FIFTEENTH ANNUAL REPORT

OF THE

AGRICULTURAL EXPERIMENT STATION

OF THE

UNIVERSITY OF MINNESOTA.

Fiscal Year July 1, 1906, to June 30, 1907.

DELANO, MINN.:
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1907.

UNIVERSITY OF MINNESOTA.

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The bulletins of this Station are mailed free to all residents of this State who make application for them.

MINNEAPOLIS, MINN., July 1, 1907.

To His Excellency, John A. Johnson, Governor of Minnesota:

I have the honor to transmit to you herewith the annual report of the Agricultural Experiment Station of the University of Minnesota for the fiscal year ending June 30, 1907.

JAMES T. WYMAN,
President Board of Regents.

List of Bulletins Published during the Fiscal Year, Ending June 30, 1907.

REPORT

OF THE

Director of the Experiment Station.

To the President of the Board of Regents:

I have the honor to transmit herewith the fifteenth annual report of the Agricultural Experiment Station of the University of Minnesota, covering the work done at the Station at St. Anthony Park; and the two sub-stations established by an act of the legislature in 1895, the one at Crookston and the other at Grand Rapids, Minnesota.

The report includes Bulletins 97 to 101, inclusive, published during the fiscal year, and a full account of the expenditure of the annual appropriation from the United States Government, as well as that received from the current expense fund of the University.

The Minnesota Agricultural Experiment Station in Account with the United States Appropriation, 1906-1907.

Dr.		
To receipts from the treasurer of the United States as per appropriation for fiscal year ending June 30, 1907, as per Act of Congress approved March 2, 1887		$15,000.00
Cr.		
By Salaries	$8020.70	
Labor		
Publications	633.49	
Postage and stationery	384.70	
Freight and express		
Heat, light, water, and power	1496.37	
Chemical supplies	56.86	
Seeds, plants, and sundry supplies	558.88	
Fertilizers	36.00	
Feeding stuffs	1779.35	
Library		
Tools, implements, and machinery	537.15	
Furniture and fixtures	82.91	
Scientific apparatus	261.24	
Live stock	643.25	
Traveling expenses	150.77	
Contingent expenses		
Buildings and land	358.33	
Balance		
	$15,000.00	$15,000.00

Dr.		
To receipts from the treasurer of the United States as per appropriation for the fiscal year ending June 30, 1907, under Act of Congress approved March 16, 1906		$7,000.00
Cr.		
By Salaries	$3460.57	
Labor	2192.32	
Publications		
Postage and stationery	1.90	
Freight and express	28.78	
Heat, light, water, and power	182.94	
Chemical supplies	27.71	
Seeds, plants, and sundry supplies	15.98	
Fertilizers		
Feeding stuffs		
Library		
Tools, implements, and machinery	387.05	
Furniture and fixtures		
Scientific apparatus	9.50	
Live stock		
Traveling expenses	79.97	
Contingent expenses		
Buildings and land	256.36	
Balance	356.92	
	$7,000.00	$7,000.00

Financial Statement.

Statement of disbursements and receipts of the Minnesota Experiment Station for the twelve months beginning July 1st, 1906, and ending June 30, 1907, inclusive:

	Disbursements.	Receipts.	Cash Outlay.
Station	$23,423.77	$ 29.30	$23,394.47
Agriculture	12,674.53	2,566.80	10,107.73
Horticulture	5,053.24	1,025.10	4,028.14
Chemistry	4,000.72	.....	4,000.72
Entomology	2,466.64	.....	2,466.64
Veterinary	3,491.01	16.01	3,475.00
Dairy	4,235.51	.....	4,235.51
Animal Husbandry	11,721.14	4,762.00	6,959.14
	$67,056.56	$8,399.21	$58,667.35
Crookston	10,610.49	2,610.49	8,000.00
Grand Rapids	5,764.65	1,764.65	4,000.00
	$16,375.14	$4,375.14	$12,000.00

HORTICULTURAL AND FORESTRY DIVISION.

In the Division of Horticulture and Forestry, the work of the past year has been confined to lines similar to those of the previous year.

The work in plant breeding has occupied considerable attention and the expense of this has been paid out of the Adams fund. This work has been confined to experiments with potatoes to determine why it is that modern varieties of potatoes do not set seed as plentifully as formerly, together with a study of the degree of immunity from diseases of the different varieties of potatoes. Both these lines of experiments have direct bearing on the improvement of the potato.

The plant breeding work in fruits has consisted of experiments, the object of which is to obtain plants in which are combined the best qualities of the American and Japanese varieties of plums. There are several places in Minnesota where the Japanese plums do fairly well and we have secured hand crossed seed as well as seed crossed in the usual way by insects. Last autumn all the seed of the American and Japanese sorts which were growing in the same orchard at Nels Anderson's farm near Lake City was purchased and planted at University Farm, with the result that we have 5,000 seedlings of much promise. Plant breeding work has also been continued in several other lines, including crossing work between our cultivated and

the hardier forms of strawberries, such as between the cultivated forms and species obtained from Alaska, which seem to be disease resisting and extremely hardy. Some work has also been done in crossing the blackberry and dewberry, and the blackcap and red raspberry, and with peonies. The results secured are of considerable interest.

The last legislature appropriated $16,000 for the purchase of a fruit breeding farm. A farm for this purpose has been purchased at Zumbro Heights, and is now in possession of this division. We have thought for several years that it was important to commence this fruit breeding work on a large scale, and that only by the handling of large numbers of plants can we hope to secure best results. This line of work has the earnest support of the Minnesota State Horticultural Society, which society assisted very largely in securing the passage of the bill providing for the fruit breeding farm. Mr. Charles Haralson, for eight years in charge of the plant breeding work at the South Dakota Experiment Station, has been made superintendent of this farm.

The last legislature also provided for forestry work in Itasca park, which gives this division a great opportunity for carrying on forestry experiments on a large scale and under most favorable conditions. This forest consists of an area of over 20,000 acres situated around Lake Itasca. It has in it a great variety of trees and there are suitable accommodations for employes. The appropriation, however, is quite inadequate for the work which we desire to undertake, and it is hoped that the next legislature will deal more liberally with this very important line of investigation.

The Division of Horticulture and Forestry has issued a special bulletin published by the U. S. Department of Agriculture entitled "Courses in Fruit Growing for Movable Schools of Agriculture."

DIVISION OF AGRICULTURAL CHEMISTRY AND SOILS.

Two bulletins have been published by this division during the year: No. 99, "The Calculated and Determined Nutrients of Rations, Digestibility of Emmer, and The Heat Producing Value of the Fat of Fodders and Grains";

and No. 101, "Forage Crops of High, Medium and Low Protein Content." Soil investigations have been a prominent feature of the Experiment Station work of this division particularly in carrying out the provisions of the Adams act for research in agriculture. During the year the Regents of the University changed the title of this division from "Agricultural Chemistry" to "Agricultural Chemistry and Soils." In co-operation with former students of the School and College of Agriculture and others, experiments with fertilizers and investigations in connection with maintenance of the fertility of the soil have been conducted. Specal attention has been given to the influence of the fertility of the soil upon the composition and value of crops. Some of the results secured are published in bulletin No. 101. At the present time studies are being made of the influence of different systems of cropping and cultivation upon the fertility of soils; the work includes the physical and chemical analysis of soils both before and after being subjected to different methods of farming. Studies are also being made upon the influence of the fertility of the soil upon the composition and bread-making value of wheat. Human nutrition investigations for the determination of the digestibility and food value of flour in other forms than bread, have been continued. As in the past numerous free analyses have been made for the farmers of the state and chemical work has been done in co-operation with other divisions of the station.

DAIRY DIVISION.

In the dairy division, aside from the keeping complete records of the amount and kind of feed consumed by each animal and the products yielded therefrom, and which has been constantly kept since the organization of the division, the composition of the milk yielded has been made a special study, with the aid and co-operation of the division of chemistry. Gravimetric analyses have been made of weekly composite samples of milk representing some eighteen hundred separate milkings. Data have been compiled covering the work of the dairy herd during the past calendar year, and the work on nutrition in milk production for the winter of 1906-07; the nutriment consumed daily on an average during the St. Louis cow demonstra-

tion by the different cows in the test, the products yielded and nutriment consumed to a unit of product; a life record of steers, giving in two cases the daily food consumption and daily average content of digestible protein, carbohydrates and fat, and a life record of thirty heifers from birth to the time when they were two years old.

Bulletins are being prepared from the data secured and will be submitted for publication during the coming year.

VETERINARY DIVISION.

There has been the usual amount of correspondence and considerable time given to medical care of our University farm stock during the past year. Dr. Lipp has given most of the immediate medical treatment.

