SCOTTISH NULLITY SUIT.

WIFE'S UNSUCCESSFUL CLAIM.

Lord Hunter has delivered judgment in the Court of Session, Edinburgh, in an action in which Agnes Lockerbie Faulder, or Guild, of Newon Cottage, Darvel, sought to have her marriage with Thomas A. Guild, teacher, of Mossbank Industrial School, Millerston, Glasgow, declared null and void on the ground that Guild had previously been married to Margaret T. Ramsay, otherwise Margaret T. R. Scarth, of Hucheson-street, Outremont, Montreal, the wife of Professor G. W. Scarth, of McGill University. Both Mr. Guild and Mrs. Scarth denied that they were ever married to one another.

Lord Hunter absolved the defenders from the conclusions of the summons, and found the defender Guild liable in expenses to the plaintiff and to Mrs. Scarth.

His LORDSHIP said that the plaintiff was married to Guild in April, 1923. About May of that year the plaintiff discovered letters written to him by a Miss Ramsay and certain documents which suggested to the plaintiff that her husband had contracted an irregular marriage with Miss Ramsay some years before. The defenders met in 1903, when Miss Ramsay was 17 and at school, living in Dundee. They were not engaged and no suggestion of marriage had been made. In 1905 Miss Ramsay became anxious as to her condition, and Guild wrote out two documents, one of which was signed by him and the other by Miss Ramsay. Guild said he got the form of declaration out of the English Church Prayer Book. Both documents were retained by Guild, whom she trusted to make them forthcoming if she became pregnant. Guild never gave Miss Ramsay a wedding ring, but bought her an engagement ring, which she wore. She also visited Guild's parents, and was received as his *fiancée*. In March, 1916, Guild sent to the Registrar-General "the contracting papers of marriage," which had been prepared and dated as of 1913, but which in reality had been signed in 1916. In any view of the case the statements in Guild's letter to the Registrar-General and in the documents were false. It was clear that no marriage took place on the date stated. What was inexplicable was Guild's retaining Miss Ramsay's letters and the declarations not only after her marriage but his own. He ought certainly to have destroyed them before Miss Ramsay's marriage, and he (the Judge) could only ascribe his not having done so to his vanity and stupidity. His Lordship did not think that there was evidence from which he would be entitled to draw the conclusion that the defenders were ever effectively married to each other.

McGILL UNIVERSITY

MONTREAL.

PRINCIPAL'S OFFICE.

July 13th, 1923.

My dear Sir Arthur:-

Will you kindly bear in mind your spoken promise to see that Mr. George W. Scarth, at present Lecturer in my Department, is made Assistant Professor.

Yours faithfully,

Francis C. Lloyd
per C.

General Sir Arthur Currie, G.C.M.G., K.C.B.,
Principal, McGill University,
Montreal.

- I saw Lloyd is anxious that this be not forgotten. AWC

Approved AWC

18/7/23

Botany

Governors

May 14th, 1923.

Dr. T.J.W. Burgess,
P. O. Box 2280,
Montreal.

My dear Dr. Burgess:-

Professor F. E. Lloyd has informed me that you have presented to the Department of Botany a very valuable collection of Canadian plants completely mounted and labelled, together with well-constructed cases, and with a number of books on taxonomic botany.

I shall have great pleasure in notifying the Board of Governors of this splendid gift and I know that they will accept it with gratitude.

Will you please accept my warm personal thanks for this evidence of your great interest in the University and in the Department of Botany.

With all good wishes, I am,

Yours faithfully,

McGILL UNIVERSITY
MONTREAL

DEPARTMENT OF BOTANY
FRANCIS E. LLOYD
MACDONALD PROFESSOR OF BOTANY
CARRIE M. DERICK
PROFESSOR OF MORPHOLOGICAL BOTANY
GEORGE W. SCARTH
LECTURER

May 11, 1923.

Sir Arthur Currie, K.C.B., LL.D.,
Principal of McGill University.

My dear Sir Arthur:-

Dr. T. J. W. Burgess has presented the Department of Botany with his very valuable collection of Canadian plants completely mounted and labelled together with well-constructed cases, and with a number of books on taxonomic botany. I beg you will transmit this information to the Governors together with my appreciation of this very valuable gift. I would appreciate it if the Governors would in some way acknowledge Dr. Burgess' generosity.

Yours faithfully,

F. E. Lloyd

September 26, 1925.

Professor Vladimit Ulehla;
Coastal Laboratory,
Carmel, California.

Dear Professor Ulehla :-

I have heard with pleasure from Professor Lloyd that you are expecting to spend a little time with us at McGill this autumn in completion of the research upon which you have been working during the present year.

We shall be very glad if the resources of McGill prove to be of service to you in your work, and we shall look forward to seeing you here.

Yours faithfully,

CARNEGIE INSTITUTION OF WASHINGTON
LABORATORY FOR PLANT PHYSIOLOGY

COASTAL LABORATORY, CARMEL, CALIFORNIA

DESERT LABORATORY, TUCSON, ARIZONA

Carmel, Cal. 9 Sept. 1925.

My dear Col. Bovie:

I have taken the liberty of inviting to work in my Dept. for a few weeks in November and December, Prof. Vladimir Úlehla, Prof. of Plant Physiology, Masaryk University, Brno, Czeckoslovakia, who is a guest of the Carnegie Institution of Washington this year. We have been doing a joint research here this summer and will bring it to a conclusion in Montreal. Ulehla is here under the auspices of the Rockefeller Educational Board.

I should appreciate it if a more formal invitation might be issued from you, if you would be so kind. It may be addressed here, care of the Coastal Laboratory.

My family and I are leaving for Montreal tomorrow. As you know, I shall be lecturing at Edmonton and Winnepeg, so tha I shall not arrive befor Oct. 10. Professor Scarth will be able to handle things in my absence. I do not suppose that the university will find difficulty in keeping going in my absence!

Owing to the exigencies of travel, I fear that my family may be a day late for my son Francis' registration but I hope you will be able to permit him to enter. If it will do any good, I would hereby apply for such privilege.

I am lecturing before the Dept. of Botany at Berkeley (Univ. of Cal.) on Monday afternoon.

Cordially, yours,

J. E. Livingston

December 19, 1924.

W.C. Leigh, Esq.,
Leigh Lecture Bureau,
152 West 78th St.,
New York City.

Dear Mr. Leigh:-

Professor Lloyd of this University has been doing some most remarkable work in Botany, some of which has been qualified by the New York Times as among the most important scientific work of the world.

While the study on which he has been lately engaged is of a very highly scientific nature, it can be readily understood and would, I think, make the basis of a most interesting lecture.

Professor Lloyd is a technician of very high skill and has been able to prepare a set of slides providing practically an X-Ray moving picture of plant processes. I am sending you herewith a brief note explaining of what the study consists. I would be very grateful if you would let me know whether you think this would prove an interesting subject, and whether you would put it on in New York.

Yours faithfully,

Wilfrid Bovey.

McGILL UNIVERSITY
MONTREAL

DEPARTMENT OF BOTANY
FRANCIS E. LLOYD
MACDONALD PROFESSOR OF BOTANY
CARRIE M. DERICK
PROFESSOR OF MORPHOLOGICAL BOTANY
GEORGE W. SCARTH
LECTURER

May 2, 1923.

Sir Arthur W. Currie, K.C.B.,
Principal's Office,
McGill University.

Dear Sir Arthur:-

Some time ago I wrote a letter of congratulation to Ex-President Francis L. Patton, Princeton University, on the occasion of his birthday. I received the following reply which I thought would interest you.

Bermuda, 15 March '23.

Dear Prof. Lloyd:-

Your kind letter of congratulation on the occasion of the eightieth anniversary of my birth was very gratifying to me, and I thank you very cordially for it. Let me congratulate you also on the important place you fill in a great Canadian University (I will not say the great, for I must keep my loyal expression for Toronto).

I see you keep Botany as a separate department. I had supposed that with the destructive effect of evolution on the Linnean classification Botany had consented to be a dominion under the Empire of Biology. But Dominions are asserting their autonomy nowadays, and I suppose it is so with Botany. I was only trying when I began to write to link your name with that of Sir William Dawson; and say that I am glad to know that Princeton has contributed to the staff of McGill in the large department which thus reflects the lustre of Dawson's name.

Many thanks for your kind word and please accept my best wishes.

Yours sincerely,
(Signed) Francis L. Patton.

I send you the original, which please return at your convenience, for your examination. I do not know whether you can prove or disprove the accuracy of my reading. At any rate I thought you would like to hear what Patton said.

Yours sincerely,

F. E. Lloyd

1 Encl.

January
Thirteenth
1923.

Professor F. E. Lloyd,
Department of Botany,
Biological Building.

Dear Professor Lloyd:-

Re your Memo:-

1, 5 and 6 might well be grouped together.

5. I would omit any lists of guests present, limiting the reference to the dinner to the fact that such an event had taken place and where it took place.

