept clean; long hairs clipped from udder, tail and flanks.

2. Dairy barns should be dry, well lighted (at least three square feet of glass per stall), well ventilated, with tight floors and gutters (cement recommended for floors and gutters). A comfortable, light, well ventilated dairy barn that is easy to keep clean and sanitary makes a desirable milk manufacturing plant.

3. A milk house which is light, clean and well ventilated, with an impervious floor, should be used for handling and storing of milk. An adequate water supply of safe quality should be available.

4. Utensils and containers should be of such construction as to be easily cleaned and be in good repair. All utensils should be rinsed with clean cold water immediately after use. This is to remove the greater part of the milk which sticks to the utensils. The rinsing should be done immediately without waiting, as milk will dry rapidly on the utensils, and dry milk is difficult to remove. The utensils should then be washed in warm water containing a washing powder, then sterilized with

steam or heat, or should be scalded. It is very important to wash and sterilize the utensils and containers after each usage. They should be protected between milkings from flies and dirt.

5. Dusty feeds should not be fed just previous to or during milking.

6. Udder and surrounding parts should be wiped with a clean, damp cloth before milking.

7. Milkers should wash their hands before milking, and milk with dry hands.

8. Milk should be taken from the barn to the milk house after each cow is milked and cooled to a temperature of 50° F. or lower, and maintained below 50° F. until delivery. One of the greatest troubles encountered in the handling of milk is the growth of bacteria. The cows, utensils and equipment may be kept immaculate, but unless the animal heat is removed and the milk kept at a safe temperature, a rapid growth of bacteria will result.

A floating dairy thermometer with a range of from 20° to 110° F., and large enough to see the lines, is recommended as part of the necessary equipment on all dairy farms. The thermometer should be tested to see if it is accurate.

Your committee, therefore, is of the opinion that the essentials for a quality milk are: Healthy cows, clean milk utensils, clean methods of milking, quick cooling of milk and storing at a low temperature.

REPORT OF THE COMMITTEE ON COMMUNICABLE DISEASES AFFECTING MAN

HORATIO NEWTON PARKER, *Chairman*

The Public Health Service, for the year 1930 lists 48 outbreaks of disease that were caused in as many cities and towns of the United States by infected milk. Of them 30 were of typhoid fever, 2 of scarlet fever, 9 of septic sore throat, 3 of gastro-enteritis, 1 of gastritis, 1 of dysentery and 2 of food poisoning. In all there was a grand total of 1,974 cases with 56 deaths which gives a mortality of 2.8%. The communities involved were mostly small ones, and the patients were mostly consumers of raw milk. Thus, thirty outbreaks occurred in towns with less than 10,000 inhabitants, in ten with populations of 10,000 to 30,000, in four with 50,000 to 100,000 and in four with 100,000 to 250,000. One outbreak was due to pasteurized milk, and 47* epidemics, or 97.9% of them all were caused by raw milk.

The food poisonings occurred in two towns of less than 10,000 inhabitants and totaled 103 cases with no deaths. Raw milk is reported to have been the cause of the illness.

Different forms of enteritis were responsible for outbreaks in five towns, of which four had populations under 10,000 and one had 73,000 inhabitants. In all there were 132 cases and 8 deaths. All of the patients used raw milk; in two of the outbreaks the milk was reported to have been infected by the cow and in the others the source of the infection was not given.

* The report of the U. S. Public Health Service lists 2 epidemics, *viz.*, those at Hastings and Midland, Michigan, as involving the use of both pasteurized and raw milk, but Dr. Barrett of the Michigan Department of Health, in a letter of September 25th, definitely ascribes these two epidemics to the use of raw milk.

Septic sore throat caused nine epidemics, of which 7 were in towns of less than 10,000 population, one was in a city of 28,000, and one in a county of 119,000. In all there were 11,162 cases and 7 deaths. All of the cases were attributed to the use of raw milk. For six of the outbreaks, milk from infected cows was held responsible; in the three others the mode of infection was not found. In three of the epidemics the infection was widespread there being 720 cases in one, 178 in another, and 88 in the third. Though there were only 7 deaths in the 11,-000 cases it is to be remembered that the sequelae of the disease are aften bad and often result in serious impairment of those who recover from the malady.

The causative organism of septic sore throat is a streptococcus, by some called *S. epidemicus,* and it is held that it may be transmitted by infected persons through the milk ducts to the udder where it multiplies in the milk in which it is discharged. It may be present in large numbers before lesions of the udder occur to warn the milker that the cow is diseased, consequently physical examination may be impotent to afford protection, and reliance therefor must be placed in pasteurization.

Scarlet fever caused but two outbreaks; they occurred in cities of about 20,000 inhabitants. In all there were 42 cases and no deaths. For both eruptions raw milk was held responsible but the manner of its infection was not reported. The streptococcus causative of scarlet fever, like that of septic sore throat, may be transmitted to the cow by humans and protection from the infection must be sought in pasteurization.

As to scarlet fever, it is well to bear in mind the statement of Godfrey that "it will always pay to investigate the milk supply whenever an unusual number of adult cases of scarlet fever or diphtheria occur in a community. Suspicion should be excited by an unusual number of adult cases occurring within a limited period. Milk-borne outbreaks which are non-explosive do occur, and a still greater number lack explosiveness in their beginnings."