During the year 145 head of cattle have been tested with tuberculin, with 12 reactions, 5 animals marked suspicious and 3 doubtful, the doubtful and suspicious being subsequently re-tested. Among 12 reactors there were probably 11 animals that had been newly purchased or were here for purchase, subject to test.

Acquisitions and Developments.—During the year, Dr. C. F. Flocken has taken up an investigation of swamp fever with us.

Mr. J. A. Rye has been promoted to position as assistant in the physiological laboratory.

Dr. W. L. Beebe, bacteriologist for the state live stock sanitary board, has continued his work in the bacteriological laboratory, and we have had very helpful co-operation from him.

A bulletin on the infectiousness of the manure of tubercular cattle which is now ready for the printer, is to be published as joint work of Reynolds and Beebe.

During the year a very satisfactory and well equipped physiological laboratory has been established in the museum room, thus giving two laboratories with two men working in each, one laboratory being devoted to bacteriological work and one to physiological work in connection with our ventilation studies.

A crematory in connection with the dissecting room has been constructed which promises to be of very great assistance in disposing of our experimental animals and

animals that may die among the farm stock.

The contagious ward has been remodeled so as to give four stalls isolated from each other and from the remainder of the stable, each stall having an outside door giving easy access to the dissecting room and crematory without risk of contaminating the rest of the building or the ground around the building.

The dissecting room has also been somewhat remodeled. Three suitable stalls have been finished and equipped in the box stall ward especially for the study of stable ventilation problems and the physiological effect upon animals of confinement in light or dark stables. These stalls are so arranged that we may have two ventilation stalls and one dark stall, or one ventilation stall, one light stall and one dark stall, especially arranged and fitted for research work. A new stable for breeding and rearing laboratory animals was gotten under way just too late to report for the year.

Research work has been along the following lines:

1. Tuberculosis.
2. Swamp Fever.
3. Stable Ventilation.

Tuberculosis.

In collaboration with Dr. Beebe of the state live stock sanitary board, a considerable amount of work in a study of the infectiousness of manure and nasal secretions of tuberculin-reacting cattle has been finished. This work has been written up and the manuscript is now ready for the printer.

The manure of forty-eight cattle and the nasal secretion of fourteen cattle have been studied. There is an abundance of information concerning the methods by which this infection may be taken into the animal's body, but very little information concerning methods in which it is given off except in bronchial secretion by coughing, and in milk. Since comparatively few tuberculous cattle cough markedly, and mature cattle are apparently not seriously exposed to infection from milk, this has appeared to be a very important and very practical subject for study.

As mentioned in last year's report, the material is on hand for a bulletin on work finished last year on pasture

dissemination of tuberculosis among cattle. The result of this work shows that out-door infestion is not by any means impossible. The manuscript for this will be prepared after other material which seems more urgent for publication is gotten out of the way.

Manuscript for a bulletin of popular information on bovine tuberculosis is nearly ready. The available supply of bulletin 51 has been exhausted for some time, and there appears to be urgent call for a bulletin of this kind. Breeders and stockmen of the state are now very much interested in tuberculosis, and anxious for information concerning this disease.

A demonstration experiment with an anti-tuberculosis vaccine (Von Behrings) has been under way since May 1, 1906. The purpose of this is to secure information on the following points:

1. Safety of the vaccine.
2. Degree of immunity given.
3. Duration of immunity.

It is quite evident that this vaccine gives a considerable degree of immunity for at least a short time and it is very important for cattle breeders to know whether the immunity persists for a sufficient length of time to be satisfactory.

Eighty-two calves are under observation that have been vaccinated. These are in three herds: at St. Anthony Park, Elk River, and St. Peter. These calves are in direct experiment and are being compared as far as possible with similar, unvaccinated calves. In addition to this we have a list of all Minnesota breeders who have had calves vaccinated with assurances from these breeders that they will gladly co-operate with us and assist in securing needed information concerning their results with the vaccine. This will give a considerable number of calves under observation.

Swamp Fever.

During the year Dr. C. F. Flocken of the Bureau of Animal Industry has been studying swamp fever in collaboration with the Veterinary Division of the Experiment Station, assisted by the State Live Stock Sanitary Board. The entire cantagious ward in the veterinary building has

been placed at the command of this work, and some important results have already been obtained. The disease has been produced several times by inoculation. Typical cases of swamp fever have developed, showing that the disease is clearly infectious by inoculation. It is important to know whether the disease is also infectious by way of the digestive tract and may be conveyed by food or drink.

Much information is needed concerning the methods of dissemination, and the final aim will be to develop preventive treatment.

VENTILATION.

Ventilation work has been continued steadily through the year by Dr. Lipp and Mr. Rye. With the new ventilation stalls and the new laboratory for this work, we are now well equipped. As stated in our report for 1906 the chief problems are:

(a) To determine whether confined animals are affected injuriously or rendered unprofitable breeders by insufficient ventilation in the absence of infectious diseases and if so where and how.

(b) To determine whether the animal confined in a stable provided with poor ventilation has its disease resisting power diminished thereby.

(c) The least amount of ventilation compatible with normal health, comfort, and profitable feeding.

(d) The most efficient method of accomplishing the needed amount of ventilation.

During the year a preliminary bulletin, No. 98, "Stable Ventilation," has been published and was kindly received by the agricultural and veterinary press considering the fact that it seemed to attack established standards and established views on ventilation.

During the past year the open and closed stall work reported in bulletin No. 98, has been duplicated in part, using different animals. The object of this has been to check up the work and to determine whether other animals would give similar results. A large amount of tabulating has been done with the blood work mentioned in bulletin No. 98, and we have now almost ready for the printer a second bulletin in this series. Copy for a third bulletin on

ventilation is perhaps half finished in the rough. This third bulletin will give the results of blood and urine study of a second set of animals. A third set of animals has recently been started in light and dark stall work and a fourth set in another series of further ventilation study work.

DIVISION OF AGRICULTURE.

Plant breeding has been one of the important lines of work during the past year, as formerly. A number of new varieties of wheat are appearing that possess valuable characteristics in strength of straw, rust resistance and quality of grain, and promise to yield exceptionally well. More attention is being given to breeding oats than in the past. For some years the Experiment Station has been distributing pedigreed oats to Minnesota farmers, the varieties being Minn. Nos. 6 and 26—the No. 6 having an average yield of 64.3 bu. for 13 years and the No. 26, 70.5 bu. Selected strains of these old varieties were placed in field trials with the parent varieties in 1904 and the accompanying yield figures show that new values have undoubtedly been created in these new varieties of oats.

Minn. No. 6, parent variety, Average yield (1904-05-06)	71.2 bu.
" " 26, " " " " " " "	79.1 "
" " 281, best new variety from Minn. No. 6, (1904-05-06)	85.3 "
" " 295, " " " " " " 26, " " "	88.4 "

Farmers have been demanding for some years, varieties of winter wheat that will stand the Minnesota winters. With a view to meeting this demand, numerous crosses and selections have been made and as a result, hybrid varieties are appearing in the nursery that show a vitality percentage of 65 to 70, whereas the old stocks are killing out almost entirely. Barring extreme disasters within the next year or two, the Station should be ready to distribute hardy varieties of winter wheat within five or six years.

More work has been done with clover and the other legumes than in the past, and very satisfactory progress has been made in hybridizing these crops.

Considerable attention has been given also to the selection and breeding of varieties of roots that are especially adapted to stock feeding and the production of sugar.

Seed from a number of valuable crosses has been grown during the year and stock provided for still further work in this direction.

The variety testing in cereals has been curtailed to some extent this year, though quite a large number of varieties are still in the field tests. No varieties are discarded or distributed without at least a three years' aveage, and frequently six years are required to determine whether or not a variety is worthy of further propagation. New varieties are constantly being added to the list from the nursery plots, and a few commercial varieties have been secured. Some new varieties are without doubt near the point where they can safely be distributed in certain sections of the state.

Crop rotation and farm management still form an important part of the experimental work in the Agricultural Division. It has been possible, through funds secured from the Adams Act, to put scales in the hands of quite a number of the men who are co-operating with us in farm management problems. This gives the data for closer study of different classes of farms, and gives definite information on the propagation from various plans of crop rotation. This work will be continued and extended through another year at least, or so long as valuable data are secured.

The statistical work has changed but little in character during the year. Data are still being secured on the three routes established five years ago in the vicinities of Northfield, Marshall and Halstad. Some changes have been made in the personnel of the co-operators on the Halstad route, and an effort has been made to include among the co-operators men who are carrying on specialized forms of farming, in order that we may include a study of specific problems and farms. Sufficient clerical help has been used to bring the data up to date, and material for bulletins relating to farm production is nearly completed and will doubtless be ready for publication during the current year. The co-operative corn breeding inaugurated in 1906 has been continued throughout the year though some changes in location and of co-operators have been made where such changes promised better results. Notwithstanding the backward season, the co-operators even in the northern part of the state have secured varieties which promise to

ripen in good season this year. It appears that the policy of having corn bred in each of the several sections of the state where conditions are varying is likely to get varieties that are adapted to this section much more quickly than where the selections are made only at some central station.