6. Might well form part of No.1.

2. I think these addresses should be published in full.

3. A photograph of the whole building might well be re-produced and I think a plan of one floor would be sufficient.

4. Yes, I think a reference to the green-house should be included.

Yours faithfully,

Principal.

McGILL UNIVERSITY,
MONTREAL.

DEPARTMENT OF BOTANY
FRANCIS E. LLOYD
MACDONALD PROFESSOR OF BOTANY
CARRIE M. DERICK
PROFESSOR OF MORPHOLOGICAL BOTANY
GEORGE W. SCARTH
LECTURER

January 12, 1923.

Sir Arthur Currie, K.C.B., LL.D.,
Principal's Office,
McGill University.

Dear Sir:-

Will you kindly take note of the memorandum enclosed, and send any suggestions which you may have, to the undersigned at your early convenience.

Yours truly,

F. E. Lloyd

Sir Arthur Currie,
Principal, McGill University.

MEMO. CONCERNING PAMPHLET, BIOLOGICAL BUILDING OPENING.

PROPOSED CONTENTS.

1. An account of the opening exercises, being a general account of all the exercises which marked the occasion.

2. The addresses of Sir Charles Sherrington, Dr. Harvey Cushing, Prof. John M. Coulter and Prof. H. J. Hamburger in full.

3. An account of the building itself, with a sufficiently detailed account of the uses to which it is being put, so as to serve as general information. Photographs of the exterior and plans of the interior of the building.
Query - Shall we publish merely one generalized floor plan, or shall we publish all the floor plans?

4. Inasmuch as the Green-House is a part of the general scheme should we not include the green-house in this account?

5. In mentioning the formal dinner shall we give a list of the guests present, or merely limit the matter to the item that a dinner was given?

6. Shall we publish a list of the people from whom congratulatory messages were received?

November
Eighteenth
1921.

Professor F.E. Lloyd,
Arts Building.

Dear Professor Lloyd:-

Thank you very much for your courtesy in letting me have the extract from Mr. Grantham's report.

It is highly gratifying and I have forwarded a copy to Dr. Harrison.

Yours faithfully,

Principal.

McGILL UNIVERSITY,

MONTREAL.

DEPARTMENT OF BOTANY

FRANCIS E. LLOYD
MACDONALD PROFESSOR OF BOTANY

CARRIE M. DERICK
PROFESSOR OF MORPHOLOGICAL BOTANY

November 16th, 1921

Sir Arthur Currie,
Principal,
McGill University.

My dear Sir Arthur:

About a year ago Mr J. Grantham of the United States Rubber Plantations, Inc. New York City, and head of the research department on the plantations in the Far East passed through Montreal on a vacation trip to his home in England.

While here I took occasion to escort Mr Grantham to Macdonald College. In a report made by Mr. Grantham to the United States Rubber Plantations, Inc. on his inspection trip he speaks as follows on Macdonald College: "I spent two days in Montreal, one visiting the works of the Canadian Consolidated Rubber Company and the second visiting the Macdonald College of Agriculture at St. Anne. This is the finest institution of its kind I have seen". Mr. Grantham's experience of agricultural work is wide and he has a scholarly, critical mind. I therefore thought that you would be interested in his comment.

Yours very truly,

F. E. Lloyd

7

November
Second
1921.

Professor F. E. Lloyd,
Arts Building.

Dear Professor Lloyd:-

Thanks very much for sending me a copy of your pamphlet "An Introductory Course in General Physiology".

I am glad I am not now a student in Medicine.

Yours faithfully,

Principal.

Fruit Dispatch

Published by
FRUIT DISPATCH COMPANY

JULY, 1920

Above: Senator Warren G. Harding of Ohio, Republican Candidate for President, and Mrs. Harding.

Below: Governor Calvin Coolidge of Massachusetts, Republican Candidate for Vice-President, and Mrs. Coolidge

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FRUIT DISPATCH

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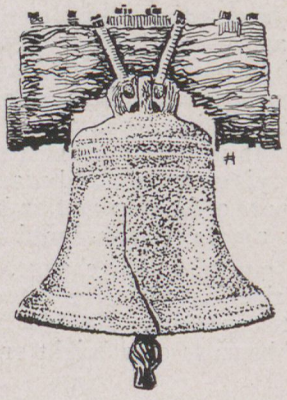


Commemorating the 144th Anniversary of the Independence of these United States of America.

The Changes Taking Place During the Ripening of Bananas

By Francis E. Lloyd
MacDonald Professor of Botany, McGill University

Editor's Note :—
Mr. W. Lewes Evans, Resident Manager for this Company at Montreal, who, himself, ever so often, writes so interestingly for "Fruit Dispatch," was instrumental in obtaining from Professor Lloyd this highly instructive banana article.
Professor Lloyd has given much study and attention to his subject, and we are very appreciative of the benefits herewith extended our readers.

The process known as "ripening" in fruits is a complex of physiological phenomena, resulting, from the gustatory point of view, in a product of maximum palatability and digestibility. So complex indeed is the series of events that as yet only the more readily studied and the practically most important have received attention. As extensive as the gaps in our knowledge may be, however, enough is known about the banana to make it distinctly worth while to offer a brief summary of this knowledge as it stands at the present moment.

The changes in question may be grouped as follows: Those namely which take place in the appearance of the fruit, of prime importance in finding a market; those in texture, which are the paramount qualities concerned in handling, but which are at the same time scarcely of secondary importance in the eating; those of flavour, which must meet the supreme test of eating; and those of food value and digestibility, undeservedly less considered, but of real importance in the long run, since the fruit of highest food value, especially when coupled with tastiness, will hold the market when it fails for others of inferior values.

Colour Changes

The changes in the colour of the banana which ensue during the ripening process are taken as indices of the condition of the fruit. Assuming it to be in good condition when received by the wholesale merchant, it will have a bright green colour. The changes which ensue during the hanging period are similar in general to those which take place in foliage during the early autumn. In the tropics this discoloration takes place at various times, according to the species of tree. These changes are chemical in nature, and consist in the disintegration of the green pigment, known to science as chlorophyll, and its supplanting by a yellow pigment, the later destruction of which is followed by the browning process. None of these changes are of necessity dependent on each other, so far as we know. For example, the yellowing is held by some to depend merely upon the removal of the green, thus unmasking the former pigment, and this is undoubtedly in part true. In the banana, however, there appears to be a transition period between the loss of the green and the full epiphany of the yellow when the colour is quite pale, and neither one thing nor the other. It would thus seem that the yellow pigment in the banana is in large part a development rather than merely a passively produced effect.

The rate of colour change, like the other ripening processes, depends on the temperature. At 68 degrees Fahr.[1] bananas of a bright green col-

[1] Except where otherwise indicated, air temperatures (Fahrenheit) are given in accordance with practice. It would conduce to a more exact understanding of the behaviours of the fruit if the internal temperatures thereof were known.

our become slightly yellow in one to two days, and fully yellow in five to seven days, most frequently in six, maintaining this colour with little change for about seven days. The colour then changes to brown, and finally black.[2]

Mr. H. C. Gore[3] has properly adopted these periods as convenient ones for delimiting stages of ripening, which is of course a gradual process. Those conversant with the handling of the fruit in ripening chambers will recognize the general validity of regarding the fully yellowed banana as "ripe" and the brown condition as "fully ripe." In the following account these terms are used in this sense.

It may be of practical importance to know that the rate of colour (as of other) changes is also affected by previous exposure to low temperatures. I exposed a lot of green fruits to a temperature of 29 degrees for three hours. The internal temperature of the fruit fell to 33 degrees and remained steadily at that point. Several fruits were then kept in a suitable vessel, together with samples which had not been chilled, at a room temperature of about 68 degrees. The green colour did not fully disappear from the chilled fruit in ten days, while the controls changed promptly in a few days. It would be interesting and probably practically worth while to experiment in this direction carefully, making use of various temperatures, and watching the subsequent effects upon the rate, not only of the colour changes but also of the more important physiological changes. This because the question of refrigeration is one which has been and is much to the fore, as a large part of the technic of transportation.

[2] According to Tallarico (Arch. Farm. sperim, 7 : 27-48, 1906), these later colour changes are quite complicated.

[3] Changes in Composition of Peel and Pulp of Ripening Bananas. Jour. Ag. Res., U. S. Dept. Agri. 3 : 187-203, 15 Dec., 1914. I have drawn on Mr. Gore's results in this paper.

Mechanical Qualities

The texture of the ripe fruit depends on two chief factors: the amount of water present, and the extent to which the cellular elements are dissociated. The fruit when received by the wholesale merchant is normally quite full of water, and its tissues are of a maximum consistency and may be snapped in two. The brittleness depends in some measure on the continuity of the cellulose structure, but chiefly on the water content.