As usual, typhoid fever leads in the number of epidemics and number of cases. In 1930 there were 30 outbreaks of the ailment with a total of 575 cases and 41 deaths which gives a mortality rate of 7.1%. Seventeen of these epidemics occurred in communities of less than 10,000 inhabitants, seven in cities of 10,000 to 20,000, three in cities of 50,000 to 100,000, and three in those of 100,000 to 250,000. Of the largest two outbreaks one was in a city of 11,000 population where there were 81 cases and 7 deaths and the other in a city of 130,000 where there were 78 cases and 5 deaths. Of the thirty outbreaks, 1 was attributed to pasteurized milk, and 29 were caused by raw milk. With regard to the sources of infection of the several milks involved in these 30 epidemics, 9 were not discovered, 1 was from infected bottles, 5 were traced to active cases, and 9 to carriers.

No milk-borne diphtheria epidemics are listed by the Public Health Service for 1930, nor does undulant fever find a place in the report. Cases of the latter disease due to milk certainly occurred. It is now known that the disease may be contracted by drinking the raw milk of infected animals, and through skin lesions that become infected by animals, as in veterinary practice, butchering, etc. There are several strains of Brucella, the infective organism, *viz*: the bovine, caprine and porcine, the last of which seems to be the most virulent for man. Recognition of the fact that undulant fever may be milk-borne has led the more progressive dairymen to rid their herds of Brucella infected cattle. Notable advance in this work has been made by the certified milk producers of Los Angeles, California, and by others as well. The literature of Brucella, its medical and epidemiological aspects and the laboratorv technique pertaining to it is so extensive as to preclude its consideration here.

For obvious reasons, tuberculosis infections are not listed by the Public Health Service. It should be noted that encouraging progress in reducing the prevalence of bovine tuberculosis in several states to not more than one-half of one per cent reactors is being reported by the Bureau of Animal Industry in its co-operative work with local officials.

As regards certified milk, it is usually raw milk, and it is always produced under the direction of a Medical Milk Commission, generally appointed by the county medical society and it operates under the rules of the American Association of Medical Milk Commissions, Inc. The statement is sometimes loosely made that certified milk has never caused an epidemic. This is untrue, for instance, in New York State, in 1920 there was an outbreak of diphtheria of 70 cases, and in 1924 one of 60 cases of paratyphoid, both of which were caused by certified milk. However, instances of this kind are not common.

The fact that 98% of the epidemics reported for 1930 by the Public Health Service had their origin in infected raw milk supplies, and that in other years a similar preponderance has occurred unquestionably indicates the greater safety of pasteurized milk, and pasteurization of market milk is generally advocated by public health authorities, but it is never to be forgotten, that as a water purification plant may fail, so may a pasteurization plant. Hassler has described a baffling typhoid fever epidemic that occurred in San Francisco in 1928. It was ultimately traced to a man who worked on a bottle-capping machine in a pasteurizing plant and who was proven to be a carrier. Sixty-two cases with 12 deaths was the toll of this outbreak. Of 17 outbreaks charged to pasteurized milk, Hassler states that in three, raw milk was substituted after pasteurization; in three the milk was not properly pasteurized; in two it was heated in a starter can, and in two faulty equipment and faulty flash methods were used. As to the remaining 7 outbreaks, information was not available.

One of the members of this committee, Doctor Pease, has completed a most thorough and penetrating study of the Montreal typhoid epidemic which extended from the second week in March to 30th June, 1927. In the city and environment there occurred well over 5,000 cases with over 500 deaths. It is the largest typhoid fever epidemic on the continent of North America in the recorded history of sanitation. For the two months of March and April, 2,600 cases were reported and the epidemic appeared to be over, especially as there was not a large number of cases reported in the first week of May, but there was a sharp rise in the number of reported cases for the week following, which was accentuated in the succeeding week and for the week of 28th May the enormous number of 770 infections were reported. The Pease report, in a careful judicial manner takes up various agencies that might have been factors in the epidemic, such as infection of milk in the country, the several public water supplies of the city and its environs, etc., and rejects them all as being either principal or contributory factors in disseminating the typhoid fever, the true vector being the pasteurized milk and milk products distributed by a certain dairy company and allied company. To appreciate the cogency of the report it must be read. Its conclusions are thus summarized:

"The epidemic was largely caused by the consumption of pasteurized milk from the ——— Dairy Company, or it is probable that a number of the cases were caused by the consumption of ice cream and milk from the same company.

"Pasteurized milk which became infected with typhoid bacilli, largely from a typhoid carrier who was foreman of the pasteurizing room, and by his successor who at the time was an incipient case of typhoid was the vehicle of infection. The actual cause of infection is not known; however, certain deficiencies in the method of operation, of the equipment, and also certain defects in the equipment could have permitted and aided the infection and incubation of typhoid bacilli in the milk.

"Pasteurized cream in a contaminated milk holding tank could have been responsible for some of the cases of the second outbreak."

The failure of pasteurization in San Francisco and in Montreal is not cited to create distrust of the process. Pasteurization will do all that it is said to do, namely, kill the disease germs that may chance to infect milk, but to do so, it must be operated strictly in accord with approved principles that have been developed from scientific experiment and by their practical application. Faulty equipment, lax operation of a plant, and the presence of carriers, or of those in the prodromal stage of communicable disease all endanger the product, as does the employment of underpaid, poorly trained operators who have little conception either of plant sanitation or of their responsibilities. All pasteurizing plants ought to be under competent official inspection, but inspectors who are untrained or who lack practical experience cannot get results, and an inspection force that is the creature of commercial American politics is worthless.

Pasteurization is commended; it is widely accepted as a necessary step in the handling of market milk, but to accomplish its purpose it must be done efficiently under official inspection of the right sort.

In conclusion the committee emphasizes the fact that milk is our best food and that it should be liberally used without fear. A small part, a very small part indeed, of the total supply becomes infected which fact should make one careful of the milk he uses, but most emphatically should not lead him to eschew milk. Most of us should have a quart a day.

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