A late spring and a backward growing season have interfered to some extent with yields and the opportunities for selections of some of the crops. Average results will be obtained, however, and the results of the year will compare favorably with those of the past.

Bulletin No. 97 on "Cost of Producing Farm Crops," which was in preparation a year ago, has been published and distributed by the Station, meeting with general favor. The demand for bulletin No. 95 on "Common Weeds" was so great that a second edition was printed during the year. No other publications were printed though one on corn breeding has been ready for the press for some time.

DIVISION OF ANIMAL HUSBANDRY.

During the year the effort in Animal Husbandry has been to weed out inferior and unprofitable stock in the breeding herds and to concentrate the energy on a few carefully chosen problems of fundamental interest. Records of productivity and profitableness are still kept in all lines of live stock husbandry. The records started a few years since relating to herd and flock management have been continued. The longer such records are kept the more valuable they become and it is contemplated that all such records be kept up for some years to come.

The forage crop experiments have taken on definite form and specific problems are being worked out on the effect of grain on stock that is being pastured, also the relative maintenance value of grain and grasses. Sheep and swine have been used throughout the year to study methods of converting into marketable form rough feeds grown about the farm. The stock is to be finished for the market during the fall season and the added data will be compiled with that already in hand. One year's work has been finished in maintenance rations for ewes, using regularly the rough feeds and farm grown grains. It seems that much wider and cheaper rations can be used for the

maintenance of such stock than has formerly been thought possible. Some progress has been made on the experiment in beef production which has been inaugurated under the support of the Adams fund. Several calves have been grown through the year on careful test, records of feed and growth being carefully kept. Others will be added to the lot as fast as possible and the experiment contemplates growing calves of different types and breeds from birth to maturity, when they will be dressed at the meat shop and a careful study made of the dressed product returned. This work also is a long time experiment and should be continued for a number of years to get reliable results. This together with some experiments in breeding milking Shorthorns undertaken in co-operation with the U. S. government are the main problems in cattle raising that are under way at the present time. Others will be added as support can be obtained. The swine feeding experiments of last year have been reported and some new ones on the best methods of managing the herd have been undertaken during the summer season, with the growing pigs.

DIVISION OF ENTOMOLOGY.

About forty-seven nurseries have been inspected, a large number of insects identified for correspondents and remedies given. In this connection the entomologist's correspondence has averaged about ten letters per day.

Bulletin No. 100 upon the "Cabbage Maggot and Other Injurious Insects" was issued in January as well as the Eleventh Annual Report of the State Entomologist. Press Bulletin No. 26, "An Entomological Calendar," was issued in December. A circular on "The Mediterranean Flour Moth" was sent out October 31, and in addition to the above there have been various communications to the Press.

Experiments have been under way and are still in progress against the following insect pests:

The Cabbage Maggot, the Leaf Hopper, the Plum Curculio and Codling Moth.

Experiments are also in progress at date of writing to test the comparative efficacy of dust and liquid spray for fungus diseases and injurious insects on fruit trees;

experiments with hydrocyanic acid gas; a study of the life history of the Bee Moth, the Stalk Borer, of insects affecting clover, and of the spread of the so-called "Green Bug" *Toxoptera Graminum* in this State.

The occurrence of this southern Grain Plant Louse has been one of the most important events of the year. It was first discovered in Minnesota by one of my field workers about July 3rd. Largely owing to the advanced condition of the grain it has done this year little or no damage though farmers and others have been much exercised over it. The native grain plant louse has been slightly injurious to oats. The "Green Bug" has been found at Breckenridge, Fergus Falls, Wheaton, Fargo, and Grand Forks.

The insectary, granted by the legislature two years ago, has been of great benefit. In it over 300 experiments have been inaugurated during the last eight months, many of which are still in progress.

NORTHWEST EXPERIMENT FARM.

The main thought at the Northwest Experiment Farm the past year has been drainage. The scheme started in the fall of 1905 and pushed in 1906, and which it was intended to have completed last fall, was hindered by the wetness of the season of 1906 and the failure of the county ditch contractor to give us an outlet for our drainage. The open ditch on the farm is already under way. Tile is being laid both by hand and machine digging. Should the weather continue as favorable as at present the whole system will be installed by about the first of October.

Engineer J. T. Stewart from the Office of Experiment Stations at Washington is stationed here at the farm again for this season and is actively superintending the work of installing the system which was planned by him.

Records are kept of cost of materials and labor, in all this work, also comparative cost of machine and hand labor in laying tile. Various makes and kinds of tile are used for comparison. Attention is also given to the different contrivances and methods for open ditch construction. Later a report of this work will be given in detail. This, we think, is the best line of experimental work that could be carried on for the northwest part of the State.

Clover and Timothy: The 50 acres seeded to clover and timothy in the spring of 1906 made an excessive catch and is giving a good yield of hay the present season. More ground was seeded to clover and timothy this spring. The clover root has an important mission in boring holes into this fine-grained soil. Also it should and will become the predominating weed in place of sunflowers, king-head, Canada thistle, mustard, etc.

Poultry: The poultry department is doing very well. It is distributing a better class of stock to farmers of the State. Over two hundred dollars worth of breeding stock and eggs were sold during one month this spring.

Cattle and Swine: The number of Galloways has been reduced. A few pure-bred Holsteins have been added to the stock. Duroc-Jerseys have also been added to the swine, the plan being to keep them as representative of the lard type and the Improved Yorkshire for a bacon type.

Sheep: The small flock of grade sheep shows up fairly well, giving an incresae of 117% for the season of 1906 and 130% for 1907, with an average clip of over 9 lbs. and about 8 lbs. for the respective seasons, the latter average being lighter on account of the greater number of yearlings.

The enthusiasm of the people in this region for better farming is encouraging.

NORTHEAST EXPERIMENT FARM.

At the Northeast Experiment Farm at Grand Rapids, valuable work is being done. Results upon this farm prove that a large part of this portion of the state is well adapted to agriculture. The mining, manufacturing and shipping industries of northeastern Minnesota are upon a firm and growing foundation, giving employment to constantly increasing thousands of men and assuring a certain and profitable market for all the food products which this portion of the state can produce. It is important to know that there is opportunity for farmers in large numbers to locate and do well in this section of the state and it is encouraging to the large number of consumers to believe that in the near future supplies can be bought from producers near at hand and a large portion of the heavy toll now paid to transportation companies on food products be saved. The farm is

producing grains, corn, grasses, vegetables, fruits, meat, butter, and other products and is raising considerable live-stock, especially dairy cattle and bacon hogs. Young trees are growing and forestry is receiving attention. A well balanced agriculture with forestry taking a leading part is sure to succeed the waning lumber industry of northeastern Minnesota.

REPORTS AND BULLETINS.

Five bulletins comprising 256 pages, with illustrations, have been issued during the year; also one press bulletin. These are free to all citizens of Minnesota who apply for them.

Respectfully submitted,

W. M. LIGGETT,
Director.

XXI.

A STUDY OF CERTAIN CATHARTICS.

By M. H. REYNOLDS.

These experiments as originally planned were on a small scale and very simple; but the study became interesting, and the result has been sixty experiments with eserine and thirty-two with barium—others with aloes and with aloes and calomel. This has naturally resulted in the accumulation of a mass of statistics and observation notes, of which only summaries and conclusions will be published in this report. It must be remembered that a majority of these experiments were upon horses not sick, and are to be regarded as experiments in physiological effects rather than actual therapeutics.

The writer has though best not to discuss the materia medica or theoretical therapeutics of the medicines used, but rather the results, comparisons, and ranges of usefulness. In studying the results of a cathartic dose, we divided the time of each experiment into two periods, A and B, and kept records as indicated by the following:

DATA TAKEN.

PERIOD A.	PERIOD B.
Period A covers twenty-four hours before the time of administration.	Period B covers the twenty-four hours immediately after the time of administration.
Data taken: Pulse, temperature, and respiration at 12 m., 5 p. m., 10 p. m., 7 a. m., and 12 m. the second day.	Data taken: Pulse, temperature, and respiration at 12 m., 1 p. m., 2 p. m., 3 p. m., 5 p m., 10 p. m., 7 a. m., and finally 12 m. at the close of period B on the third day.
Bowel discharges: Number from 12 m. to 5 p. m.; 5 p. m to 10 p. m.; 10 p. m. to 7 a m.; and from 7 a. m. to 12 m. the second day; total number for the twenty-four hours and total weight.	Bowel-discharge record taken as follows: When the first discharge appeared which showed the effect of the dose; number of discharges from 12 m. to 1 p. m.; from 1 p. m. to 2 p. m.; from 2 p. m. to 3 p. m.; from 3 p. m. to 5 p. m.; from 5 p. m. to 10 p. m.; from 10 p. m. to 7 a. m.; and from 7 a. m. to 12 m. at the close of period B. Total number during the twenty-four hours of period B and the total weight of feces discharged.
Dose given at 12 m.	