The amount of water in the pulp is indeed so great that the banana is literally too big for its skin. If a green fruit be split part way with a sharp knife, the edges of the wound will gape apart and it will require a considerable amount of pressure to bring the cut surfaces together. Or if a thin slice be cut, the pulp will become saucer-like. It is thus demonstrated that much pressure and tension is exerted by the pulp on the inner surface of the skin. During ripening there is a net loss of water, amounting, when the fruit is kept in a humidity chamber, to 3 to 4.5 per cent of the original weight in five to seven days, and to 8 to 10 per cent in thirteen days,[1] whereby the turgidity of the fruit is much reduced. This loss is probably less than occurs ordinarily in ripening rooms (where, however, the humidity is kept up by various means), and especially after the fruit has been placed on sale, which is after the fourth day of hanging. The more water loss, of course, the smaller the fruit, and, beyond a certain limit of size, the lower the price it will command, even though the food value and flavour remain unimpaired. The most interesting feature in this connection, as Gore has been able to show, is that, while the peel loses water, the pulp

[1] Gore, in the paper cited.

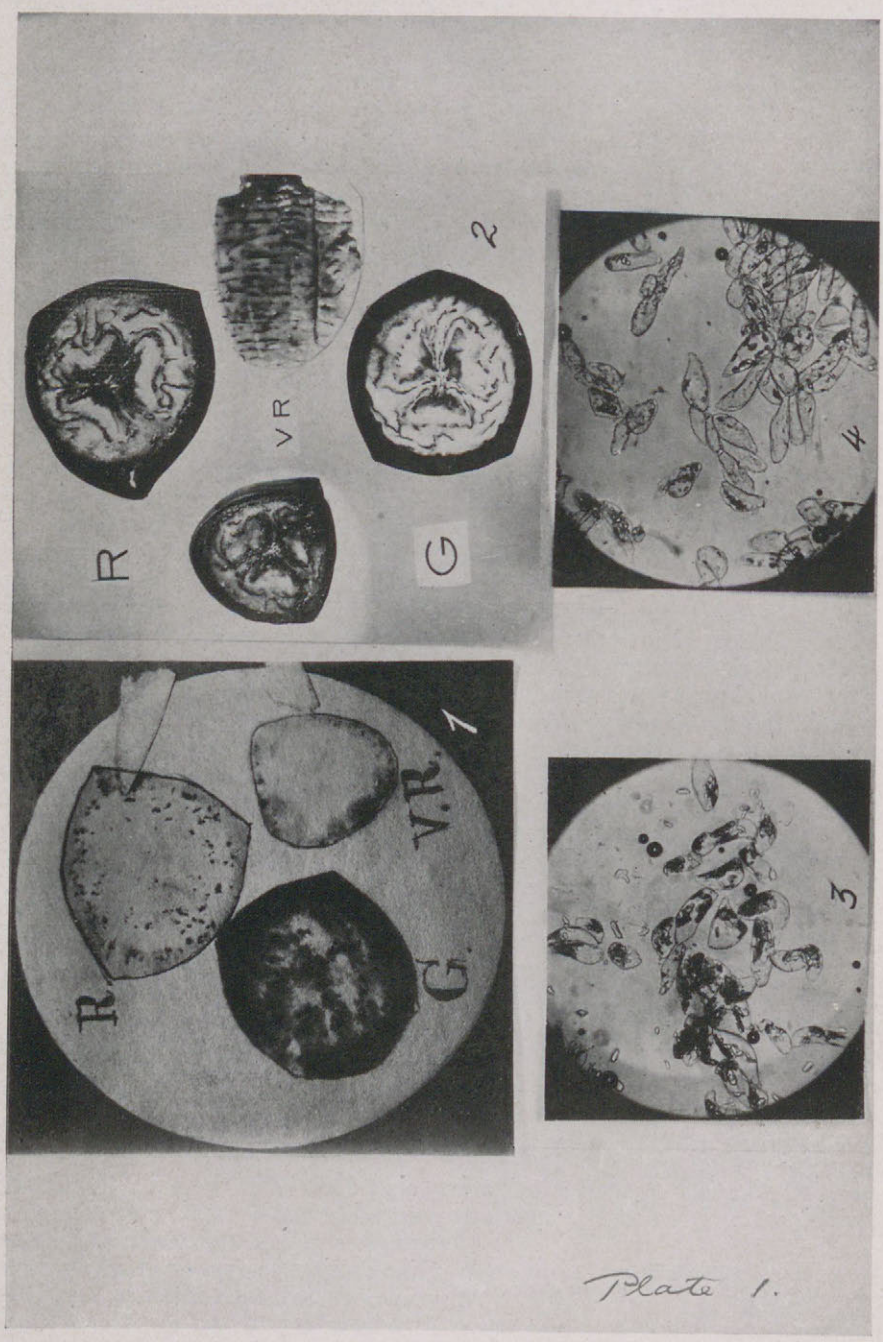


Plate 1.

Legend for Plate 1

FIGURE 1 "Absorption-prints" made by placing moist filter-paper in contact with the cut surfaces of three bananas in the green (G), ripe (R) and very ripe (V R) conditions. The decrease in the amount of "free" tannin is indicated by the unstained condition of the filter-paper. The always greater amount of free tannin in the peel is also indicated.

FIGURE 2 The corresponding cut surfaces, after treatment with nitrous ether, to which the tannin reacts by becoming dark brown. It is thus seen that, in spite of ripeness, the amount of tannin remains constant. It thus appears that non-astringency is due to the combining of the tannin with another substance. A piece of the pulp taken from the surface just beneath the peel is also shown.

FIGURE 3 Loosened pulp cells with considerable starch within them, taken from a green fruit.

FIGURE 4 Similar cells taken from a ripe fruit. There is a small amount of starch still present in some cells.

gains water, especially during the period of yellowing. The average of a number of analyses showed that the percentage of water in the pulp increased from 72.29 to 75.50, and further that the whole, or certainly nearly the whole, was drawn from the peel. It is unlikely that the greatly increased amount of sugar in the pulp, which will be mentioned below, attracts the water from the peel. Under the best conditions the pulp will be juicy as well as properly flavoured and nutritious, while if more or less dried out, the pulp becomes more or less pasty.

At full ripeness, the peel is considerably shrunken. In Fig. 2, showing transverse slices, one may note the change in form of the fruit due to this fact. From a more rounded shape (G) it becomes more angular (R), and if evaporation continues, it becomes much reduced in size (VR).

Aside from the changes in water content, other, properly called textural, changes occur. To understand these it is necessary to form a picture of the structure of the interior of the fruit. Imagine a vast number of irregularly oval, closed sacs of cellulose fastened together side by side and end to end, each sac containing as much as it will hold to distension of sap and starch grains (Fig. 3). Such, as a matter of fact, is the structure, aside from details which need no mention here. In the green fruit, these sacs or "cells" are quite firmly held together by a sort of cement called pectose. During ripening, this cement is changed by a process chemically similar to that of changing the starch into sugar, to form pectin, which is soluble in water. The cells are thus freed from each other, rendering the pulp of the consistency of paste, and the peel readily removable. If the cells die and collapse, as they do in time, the pulp then becomes watery and discoloured, but from the point of view of nature, this is the natural and inevitable end of the process.

It is well known that the ripening of bananas will not proceed normally unless they are properly ventilated. It is therefore of interest in this connection to note that in the absence of oxygen, the fruit remains firm. That is to say, the process of changing pectose to pectin is arrested if oxygen is withdrawn. It was Pasteur, I believe, who in 1872, during his studies in fermentation, was the first to discover this fact. He wrote that plums exposed to air became "soft and watery and sweet while those enclosed in a jar remained very firm and hard, the flesh was by no means watery, but they had lost much sugar" and yielded 1 per cent of the total weight of alcohol.[1]

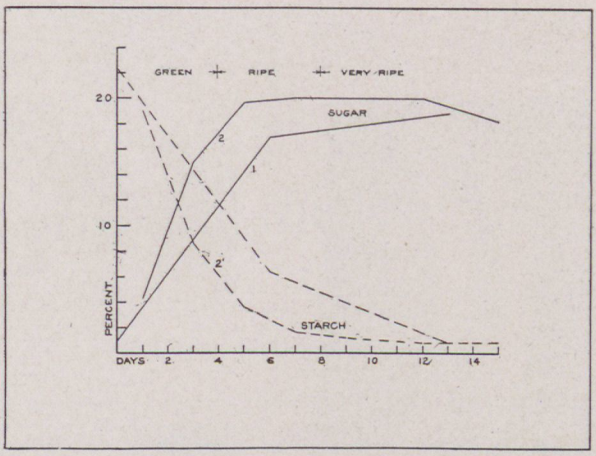
Geerligs [2] found the same to be true of bananas, by keeping them in nitrogen, itself inert, but thus excluding oxygen. In such the firmness of flesh was retained, and the starch remained unaltered, showing that the presence of oxygen is necessary not only for the change in texture, but also for other ripening processes. I found the same to be true of bananas kept in an atmosphere of carbon dioxide, which is normally generated during respiration by fruits as they ripen, while at the same time oxygen from the air is taken up. It is evident from the foregoing that proper ventilation is necessary to ripening. At the same time it must be noted that a reduction of oxygen or an increase in carbon dioxide to some controlled extent might be of use in holding back the changes involved, if so desired.

Changes in Food Content

The food material present in the banana when in the unripe state consists chiefly of starch, occurring as in-

[1] Studies on Fermentation—The Diseases of Beer. Transl. from "Etudes sur la Biere." London, 1879.

[2] Prinzen, Geerligs, H. C. Intern. Sugar Journ. 10 : 378. 1908.



Curves to show the decrease in the amount of starch (the broken lines) and corresponding increase in the amount of sugars (continuous lines) based upon two different sets of analyses made by Dr. H. C. Gore, United States Bureau of Chemistry

soluble granules in the cells (Fig. 4). Inasmuch as, at the present, the peel is a waste, the figures for the pulp only are of immediate interest. According to the most recent results, in Gore's paper already cited, about 22 per cent of the unripe pulp is starch. When in this condition the fruit may be cooked, thus rendering the starch digestible, as in the case of other vegetables, such as the potato. The starch content, however, changes rapidly during the course of ripening. At the end of five to seven days, from the fully unripe condition, the amount falls to between 6 and 7 per cent and in six to eight days more to the small amount of somewhat less than 1 per cent. This disappearance of starch (see Fig. 3) is due to the action of a chemical agent, a ferment,[1] which changes it into sugar, a change, as one sees, which alters the net food value only a little (due to respiration), but which renders the fruit more readily digestible. The amount of sugar therefore alters inversely, the amount in the unripe fruit, about 1 per cent, climbing to about 19 per cent (one-third of which is cane-sugar), in the fully ripe condition. In the curves which I show herewith these changes are shown by the two solid lines, showing the increase in sugar, and by the two broken lines showing the decrease in starch during fifteen days after the beginning of ripening. These indicate very clearly that the greater amounts of change take place during the first six to eight days. Thereafter, the amounts of such substance remain nearly the same. The loss of sugar during the last few days, shown by the dropping of the curve (No. 2), is the result of respiration, for which oxygen is needed. From these results it is seen that the full food value of the banana, both as to quantity and kind, is to be had at the earliest on the seventh day approximately after the ripening process has begun, assuming of course that it is understood that this takes place at 68 degrees.

Other food substances occur in minor amount only. Pectose, resulting from the alteration of the cell

[1] Tallarico (in the paper cited) identifies five different ferments, but even this number probably does not include all.

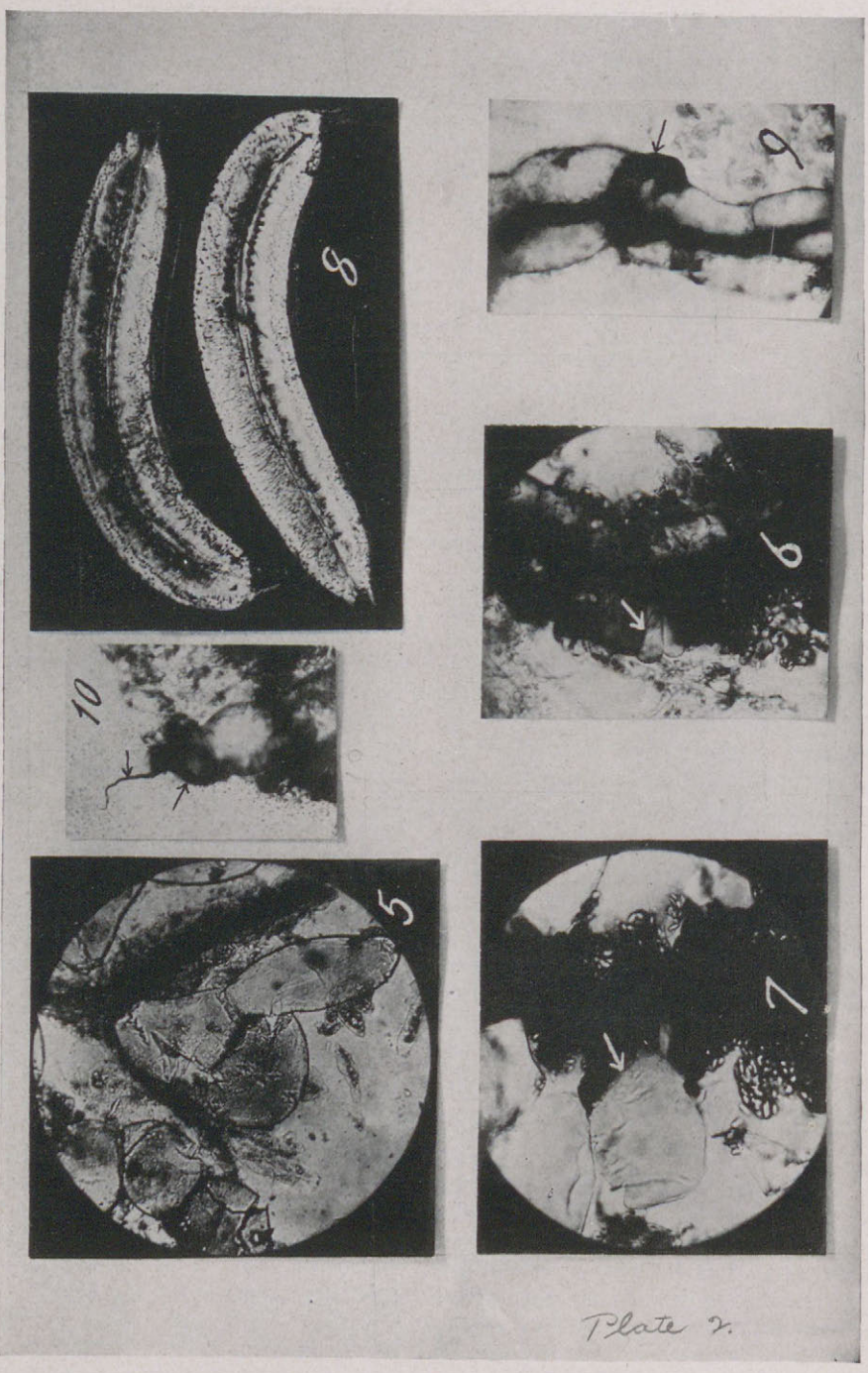


Plate 7.

Legend for Plate 2

FIGURE 5 Tannin cells partly crushed to show the characteristic fracture of their contents like that of a jelly.

FIGURE 6 Part of a string of tannin cells broken slightly at the point indicated by the arrow point, where the contained jelly is seen to protrude from two adjacent cells.

FIGURE 7 The same as Figure 6, after treatment with a weak alkali. The masses of protruding jelly are now seen to have swollen very greatly.

FIGURE 8 A green banana split lengthwise to show the distribution of the tannin, seen as dark strings and masses.

FIGURE 9 Portion of a string of tannin cells lying in water. At the point indicated by the arrow the tannin is seen to be diffusing out to form a spherical mass of precipitate.

FIGURE 10 Similar to Figure 9, but in this case the tannin is forming a curiously shaped tube reaching out into the surrounding medium. The tannin cells of such fruits behave in this manner more or less during digestion.

walls, setting them free as above described, is present in very small but undetermined quantity, while the nitrogenous food (protein) amounts to about 1 per cent.

Although the absolute food value of the banana is not greater than that of some other fruits, high though it is, nevertheless when considered in relation to the cost to the purchaser it is probably the highest. This low cost is made possible by the nature of the fruit—especially to the character of the peel which very efficiently protects the pulp and prevents the entrance of bacteria and fungi which might otherwise rapidly cause decay.

Although the peel is at present waste, it may not be superfluous to indicate something of the food and other content since some turn of conditions might very well make the use of the peels imperative. We, in a new country, are too much given to ignoring of waste, and the sting of necessity may one day force an issue.

In the unripe fruit the amount of starch is 4 to 5 per cent. This undergoes alteration into sugar as in the pulp, falling to somewhat less than 2 per cent and giving rise to about 3.5 to 5 per cent total sugars. Besides sugar there is a small but undetermined amount of resins (with fat-like physical properties), the which, so far as I know, have not been studied. These resins are associated in an intimate way with a caoutchouc (india rubber), the mixture occurring in large droplets [1] suspended in a clear watery juice or sap having very peculiar properties. This sap, which contains tannin, the agent responsible for the astringency of the fruit, is found also in numerous large cells scattered in a definite manner throughout both peel and pulp. In Figs. 2 and 8 the occurrence of these cells in the pulp can be seen—the black strands being composed of the cells in question. At this point we may naturally consider

Changes in Flavour

These consist of the following: (1) Loss of astringency; (2) increase of sweetness, and (3) development of aroma. We consider them in this order.