In some cases a further period of twenty-four hours was added to the experiment and named period C. The purpose of this was to compare various medicines and doses in their effects as to condition of the feces, number and weight of discharges during this period of twenty-four hours, and compare these with the period A; we then had an accurate record of the bowel discharges not

only during this period A, but also during two successive periods of twenty-four hours each after administration of the cathartic.

In this way we could get comparisons of the pulse, temperature, respiration, and bowel discharge records, taken at certain hours and for certain periods during the twenty-four hours preceding, with similar data taken during the twenty-four or forty-eight hours, as the case might be, succeeding the administration of the medicine and incidentally have the opportunity to study the subsequent effect of the medicine when the active catharsis had ceased.

It must be remembered that the horses used for these experiments were mainly not sick horses. Some were colics, impactions, etc. Those were purely experimental, however, which were used for comparisons and studies of physiological effects, for it is impossible to get two or more sick horses in conditions nearly enough alike to make the comparisons valuable. The hospital cases are all specified as hospital cases or H. C.

The writer feared that since these experimental horses were getting but moderate exercise in the yards, and, with few exceptions, no active work, this might lessen the value of the normal averages, which, for the bowel-discharge records, might be too low for both number and weight; and, again, their lack of active work might render them less susceptible to cathartics than working horses. To settle this point records were taken of thirteen work horses on the State farm.

TABLE A.—Normal Bowel Record.

FARM WORK HORSES.

	Name. (Working horses)	Age	Wt.	Condition.	Kind of work.	Feed.				Sex	Color.	Bowel discharges.					
						Hay.		Grain.				7 A.M. to 12 M.	12 M. to 5 P.M.	5 P.M. to 10 P.M.	10 P.M. to 7 A.M.	Total number.	Total weight.
						Kind.	Amt.	Kind.	Amt. p.day								
1	Baby,	6	1350	Good	Farm	Poor	Ad lib	Oats	21	F	Black	1	2	2	3	8	33
2	Daisy,	6	1350	"	"	"	"	"	21	F.		2	2	1	3	8	42
3	Fan,	6	1300	"	"	"	"	"	21	F.	Gray	1	1	1	1	4	22.5
4	Ned,	10	1200	"	"	"	"	gr fod	18	M	Bay	1	1	2	2	6	27.5
5	Maud,	7	1275	"	Heavy carriage	"	"	Oats	15	F.	Sor,	1	2	2	3	8	37
6	Dandy,	10	1200	"	Farm	"	"	"	18	M.	Black	2	1	2	2	7	33.5
7	Chub,	10	1200	"	"	"	"	"	18	M.	"	0	1	1	1	3	23
8	Frank,	6	1200	"	"	"	"	"	20	M	Bay	1	1	1	2	5	25
9	Pat,	6	1200	"	"	"	"	"	20	M.	"	2	1	2	2	7	32
10	Harry,	20	900	"	Driving	Good	"	"	16	M.	Sor.	1	2	3	2	8	30
11	Josie,	8	900	"	"	"	"	"	15	F	Gray	2	2	3	2	9	35
12	Brownie,	6	850	"	"	"	"	"	12	M.	Bay	3	2	3	4	12	33
13	Kit,	7	1200	"	Farm	Poor	"	"	18	F.	Gray	4	2	3	3	12	54
												Averages,				7.4	32 9

A study of these records shows an average number of discharges per horse per twenty-four hours of 7.4 and an average weight of 32.9 pounds.

TABLE B.—Normal Averages.

HORSES USED IN EXPERIMENTAL WORK.

No.	Name.	No. taken.	Bowel discharges.		Temp.	Pulse	Resp.	Number of times temp, pulse, and resp. taken
			No.	Weight				
1	Harry	3	8 33	30 0	99 76°	32 9	15.4	3
2	Jim	7	9 8	28.1	96.9	34.4	17 0	3
3	Dick	16	8 6	37.4	100 1	41.0	12 3	57
4	Lady	6	10 5	23 9	100 3	40.0	12 6	18
5	Josie	2	9 5	34 7	.....	.....	.....	...
6	Jim, 2d	6	16 5	40.5	99.0	40 0	9 5	24
7	Dolly	1	22.0	35 0	99 8	42 0	16.0	3
8	Brownie	2	12.5	33.0	100 6	45 0	15 0	8
9	Nick	4	8.7	26 9	100 5	38.5	12.8	7
10	C. C.	10	9.1	30.2	100 3	43.2	14 0	15
11	Kenwood	6	8.0	30 5	100 1	39.2	16 0	12
12	Whitey	8	10.5	31.7	100.3	47.2	14 5	16
13	Prince	1	10.0	44 5	100 4	34.0	20 0	4
14	Dandy	1	11.0	40.0	101.0	48 0	16 0	4
	Hospital horses' averages.	.....	11 07	33.3				
	FARM WORK HORSES.							
15	Baby	1	8	33 0				
16	Daisy	1	8	42.0				
17	Fan	1	4	22.5				
18	Ned	1	6	27 5				
19	Maud	1	8	37 0				
20	Dandy, 2d	1	7	33 5				
21	Chub	1	3	23 0				
22	Frank	1	5	25 0				
23	Pat	1	7	22 0				
	Averages of these nine.	1	6 2	29 7				
	Average of 23 horses.	.....	9.1	31.8	99 9	39.7	14.6	

The experimental horses in the hospital—fourteen in number—show an average of 11.07 bowel discharges in twenty-four hours and an average weight of 33.3. In each lot there were a few that varied far from the normal, but it will be observed that the averages agree closely. When the averages of both lots are taken the results show the average number of discharges to be 9.1 and the average weight 31.8.

Work with Cathartics.

With some horses the series would begin with the maximum doses, and the smaller doses be given in series later. With others the first dose would be the smallest planned, and then progressively larger ones be given, in order that the possible source of error—decreasing suscep-

tibility—might be discovered and checked. This gives a chance to compare a given dose of eserine, *e.g.*, with another dose consisting of the same eserine plus a variety of doses of pilocarpine, then eserine compared with eserine and atropine; then doses of eserine with the best selected amount of pilocarpine compared with the same doses of eserine and pilocarpine plus atropine in the best selected amount, usually 0.05 grain; then this last dose is compared with another in which the eserine and pilocarpine are the same, but strychnine is substituted for the atropine. Each dose and the series comparisons duplicated with as many horses as possible. The barium experiments give a chance to compare the most satisfactury eserine combinations with barium. Conclusions will be given later.

For the eserine experiments all doses are in grains on a standard of 900 pounds weight. The doses quoted in this paper are the doses a given horse would have received if he had weighed 900 pounds. This is done for the sake of speed and ease in comparing doses and results. The actual doses were in proportion to weight.

For all the barium experiments the doses were also given in proportion to live weight, but on a basis of 1000 pounds standard, and the doses are quoted as in grammes. Many veterinarians are in the habit of estimating eserine doses in grains and the barium doses in grammes.

For the barium chloride 8 grammes were selected as the smallest dose per mouth, and 0.75 as the minimum dose by intravenous method. The drench series consisted of 8, 10, 12.5, 15, and in two cases 20 grammes. In some cases a dose would be given in bolus, then duplicated in solution to see if there was a material difference as to the method of administration. The series selected for the intravenous method was 0.75, 1. and 1.5 grammes in 10 per cent. solution. When the ideal dose proportion or balance of the medicines used had been decided, then this dose was to be given to cases in practice and records kept.

The medicines.—It frequently happens in the use of cathartics that the results are very unsatisfactory. It may be that results are wanting—a large dose is apparently without effect upon the bowel movements, or a small dose may act with unexpected and alarming severity. It may be that there is an extreme depression, painful peristaltic activity, severe muscular tremors, and so on, and the ques-

tion becomes an interesting one why, in this particular case, the results were so unsatisfactory. We shall try to answer some of these questions later.

TABLE C.—Medicinal Dose.