Astringency, being due to the presence of tannin, has been thought to disappear through the loss of the tannin by chemical change (oxidation). The fact, however, that tannin is present in the ripe banana, apparently in undiminished quantities, was observed by Jaehkel [1] but he was able to offer no explanation of the apparent contradiction. My own studies of the banana show that this fruit is, in regard to the behaviour of the tannin, in precisely the same case as certain other fruits, among which are the persimmon, sapote, and date.[2]

As above noted, the cells which contain tannin also contain a watery solution of a substance which can be turned into a sort of jelly, and which as a matter of fact does so during the ripening process. As long as the jelly-forming substance remains watery, the tannin comes out readily, as can be demonstrated by laying a piece of moist blotting paper on a cut surface of unripe fruit,[3] (Fig. 1G). As, however, the jelly becomes firmer, less tannin can escape from it, so that in four days after the beginning of ripening only a small amount can be taken up by the blotting paper (Fig. 1.R). When the fruit is fully ripe, very little indeed of the tannin can be so separated (Fig. 1.VR). It will be noticed from the figures that more tannin can

[1] These were incorrectly described by Jaehkel as oil-droplets. (Ueber Anatomie und Mikrochemie der Bananenfrucht und ihre Reifungserscheinungen. Kiel, July 24, 1909.)

[1] In the paper cited.

[2] Lloyd, F. E. The Tannin-colloid complexes in the Fruit of the Persimmon, Diospyros. Biochemical Bulletin, 1: 7-41. Sept., 1911.

[3] Lloyd, F. E. A visual method for estimating astringency. Plant World 19: 106-113, April, 1916.

escape from the peel than from the pulp at all times, though the difference in amount is quite small. The jelly-substance is shown in Figs. 5, 6 and 7, those being photographs taken through the microscope of the cells in question, separated from the surrounding pulp and treated so as to demonstrate the nature of the substance and, in Figs. 9 and 10, the escape of the tannin, which in photographs appears as a dark granular mass. The jelly structure is seen in Fig. 5 in the manner of its breaking when pressed. When treated with weak alkali (soda, for example) jellies will swell more than they do in water. In Fig. 6 are seen two protruding masses of the jelly. When treated with alkali they swelled up to the size shown in Fig. 7. This jelly has been shown to be chemically closely related to cellulose.[1] The non-astringency in the banana when ripe is therefore due to the formation of a sort of vegetable leather which cannot give up the tannin (except in very minute amounts and therefore not perceptible to the taste) and which, like true leather, cannot decay. I have kept these curious bodies for eight years in water, and, while the pulp with them has decayed, they themselves have remained in their original condition without change.

In the process of cooking, which itself renders an unripe banana edible, in spite of the tannin present, this substance escapes from the tannin cells and is taken up by the swollen starch. This alone makes the fruit, when thoroughly cooked, non-astringent.

The increase in sweetness, it need scarcely be said, results from the above described increase in sugar, especially cane sugar.

The odour of the unripe fruit is difficult to describe. It is certainly not a pleasant one. In the ripening rooms it is quite noticeable. Gerber[1] investigated the changes which result in aroma, that which is characteristic of "banana oil"[2] or more properly speaking, amyl acetate. At a low temperature (55 degrees) no aroma is developed, while at 85 degrees ethyl- and amyl-alcohol are formed in small amounts, together with acetic,[3] formic and valerianic acids. These together, being volatile, accompanied by a small amount of citric and of malic acid, commonly found in fruits, combine to give the full complement of flavour and aroma. It is important to know, and this should be known by the consumer, that the full aromatic qualities of the fruit are not developed as quickly as the change from starch to sugar. Bananas are as a rule eaten too soon, and furthermore they are frequently kept in too cool a place for the proper development of the aroma. I have found that when a hand of fruit was kept for two or three days in a quite warm place a fruit was obtained which far excelled that newly purchased.

"Condition" of Green Fruit after Transportation

There remains to consider briefly the behavior of green fruit, when received by the wholesale merchant off the cars. The test for condition of fruit in cold weather consists in breaking a fruit in two and observing the exudation of sap.

In fruit which has been cooled, as previously described, I found, in fact, that there was a cessation of active exudation, much earlier than normally. There was, however, an exudation of

[1] Clark, Ernest D. Notes on the Chemical Nature of the "Tannin-masses in the fruit of the Persimmon." Biochemical Bulletin, 2: 412-418, April, 1913.

[1] Ann. de Sci. Nat. Ser. VIII (Bot.), 1896, p. 4.

[2] This is not the flavouring "extract," of which methyl perlargonate is also a constituent.

[3] The amyl alcohol and acetic acid probably form the ester (the above mentioned amyl acetate), which Tallarico in the paper cited holds to be in part responsible for the blackening in the very ripe fruit.

clear watery sap, but in smaller quantity to be sure. The amount could be increased readily by pressure on the surface of the fruit. This fact made it difficult to think that the cessation of exudation was due to the jelling of the latex, and subsequent observation proved the idea untenable, but, on the other hand, showed that the droplets of oil and india-rubber within each particular cell had run together into a single mass. The masses so formed plug up the ends of the cells, which under mechanical pressure (caused by breaking the fruit and even by the internal pressure due to the large water content) break open into each other and form sap channels through which otherwise the sap would flow.

The Great Adventure

(*With acknowledgments to George Matthew Adams*)

What is the profit that men can find
In the frozen North or the jungle heat?
What is the vision they hold in mind
When they face the hardships that they must meet?
It cannot pay, yet they see it through,
And the magic purpose that keeps them to it
Is doing the work that they want to do
In the way that they want to do it.

It isn't money, it isn't fame
That stirs the soul to a true adventure,
Or makes men stick to the grimmest game
In spite of ridicule, doubt and censure.
It's just the spirit that holds you true
To what you've started, and bears you through it;
It's doing the work that you want to do
In the way that you want to do it.

Oh, the weary souls who are chained by chance
To a treadmill track they must always amble,
Who never thrilled to a mad romance,
Who feared the risk of a mighty gamble—
They are the failures of life, not those
Who dreamed and struggled and risked and lost,
Who toiled and battled and baked and froze
But never whined when the dice were tossed.

It's the thought that lifts us above the beast,
The dream that moves us to discontent,
The thing that's driven us west and east
And conquered ocean and continent;
And when we win to the heaven true
We'll find a place, when we come to view it,
Where men do work that they want to do
In the way that they want to do it!

Berton Braley

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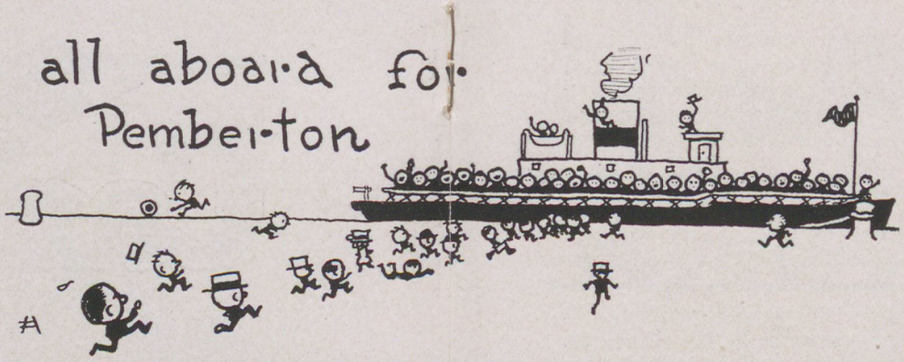
Messrs. Nickerson & Crease, Ltd., of Halifax, Nova Scotia, whose home we herewith feature, took over the business of Nickerson & Company, Ltd., in January of 1917. The latter concern had then been established for several years.

Mr. W. C. Nickerson is President of the firm, Mr. E. Crease is its Vice-President and Mr. R. S. Nickerson holds the office of Secretary-Treasurer.

This is their main house, 108-110 Barrington Street. They also have a branch house in New Glasgow, Nova Scotia.

Nickerson & Crease, Ltd., handle "THE BEST."



Fifth Annual Outing of the United Fruit Company

"Another big success" was the verdict of all the Boston employes of the Company who attended the Annual Outing at Pemberton, on June 12th.

The fun started before the steamer had left the dock at noon and the moon was high in the sky before the last echoes of laughter scattered across the harbor. There was a goodly representation from all of the Boston offices of the United Fruit Company and its affiliated companies.

Old Sol and Jupe Pluv had made special arrangements with Captain Stuffy McInnis Gagin of the General Office Ball Team, so that the contest for the cup that was held by the general office during the previous year, was especially exciting and brought out talent that was decidedly worthy of Big League. The game was the most closely contested of any that has yet been played among the clubs of the various Boston offices and the de-

cision was in the air until almost the last crack of the bat. The general office finally won with the result that the beautifully engraved silver cup now becomes a permanent fixture at that office.

Because of the keen interest in the ball game, it was not possible to complete the intended program of races but an opportunity was afforded for the ladies to shine in this branch of sport. In the 75-yard ladies' dash, Miss Pentz captured the honors and the comment seemed to be that it was fortunate that there were no mixed races because, had such been the case, the little lady who won the above mentioned race would have forced any male competitors to exert their utmost.

The second ladies' race of 100 yards was won by Miss Gardner. This race was closely fought and but for the fact that one of the young ladies nearly turned a somersault at the start, or possibly because of that fact, the race was extremely exciting.