Drug.	Pulse.	Respiration	Temperature.	Arterial pressure.	Secretions.	Arterioles.	Vascular tone.	How eliminated.	Peristalsis.	Involuntary muscle-fibres	Hollow organs.
Eserine,	—	x then —	o	— then x	*—x	....	....	Secretion	x	x	(—)
Pilocarpine	†—	o	o	—	x	x	—	Secretion	x	—	(—)
Atropine,	x	x then —	x	x	—	*(x)(—)	*—x	Secretion, especially urine	*—x	*—x	
Strychnine,	x	x	o	x	x	(—)	x	Urine.	x	x	(—)
$BaCl_2$,	—	x	o	— then x	x	(—)	x	.....	x	x	

o. Nil.
—. Lessens or depresses.
x. Increases or stimulates.
*. Depends on large or small dose.
(—). Contracts
(x). Dilates or expands.
†. Authors differ.

It will be noticed that all these medicines increase secretions except atropine in large doses, and that even it has this effect in small doses, and the same remarks apply to their effects on peristalsis. All stimulate contractions of involuntary muscle-fibres except pilocarpine, which has something of a reverse effect. Atropine stimulates the involuntary fibres in small doses and the reverse in large doses. Upon the hollow organs in general, eserine, pilocarpine, and strychnine contract them.

Barium—Bartholow says of barium, in his *Materia Medica,* in speaking of the physiological effects of barium chloride on the human, that in full medicinal doses it causes irritation of the stomach with sense of heat or burning at the epigastrium. One case is reported where symptoms of poisoning came on in one week after the administration of .5 grain three times daily, the whole amount taken being 2.5 grains. The symptoms were extreme exhaustion and nervousness. He thinks a peculiar idiosyncrasy must have existed in this case or so small an amount would not have produced such pronounced symptoms. . . . He says the usual symptoms in cases of poisoning are intense anguish, free salivation, great thirst, loss of voice, vomiting, purging, dilated pupils, frequent micturition,

respiration slow and labored, and slow pulse, increasing weakness, and finally complete paralysis of the extremities. The chief post-mortem conditions are pronounced rigidity, bronchial effusion, and hyperæmia of the lungs, heart distended, with black blood, and brain engorged. In the stomach intense hyperæmia, sometimes perforation; 2.5 grains have produced serious symptoms; 1 drachm has caused death in seventeen hours and one ounce in one hour. He says also that large doses suddenly injected into the jugular cause paralysis of both heart and lungs; death is caused rather by paralysis of the respiratory muscles than by cessation of the heart-action. Paralysis in the lower animals begins at the lower extremities. Barium causes strong cardiac contractions, dilated pupils, energetic peristalsis of the bowels, even closure of the lumen of the intestine and of the bladder, and almost complete approximation of the peripheral vessel-walls.

Unafvorable Catharsis.—Let us study for a moment the criticism of a cathartic effect. What are the unsatisfactory results that may follow the administration of a cathartic?

We may have a fatal poisoning; the result may be less serious, but there may be extreme pain; there may be severe depression, severe muscular tremors, or an agent may be uncertain and results difficult to estimate. There may be actual constipation; the effect may be *nil*, or extreme purging and a possible enteritis. There may be a persistent and objectionable after-period of constipation when the cathartic action has ceased. A common and very unsatisfactory result appears in those cases in which there is at first a very active effect apparently, but the discharges are small, little but watery fluid passes, and there is little movement of actual feces. It is very common that after the administration of a cathartic there appear quite a number of discharges—many more than would have appeared under normal conditions; but the total weight of feces passed during the twenty-four hour period may be very much less than would have occurred without the cathartic, and so whereas we wish to unload the bowels, as a matter of fact we may have accomplished just the reverse.

Ideal catharsis.—What constitutes an ideal cathartic effect? The answer to this must depend to a large extent on the object to be accomplished; but in general there should result the movement, during twenty-four hours, of

from three to ten or more pounds of feces, more than would have occurred without the medicine during the same period; there should be a gain in number for this period of perhaps five; the pain resulting from the dose must be *nil* or moderate; there should follow slight or no after-constipation; there should be no extreme depression during the active catharsis, and we dislike very much the severe muscular tremors that sometimes follow the use of certain drugs. The drug should be such that there is no danger of fatal or even alarming results in horses that we do not know as to their susceptibility.

Unsatisfactory results—reasons.—In studying unfortunate and unsatisfactory results of eserine we must not forget that there are two alkaloids in the calabar bean which are diametrically opposed in physiological effects, and that a commercial sample of esserine is liable to be contaminated with calabarine. Again, eserine in the presence of acids takes up water and changes to eseridine, which has at the best but one-sixth the activity of eserine. These alkaloids are quite easily separated because of their differing solubilities. For instance, eserine is soluble and calabarine insoluble in ether.

When using pilocarpine it must be remembered that jaborandi also has two alkaloids that are antagonistic in physiological effects, and that pilocarpine is changed into jaborine by oxidation or by heat alone. Jaborine is more easily soluble in ether and less easily soluble in water than pilocarpine. Commercial pilocarpine may be contaminated with jaborine. We must not blame pilocarpine too readily; the fault may not be in the pilocarpine.

Again, patients vary greatly in susceptibility to all the drugs commonly used for cathartic effects. Drugs may be old and have deteriorated, or they may be adulterated. In cases wherein several drugs are used—for instance, in hypodermic cathartics—in which either or all of those used in our experiments may be given, the combination may be a poorly balanced one—for instance, in combining eserine or pilocarpine, or both, with atropine. The addition of a very small amount of atropine, say 0.05 or 0.04 of a grain, may be very desirable, whereas if the dose had been increased to 0.1 grain the eserine is neutralized to such an extent as to make that amount of atropine very objectionable. Too much of a drug may be given, or too little,

for satisfactory results. Finally, in considering the results of a cathartic which has been unsatisfactory, we should not lose sight of the condition of the bowels at the time of administration. The condition of the stomach, after a full feed or before, may have much to do with determining a cathartic effect, as, for example, barium experiments 1, 2, and 3.

When a horse is feverish and consequently constipated effects are apt to be slow and indefinite; a horse should never have a full purgative when weak from pre-existing illness or depressed from any cause; purgatives should be administered with extreme care in inflammatory diseases of the respiratory organs, and very rarely when any portion of the alimentary canal is suffering from an inflammation.

Of 98 experiments the following have been quite unsatisfactory: Eserine experiments, 6, 9, 12, 13 (fatal), 14, 17, 19, 20, 21, 22, 23, 26, 30, 32, 37 40 48, 53, 55, 56, 58; also barium experiments, 16, 19, 24, 28, and 32. (For doses and results, see Tables D, E, and F.)

Autopsy Records.

(I.) E. (13). Brown horse; poor condition; quite old; weight, 1200 pounds; dose, 3 grains eserine at 12 M. This horse was poor and weak and supported in slings at the hospital at the time of this experiment. On the basis of 3 grains per 900 pounds this horse actually received 4 grains. The purpose of the experiment was to study the effect of such a dose upon a horse in his condition, and then to post-mortem the horse and study the effect upon the mucous membrane involved. This was evidently a very sick horse from the time the medicine took effect until he was dead. The disturbance was in genedal *violent*, such as a practitioner would not care to see in actual practice. The pain was very severe, and the feces effect also very severe, with six discharges during the first hour and thirteen during the first three.

(II.) Subject "John," died suddenly at 5 P. M. and was post-mortemed at 5 P. M. November 14th. Parts were normal except as noted, only alimentary canal being examined. *Cæcum*—Arch and also mesocæcum show large bright blush, with somewhat darker pin-head spots. *Large*

colon—First portion and suprasternal flexure similar but less marked. *Ileum* shows same condition, practically whole length. *Jejunum* terminal, half, same condition. The congestion or hyperæmia involved noticeably the muscular coat. As normals could not be obtained for this experiment, the writer was therefore unable to make comparison of them with those obtained under effect of medicine. *Feces,* first catharsis at 12:35; 6 during the first hour, 5 during the second, 2 during the third, 1 from 3 to 5 P. M.; died at 5 P. M.; total number to that time, 15; total weight, 9.07 pounds. Tenesmus was evident during the whole time after the effect of medicine appeared until horse died; slight pain at 12:25; considerable gas; perspiring very freely at 12:40, which continued until death. At 5 o'clock, just before dying, the heart action was irregular and violent, with pulse 36 and weak; dropped suddenly into slings and died.

(III.) B. experiment (11). Illustrates a rather large dose of barium with *poisonous effect* in a peculiarly susceptible horse. Dose, 15 grams at 7 A. M. in bolus. This experiment is interesting in that the horse died, and a post-mortem was obtained showing some interesting developments. Feces record for twenty-four hours: Period A, 8 discharges; weight, 32 pounds; normal in all respects; horse in good health.