The 100-yard dash for men was won by Paul Thomson and this race brought out unexpected talent.

The Boston Division, having in mind the needs of the crowd, strung bunches of bananas from every available tree and in line with the idea that they must have only "The Best," there was on hand a liberal supply of Simpson Spring tonics. Some of the trade, having heard about the affair, shipped down a sack of peanuts.

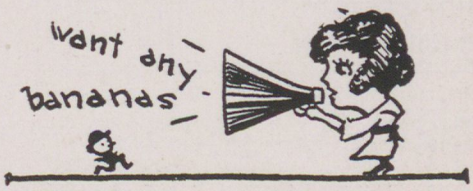
Another contest that created especial interest was the Tug-o'-War, with the husky fruit handlers of Boston Division on one end of the rope and the somewhat less husky, but

equally firm of purpose, pen-handlers of the general office on the other end. Even though the general office had a dark horse in the contest, they were hauled many feet over the line and the honors went to the Division.

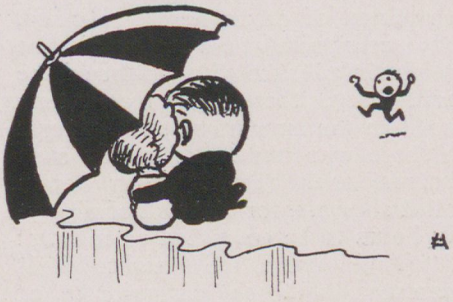
The race between the men who topped the scale at more than 180, was won by Scott Ryder, the genial and well known representative of Boston Division. This contest would, of course, ordinarily be called the fat man's race, but Scott is a bit touchy on the question of avoirdupois.

There was one other contest, but unfortunately the winner's name cannot be stated. This was the banana eating contest and the winner had eaten so many bananas that speech and the telling of his name was out of the question.

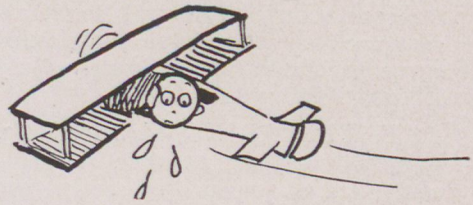
After the sports, a silver-toned young lady's voice called through a megaphone "on to the dinner" and there was a wild rush for the dining room. One of the boys, who has just returned from overseas, nearly lost out on the dinner because of the fact that, from habit, he went hunting for a mess-kit. During the dinner a cabaret entertainment kept the party lively and dancing helped to settle the excellent food that was served.



Just after the dinner a couple were strangely missing and though a diligent search was made, because the sun was setting the photographer insisted on taking his panoramic view of the party without the wanderers.

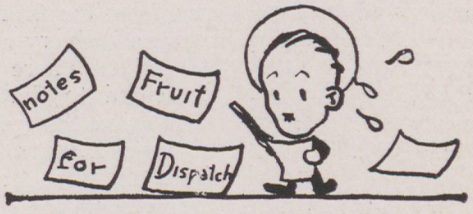


The tennis tournament was then completed. The tennis stars were urged on by a large gallery and the throng were treated to the fastest playing that has taken place on the courts this year. The tournament was won by Jack Kansas and Sydney Holden, representing the general office Accounting Department.



A venturesome member took an airplane spin

During the evening there was dancing in the ball-room and moonlight on the beach. At ten o'clock the party set sail for home with song and laughter resounding over the harbor.



"Fruit Dispatch" had its reporter right on the ground

"But should some power the giftie gie us
To see ourselves as others see us,
Methinks 'twould so reduce our chests
That some of us could wear our vests
Twice wrapped about and still so slack
That they would button up the back."

Selection

Traffic Department

Payment of Freight Charges

The Interstate Commerce Commission is given authority under the Transportation Act 1920 to prescribe regulations as to the payment of transportation charges and credit arrangements. They have just issued an order, Ex-Parte 73, effective July 1, 1920, reading as follows:

"IT APPEARING, That section 3, paragraph (2), of the interstate commerce act, as amended by section 405 of the transportation act 1920, provides:

'From and after July 1, 1920, no carrier by railroad subject to the provisions of this Act shall deliver or relinquish possession at destination of any freight transported by it until all tariff rates and charges thereon have been paid, except under such rules and regulations as the Commission may from time to time prescribe to assure prompt payment of all such rates and charges and to prevent unjust discrimination; PROVIDED, That the provisions of this paragraph shall not be construed to prohibit any carrier from extending credit in connection with rates and charges on freight transported for the United States, for any department, bureau, or agency thereof, or for any State or Territory or political subdivision thereof, or for the District of Columbia.'

"IT FURTHER APPEARING, That a full investigation of the matters and things involved has been had, and that the Commission, on the date hereof, has made and filed a report containing its findings of fact and conclusions thereon, which said report is hereby referred to and made a part hereof:

"IT IS ORDERED, That the following rules and regulations be, and they are hereby, prescribed to become effective on July 1, 1920, and to remain in force until the further order of the Commission:

"1 Where retention of possession of any freight by the carrier until the tariff rates and charges thereon have been paid will retard prompt delivery or will retard prompt release of equipment or station facilities, the carrier, upon taking precautions deemed by it to be sufficient to insure payment of the tariff charges within the period of credit herein specified, may relinquish possession of the freight in advance of payment of the tariff charges thereon and may extend credit in the amount of such charges to those who undertake to pay such charges, such persons being herein called shippers, for a period of ninety-six hours to be computed as follows:

"(A) Where the freight bill is presented to the shipper prior to, or at the time of, delivery of the freight the ninety-six hours of credit shall run from the first 4:00 P.M., following the delivery of the freight.

"(B) Where the freight bill is presented to the shipper subsequent to the time the freight is delivered the ninety-six hours of credit shall run from the first 4:00 P.M., following the presentation of the freight bill.

"2 Every such carrier shall present freight bills to shippers not later than the first 4:00 P.M. following delivery of the freight, except that when information sufficient to enable the carrier to compute the tariff charges is not then available to the carrier at the delivery point, the freight bills shall be presented not later than the first 4:00 P.M., following the day upon which sufficient information becomes available to the delivering agent of the carrier.

"3 Shippers may elect to have their freight bills presented by means

of the United States mails, and when the mail service is so used the time of mailing by the carrier shall be deemed to be the time of presentation of the bills. In case of dispute as to the time of mailing the postmark shall be accepted as showing such time.

"4 Sundays and legal holidays, other than Saturday half holidays, may be excluded from the computation of the period of credit.

"5 The mailing by the shipper of valid checks, drafts, or money orders which are satisfactory to the carrier in payment of the tariff charges, within the period of credit prescribed above, may be deemed to be payment of the tariff charges within the period of ninety-six hours of credit. In case of dispute as to the time of mailing the postmark shall be accepted as showing such time."

Refrigerator Car Supply

One of the sections of the Transportation Act 1920 provided for a revolving fund to be used for loans to carriers at the discretion of the Interstate Commerce Commission and the Commission on June 7 issued a circular fixing an appropriation of $75,000,000 to be loaned to carriers to aid in the acquisition of freight cars and $50,000,000 for locomotives.

The Commission is of the opinion that it would be both desirable and practicable for the carriers to devise a plan for the formation of an equipment corporation or corporations, particularly in the case of refrigerator equipment, and will give preferred consideration to applications for loans to or for the purpose of such a corporation.

The Commission also states that of the $75,000,000 apportioned for freight cars it is desirable that 20,000 new refrigerator cars be built promptly and allotments will be made first to those carriers who offer the largest proportional contributions to meet the advances of the Government, although this does not preclude the possibility of making loans to carriers who may not be able to advance proportionately as much as other carriers but whose equipment urgently needs expansion.

The time for filing applications and amendments in the first general plan of distribution was extended to June 19, 1920, and action is being taken by various interests to induce the carriers who need additions to their equipment to make suitable application. Up to the present time it is understood the following orders have been placed or are in contemplation:

PFE.	4,000	refrigerators
Santa Fe	2,500	"
I. C.	1,000	"
B. & O.	400	"
N. N. C.	250	"
Fruit Growers Express Co.	9,000	"

This indicates that the car builders will be busy for some time as there will also be a number of box cars and other equipment built, but the crying need is for more refrigerators.

In this connection, it is interesting to note that the American Railroad Association has recommended an increase in mileage rates to be paid owners of private cars, said increase to be confined to standard refrigerator cars under MCB classification symbol "RS," which means a car with body, doors and hatch plugs, equipped with insulation, with ice tanks and either with or without ventilating devices. The recommendation is that the new rate be two cents per mile, effective July 1, 1920. Whether or not the Commission will approve the advance is not known but should it do so it will greatly stimulate the building of private cars.