Period B, first discharge at 7:35; 6 the first hour; 14 the second; 8 the third; 11 from 10 A. M. to noon; 12 from noon until 3:30 P. M.; died at 3:30; total number for the 8½ hours, 51; weight, 50 pounds. Temperature not materially varied; pulse 60 at 10 A. M.; 54 at noon; respiration 42 at 9 A. M.; 48 at noon. Slight tenesmus between 7:50 and 8:40; uneasy at 8:45; lay down at 9 o'clock; no excessive pain from 9 until noon. Feces very thin; commenced trembling at 3:30; struggled; fell suddenly at 3:32; struggled to her feet again after considerable effort; immediately fell on left side; leg and body-muscles quivered spasmodically; died very suddenly.

(IV.) *Kenwood (black mare).* Thoracic cavity and contents were apparently normal. We omitted to examine interior of œsophagus. Stomach shows two very distinct areas of intense local inflammation (both in right cul-de-sac and greater curvature). Mucous membrane is swollen and purple in two spots just the shape and size of the bar-

ium balls; borders sharply defined. She had lain down several times during operation of the physic, and we noticed she would stagger a little and tremble slightly for a moment after rising. She had also acted in the same way during operation of her last dose of barium.

Jejunum and ileum were normal; mucous membrane of cæcum and first, second, and third portions of the colon (less marked on fourth portion) mildly congested; small colon and rectum filled with soft feces, consistence of cow's feces, dirty gray color; feces about this same condition throughout the entire canal, all soft and uniform. There was very little feces in the small intestines, but throughout this portion there was a great abundance of fluid about the consistence of gravy and about the color of light blue clay. Peritoneal surface of the diaphragm was nearly covered with little patches of organized fibrinous exudate—possibly the result of some pre-existing peritonitis, but singularly local.

The brain substance and meninges were apparently normal, except a congestion of each choroid plexus and a decided congestion of the pia mater and the inner arachnoid, around inferior portions of the cerebellum. The inferior surface of all three lobes of the cerebellum was deeply reddened, with raised, swollen appearance—could easily separate a thin layer from this portion of the cerebellum that resembled a blood-clot, quite firm, difficult to tear.

(V.) B. Experiment (32). Shows an interesting result from intravenous use of barium. *Severe local swelling.* Dose, 1. gramme, intravenously given in 10 per cent. solution.

Feces record, Period A, twenty-four hours; number of discharges, 8; weight, 22 pounds; normal. Period B, total number, 12; weight, 12 pounds. A distinctly constipating effect was evident; pain moderate; effect on pupils, *nil.*

This experiment was continued during the third period of twenty-four hours, C, to study the effects of this dose upon the feces records, with the following results: Total number, Period C, 8; weight, 28 pounds. A very unfavorable showing from Period B, when the cathartic effect should have been active. A large swelling slowly appeared on the side of the neck and extended downward perhaps eight inches, and upward about two inches from the side of injection. The next day after injection it was about one

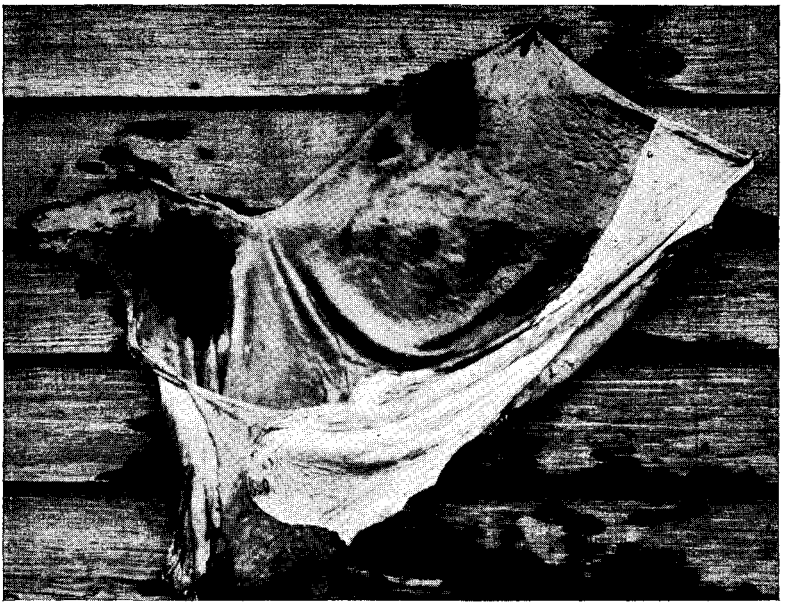

Fig. 1.—Stomach of Horse, showing the effect of two barium chloride balls. Barium experiment (11). Note the two dark inflamed areas, the size and shape of the two barium balls given. See Autopsy IV.

foot long and five inches wide, and perhaps an inch and a half above the level. The swelling did not seem painful or annoy the horse, and went down by the 24th. No abscess developed. The horse was in good health, eating and feeding well all the time. The vein was not obstructed, as shown by pressure below the swelling. The needle entered the vein easily, and the blood flowed through the needle very freely, showing that the needle was unquestionably in the vein. The horse stood quietly for the injection, and it is almost impossible that any barium should have been injected outside the vein. In view of this the swelling is difficult to account for.

Unsatisfactory experiences with barium reported by others. (See *Journ. Comp. Med. and Vet. Archiv.,* vol xvii. No. 7, Mollereau; *Ibid.,* Ries; *Berliner Wochenschrift,* No. 24; *Ibid.,* No. 27; *Vet. Journ. and An. Comp. Path.,* vol. xli. No. 246, Nemo; *Veterinary Magazine,* vol. iii. No. 2, Treacy; *Am. Vet. Review* (from *Berl. Thier. Woch.*), vol. xx. No. 1, Bieser; *Journ. of Comp. Med. and Vet. Arch.,* vol. xvii. No. 9, Plaskett; *The Veterinary Magazine,* vol iii. No. 7, p. 445, Cary.)

TABLE D.—Hypodermic Experiments.

Abbreviations explained at the end of the table.

Dose	Name	Exp. No.	Bowel discharges.					
			No.*	Weight *	Pain.	F. effect	1st hour	1st 3 hrs.
E .5	Jim, 2d,	19	17 15	32 5 32.5	o	o	3	3
"	Dick,	22	8 11	30 37	o	o	1	3
E .5 P 1.	Jim, 2d,	20	14 12	25.5 32 5	o	o	3	3
E 5 P 2.	Dick,	23	8 6	37 5	o	o	0	1
E .75	Lady	35	9 10	26 28	o	x	1	4
E 1.	Jim, 2d,	18	18 46	47 5 76.5	x	xxxx	6	30
"	Josie,	48	10 9	37 24.5	o	— C	1	1
"	Dick,	27	10 10	50 32 5	o	x	2	5
E 1., P 2.	Dick,	24	7 14	32 41	o	xx	1	6
E 1., P 2. A .25	Dick,	30	8 9	38 34.5	o	— C	0	0
E 1., P 2. A .08	Dick,	31	10 7	39.5 34.5	o	x	3	0
E 1., P 4 A 08	Dick,	32	10 7	39 5 34.5	o	— C	0	1
"	Dick,	33	10 10	31.5 36.5	o	o	2	2
E 1., P 4 A 04	Dick,	34	11 10	38.5 41	o	x	2	3
E 1.5	Jim, 2d,	17	17 49	47 53	x xxx	Sec rec. 17 xxx	20	42
"	Josie,	50	9 11	32 5 34	x	o	2	2
"	Dick,	28	8 25	32.5 36 5	xx	xx	16	22
E 1 5, P 2.	Dick,	25	9 11	33 35	x	x	2	5
E 1 5, P 4. A .05	C. C.	55	8 13	29 31	Sec rec xx	x	Mistake 2	in A. 2
E 1 5, P 4. A 05	C. C.	57	8 13	34 37	xx	xx	3	4
	Whitey,	56	12 14	40 37	x	—	Mistake 0	in A. 1
	Whitey,	58	9 14	31 40	xxx	xx	5	7
"	Kenwood,	54	10 14	33 34	o	x	3	8
E 1.5, P 4. A .14	Dolly	31 A	 0	 0	o	o	H C. Im paction 0	0
E 1.5, P 4. S .5	Lightfoot.	46	 18	 25	x	xx	7	17

Dose.	Name.	Exp. No.	Bowel discharges.					
			No. *	Weight. *	Pain.	F. effect	1st hour	1st 3 hrs.
E 2.	Jim, 2d	21	15 57	....	xxxx	xxxx	15	47
"	Dick,	29	7 37	39.5 46 5	x	xxx	17	28
	Jim,	4	16 15	39 32	x	x	0	3
E 2. A .05	Whitey,	59	14 22	42 44	xx	xx	5	7
"	C. C.,	60	12 23	42 42	x	xxx	7	9
E 2., P 2.	Jim,	7	9 18	39 37	xx	xx	6	14
"	Jim, 2d,	15	18 47	50 51	xxx	xxx	17	38
"	Dick,	26	8 23	47 52	xxx	xx	13	20
E 2., P 2. A .2	Dolly,	30 A	 2	 4	xx	x	H C Im 2	paction. 2
"	Dick, 2d,	38	....	....	o	o	H. C. Im 0	paction. 0
E 2., P 2.5 S .5	Jim,	11	9 40	26.8 31.5	xxx	xxx	11	35
E 2., P 4.	Lady,	37	9 27	23.5 26	xxx	xx	See re 14	cord. 21
E 2., P 4. A .05	Lady,	43	11 19	29 32 5	xx	xx	10	16
"	Lady	49	13 12	24 5 28	xx	o	3	3
"	Dick, 2d'	39	....	....	o	x	See exp 0	record 4
	Dick,	36	10 25	38 5 36	x	xxx	15	19
"	C. C.,	51	8 23	19 5 36	xx	xx	9	14
"	Whitey,	52	15 15	32.5 40	xx	xx	7	8
"	Kenwood,	53	9 29	33 42	xx	xxx	4	20
E 2 , P 4. S .25	Lady	47	*10 32	*26 24 25	x	xxx	15	26
"	Dick,	44	11 22	33 42	o	xx	7	17
E 2., P 4. S .5	Lady,	45	11 16	20.25 25	xx	xx	2	14
	Dick, W. W.,	41	 13	 21	o	xx	4	12
	Dick,	42	9 32	38 54.5	o	xxx	20	28
E 2.5, P 2.5	Jim,	9	4 27	19.3 27.2	xxx	xxx	4	25
"	Harry,	8	7 14	25.7 31	xx	xx	5	12

Dose.	Name	Exp No.	Bowel discharges. No.*	Weight.*	Pain.	F. effect.	1st hour.	1st 3 hrs.
E 2.5 P 2.5 A .1	Jim	10	10 13	15.3 20.3	x	x	2	7
"	Jim, 3d,	16	13 20	40 45	x	xx	5	10
E 2 5 P 1 5 A .25, S 1.	Jim,	12	10 10	20.3 25	o	o	0	0
E 3.	Harry	5	 19	 33	xxx	xxx	3	16
	Jim,	6	11 30	37 33	xxx	xxx	10	24
"	John,	13	15	9	xxxx	xxxx	6 Died.	13
"	Jim, 2d,	14	5 56	10 55	xxx	xxx	4	39
E3 S.1, A1	Cow,	40	....	....	— C o	o	0	0

TABLE E.—$BaCl_2$, per Mouth.

Dose.	Name.	Exp. No.	Bowel Discharges. No *	Weight *	Pain.	F. effect.	1st hour.	1st 3 hrs.
8.	Kenwood,	1	6 9	28 27.5	o	x	1	3
8.	Whitey	3	7 19	23 49	o	xxx	3	15
8.	C C.,	2	7 14	22 46	o	xx	2	8
10.	Kenwood,	4	8 52	28 48	xxx	xxx	1	19
10.	C. C ,	5	13 15	40 25	Mistake in dose. x	x	26 hours. 0	26 hours. 0
10.	Dolly,	15	23 19	35 33	o	xx	4	9
10.	Brownie,	14	— 13	— 26.5	o	x	1	2
10.	Nick	16	9 11	27 23	o	o	1	4
10.	Dandy,	29	11 16	40 42	o	x	3	4

* Total numbers and weights of bowel discharges for Periods A and B in each experiment.

E. Eserine. P. Pilocarpine. $BaCl_2$ Barium Chloride. A. Atropine. S. Strychnine.
o. Nil. xx. Severe or decided.
x/2 Very slight effect. xxx. Very severe or decided.
x. Slight effect. xxxx. Extreme.
F. effect. General cathartic effect. H. C. Hospital case.
1st hour. Number of bowel discharges during the first hour after giving dose.
1st 3 hours. Number of discharges during the first three hourse after giving dose.
Doses quoted are on basis of 900 lbs. weight and expressed in grains for E., P., A. and S., and for Barium in grammes.

Dose.	Name.	Exp No.	Bowel discharges.					
			No *	Weight.*	Pain.	F effect.	1st hour.	1st 3 hrs.
12.	Kenwood,	6	7 49	29 43	x	xxx	6	32
12.	Whitey,	8	11 11	34 32	o	o	0	1
12.	C. C.	7	10 28	31 36	x	xxx	4	18
11.6	Nick,	19	9 11	27	o	— C	1	2
12 5	Queen,	9	....	....	o	x	1	4
12 5	Brownie,	20	14 11	32	x/2	x	1	2
12.5	Brownie,	27	11 13	34 44 5	xx	Active 12 M to 5 P M. xxx	0	1
12 5	Nick,	25	9 14	29.5 37	o	x	1	4
12 5	Kit	24	12 12	54 57	o	o	0	1
12 5	Prince,	26	10 34	44 5 84	x	Gaunt and much depressed afterward xxxx	3	10
15.	Kenwood,	11	8 51	32 50	xx	xxxx	8½ h s. then died. 6	28
20.	Whitey,	13	11 28	26 5 51	xx	xxx	Active 12 M. to 5 P M. 0	2
15.	C C.,	12	9 48	31 40	xx	xxx	13	35
15	Queen,	10	....	....	o	x	0	0
19 1	Nick,	13	8 14	24 33	x	x	1	3

TABLE F.—$BaCl_2$, Intravenous.

Dose.	Name.	Exp No.	Bowel discharges.					
			No *	Weight.*	Pain.	F. effect.	1st hour	1st 3 hrs.
0.75	Whitey	18	10 16	33 34	o	xx	9	12
0.75	C. C.,	17	11 30	28 32	x/2	xx	12	20
1.	Whitey,	21	12 24	39 40	o	xx	11	12
1.	C. C ,	22	9 28	37 42	x/2	xxx	14	15
1.	Nick,	32	8 12	22 12	xx	— C	1	4
1.	Dandy,	31	16 20	37 27	x/2	x	7	9
1.5	Whitey,	28	12 14	42 35.5	xxx	xx	7	9
1 5	C C.,	30	11 43	41.5 42	x/2	xxx	28	38

Abbreviations same as in Table D.
Doses quoted on a basis of 1000 weight and expressed in grammes.
Doses administered in 10 per cent. solution.

COMPARISONS AND CONCLUSIONS.

The following comparisons are made in view of similar doses, the differences being only such as necessary to furnish the desired data. The number of bowel discharges for twenty-four hours, the weights of the same, the pain effect with general disturbance, and the general bowel effects are considered. The number of discharges during the first hour after the administration of the medicine, or after the first appearance of the cathartic effect, and the number during the first three hours after that time, are also considered. (See Tables D, E, and F.)

Pilocarpine with Eserine.—As to the value of pilocarpine in connection with eserine, the comparison of experiments (5) and (8), (28) and (24), (28) and (25), (29) and (26), (27) and (24), (4) and (7), (6) and (9), (21) and (15), (59) and (52), (60) and (51), (60) and (57), making a total of eleven comparisons, shows six in favor of pilocarpine and five in favor of eserine alone.

A few of the experiments seem to show distinctly in favor of pilocarpine; with the others the comparison is but slightly in its favor. On the whole, the comparison is not strongly in favor of pilocarpine.

Eserine alone, as compared with eserine and atropine.—A comparison of experiments (21) and (59), (29) and (60), (4) and (59), (5) and (59), (6) and (60), (13) and (59), (14) and (60)—a total of seven comparisons—shows six strongly in favor of atropine and one with results about equal.

NOTE.—All the comparisons in this paragraph, of eserine with eserine and atropine, are with different horses, and should not, therefore, be estimated at the same value as though the compared doses had been given to the same horse for each comparison. It seems quite clear, however, that atropine in very small doses makes a desirable addition to eserine.

Eserine as compared with eserine, pilocarpine, and atropine.—The comparison of experiments (29) and (51) (different horses); (17) and (57) (different horses); (5) and (43) (different horses); (4) and (53) (different horses); (28) and (54) (different horses); (21) and (52) (different horses); (27) and (31) (same horse); (27) and (33) (same horse); (29) and (36) (same horse); (27) and (34) (same horse); (48) and (34) (different horses); (18) and (31) (same horse), making a total of twelve comparisons, with seven distinctly in favor of pilocarpine and atropine, three

in favor of eserine alone, and two with results practically equal. On the whole, the comparison is decidedly in favor of the combination.

Eserine and pilocarpine as compared with eserine, pilocarpine, and atropine.—A comparison of experiments (9) and (10) shows distinctly in favor of atropine; (37) and (43) also distinctly in favor of atropine.

Eserine and pilocarpine as compared with eserine, pilocarpine, and strychnine.—A comparison of experiments (7) and (11), (37) and (45), (37) and (47), (15) and (11), (26) and (11), making a total of five comparisons, with two strongly in favor of strychnine; two distinctly in favor of strychnine; and one with results about equal.