War Tax on Demurrage

Demurrage, for the purpose of war taxes, is not transportation, the treasury has ruled. Its ruling has been made public in Treasury Decision No. 3022, addressed to collectors of internal revenue and others concerned, dated May 26. The decision revises and amends articles 2 and 51 of Regulation 49, revised, by omitting therefrom the word "demurrage" from Article 2, which defines transportation and will make Article 51 read as follows:

Article 51, Storage and Demurrage Charges.—Amounts paid for storage, if a part of transportation, are subject to tax. Storage after delivery to owner is not a part of transportation. Storage by or in behalf of a carrier furnished to a shipper on receipt of his goods for shipment, or storage by or in behalf of a carrier at destination before delivery to owner, whether in outside warehouse or otherwise, is a part of transportation and subject to tax. However, where the consignee has been notified of the arrival of a shipment at destination and fails to remove it within a reasonable time after such notification, the transportation is considered as having ended after such reasonable time, and charges for storage thereafter are not subject to tax. Demurrage is a charge and a penalty imposed by a railroad company for the detention of its cars and the occupation of its tracks beyond a reasonable time after the arrival of the goods; it is not a part of the transportation and is not subject to tax. A "reasonable time," as used in this article, is held to mean the free time allowed by the carrier under its tariff.

The decision of the treasury that demurrage is not part of transportation can have no effect on the Interstate Commerce Commission. That body regulates demurrage on the theory that it is part of transportation. The courts, also, have sustained the Commission whenever there has been a question. On no theory other than that demurrage is transportation or a service connected with transportation has the Commission power over storage or demurrage.

The effect of the revision of the regulation is to exempt from the transportation tax practically all those parts of freight bills caused by the imposition of penalties, because, in the last sentence, the words "reasonable time" for removal, are held to mean the free time allowed by the carrier, in its tariffs, for the removal of the goods. There may be storage in transit, before delivery or tender of delivery. On such storage, by implication, the tax would be imposed.

The Commission could not assent to the proposition that transportation has ended when the free time has expired. That would rob it of the control it has exercised over the rates, rules, regulations and practices of the railroads in the making and enforcement of demurrage and storage charges. The Treasury, however, is not bound by the views of the Commission or the courts in the matter of levying and collecting taxes. It can exempt some of the charges made by the common carriers if it thinks they are for services that are not transportation.

—*The Traffic World* Washington Bureau

Cars for Perishables

The following extract is from the *Traffic World* of June 14th:

In Supplement No. 1 to Circular CCS-20, Chairman Kendall of the A. R. A. commission on car service, says to carriers:

"Very acute situation now impends both in the Southeast and Southwest for ventilated cars to move perishable products, including pineapples, watermelons, etc. The very large ownership of ventilated cars in the Southeast is badly scattered in the northern and western states. Vigorous action to obtain the immediate return of these cars to this loading territory is necessary to avoid possible loss of food products. The watermelon crop alone, in some districts, is expected to be nearly three times as large as last year.

"Please immediately put the following instructions in effect:

1 See that ventilated box are not used as common box except for loading to owners or to southeastern or southwestern vegetable-loading territory.

2 Move ventilated cars empty in homeward direction if no immediate loading available.

"Roads in northern and western territory have been requested by wire to put these instructions into effect.

"Reports reaching here indicate that roads in southern territory continue to load ventilated box cars north with dead freight. This practice should be discontinued at once and cars assembled for perishable loading, or moved on Commission orders to roads now short this class of equipment.

"Any conflicting instructions are hereby cancelled."

On page 57 of our June issue we featured "Service Order No. 1," issued by the Interstate Commerce Commission. We are now extending our readers a supplementary notice in this connection which will be found to improve the situation somewhat so far as fruit and vegetable dealers are concerned:

INTERSTATE COMMERCE COMMISSION

Washington, D. C., June 9, 1920

NOTICE TO CARRIERS AND SHIPPERS:

Service Order No. 1, which ordered and directed common carriers by railroad to divert freight via the routes most available to expedite its movement and to relieve congestion, also ordered and directed the carrier responsible for the diversion to mail a notice to the consignee of the traffic stating the car number, places and dates of shipment and other essential information. It has been urged that a telegraphic notice should be sent to the consignor by the carrier responsible for diversion as to shipments in private cars subject to equalization of empty mileage, and also as to fruits and vegetables, live poultry and other shipments customarily reconsigned upon instructions of the consignor.

While the Commission does not consider it necessary at this time to amend Service Order No. 1 in this respect, it is of the opinion that a telegraphic notice of the diversion should be sent to the consignor by the carrier responsible therefor in the case of shipments in private cars, which are subject to equalization of empty mileage, and also of fruits and vegetables, live poultry and other shipments customarily reconsigned upon instructions of the consignor.

GEORGE B. MCGINTY
Secretary

Five Hundred Dollar Claim Limit

Last month we advised that the United States Railroad Administration was contemplating changing the rule that loss and damage claims amounting to more than $500 would have to be referred to regional counsel of the Administration for approval before payment could be made by the carriers of any claims accruing during federal control.

We are now advised that, effective June 25th, the limit was lowered to $250 and we are filing protest, as we have information to the effect that the previous instructions placing the limit of $500 caused numerous delays in settlement and was causing congestion in the offices of regional counsel and freight claim agents.

Apparently the only man who can change this ruling is John Barton Payne, Director General of Railroads, who succeeded Mr. Hines, and we suggest that all claimants who will be adversely affected by this rule enter protest along the lines suggested in our last month's issue.

The above is a picture of the Honorable Pun Tai, Manager of the Banana Department of the L. Scatena & Co. & A. Galli Fruit Company, Consolidated, of 224 Franklin Street, Oakland, California.

"Ti," as he is familiarly known, has been connected with his present firm and with its predecessor, the L. Scatena Company, for over twenty years in the banana department. He is a son of China, that flowery land of the Orient, but in the early years of his life he migrated to the "Land of the Free and the Home of the Brave." Tai is well and favorably known to the fruit men of Oakland.

The smile that the camera caught on his face is entirely characteristic for Tai is splendidly good-natured, genial in all his relationships. Because he is a thoroughly-trained and a most able banana man he is partial to "THE BEST."

Tai is the only Chinese in this territory who manages a banana department; we extend greetings and wish him long life and prosperity.

CAR SHORTAGE

Save refrigerator car days by diverting and unloading promptly. Delays cause car shortages. Shortages cause waste.

DON'T WASTE FOOD PRODUCTS

NOTICE

This Company has branch houses throughout the United States and Canada, each with a representative in charge who is familiar with conditions affecting his territory and with points that might prove of interest to anyone visiting that particular city. We are always ready and willing to assist our customers whenever the opportunity presents itself, and in keeping with this policy we are inserting herewith a list of our branch houses, with the names of our various managers and the addresses at which they may be found. If at any time our many friends have occasion to visit any of these cities, our representative will esteem it a privilege to have them call on him.