Eserine, pilocarpine, and atropine as compared with eserine, pilocarpine, and strychnine.—A comparison of experiments (43) and (47), (43) and (45), (36) and (62), (36) and (44), (52) and (47) (different horses); (54) and (46) (different horses); (51) and (44) (different horses); (57) and (46) (different horses)—a total of eight comparisons, seven strongly in favor of strychnine and one with results about equal. The whole comparison is strongly in favor of the strychnine in the matter of weights of actual feces removed, number of discharges, and permanence of effect. (See Tables D, E, and F.)

With hypodermic cathartics the item of balancing the medicine used is very important, especially with atropine and strychnine, too much of either being objectionable and too little without effect.

Eserine combinations compared with barium.—We have endeavored to make a comparison of eserine combinations with barium chloride, using moderate and representative doses of each. These comparisons are selected at random, some of them being upon the same horse and quite a number with different horses. The writer wishes to emphasize the fact that he does not attach much importance to comparisons of cathartics on different horses in isolated cases, but if a number of experiments can be gotten together the general averages mean something. Another lot of comparisons, selected at random, might vary the results to some extent, but not a great deal.

A comparison of E. 59 (dose, eserine 2 gr., atropine 0.05 gr) with B. 3 (dose, 8 grammes per mouth) shows distinctly in favor of the barium.

A comparison of E. 60 (dose, eserine 2 gr., atropine 0.05 gr) with B 2 (dose, 8 grammes per mouth) shows results practically equal, the weight somewhat in favor of barium.

A comparison of E 58 (dose, eserine 1.5 gr., pilocarpine 4 gr., atropine 0.05 gr.) with B 8 (dose, 12 grammes per mouth) shows in favor of the eserine, but both very unsatisfactory.

Comparison of E. 52 (dose, eserine 2 gr., pilocarpine 4 gr., atropine 0.05 gr.) with B. 21 dose, 1 gramme intravenously) shows slightly in favor of the barium; pain in favor of the barium; weight of feces in favor of the eserine.

Comparison of E 51 (dose, eserine 2 gr., pilocarpine 4 gr., atropine 0.05 gr.) with B 22 (dose, 1 gramme intravenously) shows very strongly in favor of the barium.

Comparison of E 54 (dose, eserine 1.5 gr., pilocarpine 4 gr., atropine 0.05 gr.) with B. 1 (dose, 8 grammes per mouth) shows results practically equal.

Comparison of E. 53 (dose, eserine 2 gr., pilocarpine 4 gr., atropine 0.05 gr.) with B. 4 (dose, 10 grammes per mouth) shows strongly in favor of eserine.

Comparison of E. 43 (dose, eserine 2 gr., pilocarpine 4 gr., atropine 0.05 gr.) with B. 15 (dose, 10 grammes per mouth) shows slightly in favor of the eserine (different horses).

Comparison E. 36 (dose, eserine 2 gr., pilocarpine 4 gr., atropine 0.05 gr.) with B. 32 (dose, 1 gramme intravenously) shows very strongly in favor of eserine (different horses).

Comparison of E. 47 (dose, eserine 2 gr., pilocarpine 4 gr., strychnine 0.25 gr.) with B. 28 (dose, 1 gramme intravenously) shows strongly in favor of eserine (different horses).

Comparison of E. 44 (dose, eserine 2 gr., pilocarpine 4 gr., strychnine 0.25 gr.) as compared with B. 8 (dose, 12 grammes per mouth) shows strongly in favor of eserine (different horses).

Comparison of E. 45 (dose, eserine 2 gr., pilocarpine 4 gr., strychnine, 0.5 gr) with B 7 (dose, 12 grammes per mouth) shows distinctly in favor of barium (different horses).

Comparison E. 41 (dose, eserine 2 gr., pilocarpine

4 gr., strychnine 0.5 gr.) with B. 30 (dose, 1.5 grammes intravenously) shows strongly in favor of the barium (different horses).

Comparison E. 42 (dose, eserine 2 gr., pilocarpine 4 gr., strychnine 0.5 gr) with B. 31 (dose, 1 gramme intravenously) shows strongly in favor of the barium (different horses).

Comparison E. 53 (dose, eserine 2 gr., pilocarpine 4 gr., atropine 0.05 gr.) with B. 6 (dose, 12 grammes per mouth) shows slightly in favor of the barium, both nearly ideal; both pain and weight slightly in favor of the barium (same horse).

Comparison of E. 57 (dose, eserine 1.5 gr., pilocarpine 4 gr., atropine 0.05 gr.) with B 17 (dose, 0.75 grammes intravenously) shows strongly in favor of the barium, especially as to pain (same horse).

Comparison E. 58 (dose, eserine 1.5 gr., pilocarpine 4 gr., atropine 0.05 gr.) with B. 18 (dose, 0.75 grammes intravenously) shows results practically equal; pain in favor of the barium; weight of feces in favor of the eserine.

A total of seventeen comparisons shows seven in favor of the eserine combinations, seven in favor of barium, and three with results practically equal—a remarkably even comparison for experiments selected at random.

We have endeavored to select only such experiments as illustrate moderate doses wherein the effects were representative. It is evident that with the intravenous use of the barium the results are more uniform, and there is a greater uniformity among the different horses as to susceptibility than when this drug is administered per mouth.

When we compare the newer cathartics—eserine and barium—with aloes as to the actual amount of feces moved, uniformity of satisfactory results (when used solely for cathartic effect), uniformity of susceptibility, and in any case when the element of time is not all important, the result is very much in favor of the latter. Especially is it true in the matter of actually unloading the colon. The cathartic effect seems to last longer, the pain disturbance is uniformly less, with no muscular tremors under ordinary circumstances. There is no objection to aloes as to possible heart-complications; there is but a slight tenesmus under ordinary circumstances and much less after-constipation than with either eserine or barium. In any case, when we

have time to wait, the preference among these is decidedly in favor of aloes for horses.

General comparison of eserine, pilocarpine, etc., compared with barium. In the item of expensiveness the comparison is decidedly in favor of barium. Permanence of chemical form is greatly in favor of barium. Ease of administration is in favor of eserine. Promptness of effect is, first, in favor of the barium per intravenous method; next, in favor of the eserine hypodermically; third, in favor of the barium per mouth. As to cathartic results, considering numbers and weights of discharges, the decision is uncertain, results being practically equal. The comparison as to pain disturbance is in favor of the barium. Muscular tremors stand distinctly in favor of the barium. The comparison as to certainty of cathartic effects is in favor of the eserine, for several horses did not respond to large doses of barium. It is true that horses vary somewhat in susceptibility to eserine, but not to the extent as with barium. We have not thus far found any horse in normal condition that did not respond to reasonable doses of good eserine.

When we compare the two in reference to the possibility of serious or even fatal results, the comparison is very much in favor of the eserine.

As to the disturbance in temperature, pulse, and respiration, neither has shown any uniform results. As to the after-effect upon the bowels we are not prepared to express an opinion. Our experience with the two drugs gives the impression that with repeated doses of eserine the susceptibility increases and with barium it decreases; but this is not given as an assertion of fact.

As to dosage: The smallest dose of eserine which has given good results was 1 gr. (see E. 18). The largest dose of atropine which has allowed satisfactory results has been 0.1 gr. (see E. 16). We consider the largest dose of eserine advisable under ordinary circumstances to be 3 gr., and would usually give less.

In using strychnine with the eserine we should not use more than 0.5 gr., and usually but 0.25 gr. This agent commonly increases the amount of actual feces moved and adds to the desirable effect of the eserine. Ordinarily we should not use more than 0.05 gr. atropine.

The value of pilocarpine in connection with eserine is very doubtful.

As to barium, we should not give less than 8 grammes nor more than 15 grammes per mouth, and not more than 1.5 grammes intravenously, nor less than 0.75 grammes per 1000 pounds, if anxious to have definite results. Barium should not be administered in bolus or capsule. When using barium in solution, an ordinary dose should be dissolved in from six to eight ounces of water.

Three to 5 c. c. of air have been injected several times without noticeable effect. We have only known one case of serious local trouble among all that have been reported with the exception of our own (B. 32).

The physiological effects which writers on human materia medica describe—depression of the temperature and slowing of the heart, etc.—have not been manifested in these experiments; neither any posterior paralysis, except in the fatal case (B. 11), and no case of peculiar posterior lameness such as others have reported.

Our experience with hypodermic cathartics, of which eserine forms the basis, and with barium, gives us the opinion that both are useful, but should not replace the old cathartics.

Barium may be useful, but is not the ideal, harmless drug of magic power and accuracy for simple catharsis or the treatment of colics which some writers would lead us to think.