BRANCH HOUSES

Atlanta, Ga.	Atlanta National Bank Bldg.	F. O. Cassidy, Res. Mgr.
Baltimore, Md.	Pier 1, Pratt St.	J. C. Hall, Manager
Boston, Mass.	Long Wharf.	Fred Field, Manager
Buffalo, N. Y.	39 East Market St.	J. C. Carpenter, Res. Mgr.
Burlington, Ia.	Iowa State Sav. Bank Bldg.	V. L. Mitchell, Res. Mgr.
Butte, Mont.	Daly Bank Bldg.	L. W. Huse, Res. Mgr.
Charlotte, N. C.	Realty Bldg.	A. B. Johnston, Res. Mgr.
Chicago, Ill.	236 N. Clark St.	J. W. Leathers, Res. Mgr.
Cincinnati, Ohio	Union Trust Bldg.	E. H. Calkins, Res. Mgr.
Cleveland, Ohio	Electric Bldg.	B. F. Sullivan, Res. Mgr.
Columbus, Ohio	Schultz Bldg.	P. H. Deering, Res. Mgr.
Denver, Colo.	Central Savings Bank Bldg.	R. A. Patch, Res. Mgr.
Detroit, Mich.	Campau Bldg.	B. E. Reiff, Res. Mgr.
Dubuque, Ia.	Dodge and Iowa Sts.	J. J. Loftus, Res. Mgr.
Evansville, Ind.	Boehne Bldg.	I. G. Emery, Res. Mgr.
Fort Wayne, Ind.	414 Central Bldg.	A. G. Hughes, Res. Mgr.
Fort Worth, Texas.	Moore Building.	W. Esch, Act. Res. Mgr.
Grand Rapids, Mich.	Ashton Bldg.	A. W. Pasbach, Res. Mgr.
Hartford, Conn.	D'Esopo Bldg.	W. J. Walker, Res. Mgr.
Indianapolis, Ind.	Majestic Bldg.	E. S. Fisher, Res. Mgr.
Jacksonville, Fla.	Graham Bldg.	F. N. Martin, Res. Mgr.
Kansas City, Mo.	Railway Exchange Bldg.	C. C. Bowlus, Res. Mgr.
Los Angeles, Cal.	Wholesale Terminal Bldg.	Luigi Dell'Orto, Res. Mgr.
Louisville, Ky.	Inter-Southern Bldg.	E. J. Hotard, Jr., Res. Mgr.
Memphis, Tenn.	Bank of Com. & Trust Co. Bldg.	G. W. Palmer, Res. Mgr.
Milwaukee, Wis.	Railway Exchange Bldg.	M. B. Remley, Res. Mgr.
Minneapolis, Minn.	Plymouth Bldg.	L. W. Dietrich, Res. Mgr.
Montreal, P. Q.	Board of Trade Bldg.	W. Lewes Evans, Res. Mgr.
New Orleans, La.	839 Poydras St.	Chas. Weinberger, Manager
New York City, N. Y.	Pier 15, East River	J. B. Anderson, Salesman
Oklahoma City, Okla.	First National Bank Bldg.	J. W. Miller, Res. Mgr.
Omaha, Neb.	City National Bank Bldg.	J. C. Moise, Res. Mgr.
Parkersburg, W. Va.	Union Trust Bldg.	R. E. Ritchie, Acting Res. Mgr.
Peoria, Ill.	Schradzki Bldg.	A. T. Brannon, Res. Mgr.
Philadelphia, Pa.	Pier 5, North Wharves	R. J. Watson, Manager
Pittsburgh, Pa.	Wm. Penn Trust Bldg.	W. M. Wilson, Acting Res. Mgr.
Providence, R. I.	Grosvenor Bldg.	C. W. Tukey, Jr., Res. Mgr.
Richmond, Va.	Mutual Assur. Society's Bldg.	L. D. Harper, Res. Mgr.
St. Louis, Mo.	Security Bldg.	W. H. Grove, Res. Mgr.
San Antonio, Texas.	Gunter Bldg.	Frank Scanlin, Res. Mgr.
San Francisco, Cal.	Bank of Italy Bldg.	N. N. Fritz, Res. Mgr.
Scranton, Pa.	No. 4 Lackawanna Ave.	W. C. Katzmann, Res. Mgr.
Seattle, Wash.	Empire Bldg.	W. F. Yuille, Res. Mgr.
Sioux City, Ia.	Metropolitan Bldg.	J. H. Hansen, Res. Mgr.
Springfield, Ill.	Farmers Nat'l Bk. Bldg.	W. F. Rareshide, Acting Res. Mgr.
Toronto, Ont.	Board of Trade Bldg.	P. D. Walty, Res. Mgr.
Utica, N. Y.	Utica City Nat'l Bank Bldg.	E. L. Buckman, Res. Mgr.
Wichita, Kan.	Johnson & Frazier Bldg.	H. R. Roglin, Res. Mgr.
Winnipeg, Man.	Confederation Life Bldg.	W. C. Walker, Res. Mgr.

For the information of our customers we publish below a list of names and addresses of manufacturers of Banana Crates throughout the country.

Advance Manufacturing Company	Portland, Ore.
L. Albertelli & Co	Chicago, Ill.
Anacortes Box & Lumber Co	Anacortes, Wash.
Anderson Spool & Bobbin Mfg. Co	Charleston, S. C.
Beach & Fuller Basket Co	Evansville, Ind.
Bennett Box Co	Seattle, Wash.
British Columbia Mfg. Co	New Westminster, B. C.
C. B. Coles & Sons Co	Camden, N. J.
Chicago Mill & Lumber Co	Nashville, Tenn. Cairo, Ill. St. Louis, Mo.
Fruit Package Co	Minneapolis, Minn.
The Farmers' Mfg. Co	Norfolk, Va.
Hoffman Box Mfg. Co	Dallas, Texas.
Indianapolis Basket Co	Indianapolis, Ind.
Leigh Banana Case Co	Little Rock, Ark. Trimble, Tenn. Kansas City, Mo. Denver, Colo. Minneapolis, Minn. Evansville, Ind. Knoxville, Tenn. St. Louis, Mo. Atwater, Ohio. Chicago, Ill. Macon, Ga. Omaha, Neb. Nashville, Tenn. Milwaukee, Wis. Selma, Ala.
Maryland Veneer & Basket Co	Westport, Md.
G. Meisle & Bro	Philadelphia, Pa.
Multnomah Box Co	Portland, Ore.
Marshfield Banana Crate Co	Marshfield, Ore.
Oregon Box Co	Portland, Ore.
Pacific Box Co	Vancouver, B. C.
Jos. T. Pearson & Sons Co	Philadelphia, Pa.
Powhatan Basket & Veneer Co	Suffolk, Va.
The Marietta Fruit Package & Lumber Co.	Marietta, Ohio.
Pierpont Mfg. Co	Savannah, Ga.
Rudolph Veneer Products Co	Denver, Colo.
Frank J. Schmitz & Co	Streator, Ill.
Standard Basket Co	Chicago, Ill.
Seattle Box Co	Seattle, Wash.
Standard Box Co	Langley Prairie, B. C.
Union Box Mfg. Co	Atlanta, Ga.
Van Veneer Co	Malvern, Ark.
West Virginia Veneer Works	Williamstown, W. Va.
West Coast Box & Lumber Co	Portland, Ore.
Fred. W. Weber	Chicago, Ill.
Wines Banana Case Co	Helena, Ark.

Peelings

To Be Or Not to Be

I'd rather be a Could Be
If I could not be an Are;
For a Could Be is a Maybe,
With a chance of touching par.
I'd rather be a Has Been
Than a Might Have Been by far;
For a Might Have Been has never been,
But a Has was once an Are.

Stanford Chaparral

"There is said to be a great demand for $10,000 a year men," remarked Mr. Gadspur.

"So I hear," said Mr. Dubwaite. "Any special requirements?"

"Well, I understand there isn't much talk about a five-day week and a six-hour day in $10,000 a year circles. The idea seems to be that a man can work six days a week for eight or ten hours a day without wrecking his health, and he might even look in on the job for an hour or two Sunday, if necessary."

Birmingham Age-Herald

"Don't you want to buy a bicycle to ride around your farm on?" asked the hardware clerk, as he wrapped up the nails. "They're cheap now. I can let you have a first-class one for $35."

"I'd rather put $35 in a cow," replied the farmer.

"But, think," persisted the clerk, "how foolish you'd look riding around on a cow."

"Oh, I don't know," said the farmer, stroking his chin; "no more foolish, I guess, than I would milkin' a bicycle."

Think of what you are doing. You may rub out a blot, but the paper will never be as clean as the original sheet.

A Brooklynite recently sent in to the New York *Evening World* a rhyme which he says he wrote to relieve his mind. Read it and see if it will relieve yours:

"I'd like to take a trip
On an old banana ship
Where the deck with ripe bananas glows and glitters.
Where the captain and the crew
Live on green banana stew,
Interspersed, at times, with ripe banana fritters."

Two sailors, at a dog show, were gazing at a valuable sky terrier which had so much hair that it looked more like a woollen mat than a dog.

"Which end is 'is 'ead, Tom?" asked one.

"Blowed if I know," was the reply. "But 'ere, I'll stick a pin in him, and you look which end barks."

Don't think that every sad-eyed woman has loved and lost. Perhaps she loved and got him.

"Got any mail for Mike Howe?" asked the stranger at the small town post office window.

"No, nor anybody else's cow," retorted the indignant postmaster.

U-Between-S

Don't Do It

We have yielded their plums to the plumbers; and added the sums of some summers. To the mitre give might, to the nightingale, night; and even the drums to the drummers. But we never shall greet with hosannas the attempt to rob man of mañanas. And we swear we shall take a fast boat to Jamaica, if they put this new "ban on bananas"!

—*The Evening Sun*

Bananagraphs

Mr. J. C. Carpenter, our Resident Manager at Buffalo, New York, writes us:

"We are sorry to be obliged to inform our readers that Mr. John W. Banks, who handled the fruit department for Frank T. Miller at 74 W. Market Street, Buffalo, N. Y., has been ordered to Colorado for his health.

"Mr. Banks has been on the Buffalo market for the past thirty years and was considered one of the best fruit men here. He left for the West May thirtieth and was accompanied by his son who will stay in Colorado with him. It was a pleasure to give Mr. Banks a letter of introduction to our Resident Manager at Denver, Mr. R. A. Patch, who we are sure will be able to give him considerable valuable information regarding general conditions in that part of the country. Of course it is Mr. Bank's intention to return to Buffalo as soon as he has recovered his health. In the meantime Mr. Miller has decided to discontinue his fruit department for the present; and we thereby lose a valuable Port Limon customer."

Mr. J. W. Miller, our Resident Manager at Oklahoma City, informs us of a call he made on the O'Leary Produce Company, who have lately purchased the Fort Smith Commission Company's business, and who are now occupying the building formerly used by the Commission Company, who also disposed of all its merchandise, equipment, etc., to the O'Leary people.

Mr. Miller in this connection further says: "Mr. O'Leary wants to handle our fruit and I have promised him that we would do our best to take care of him.

"A new cold storage plant will be put in immediately. The material is on the ground now. They will put in three banana rooms of one and one-half cars capacity each, and a large plant to care for other commodities."

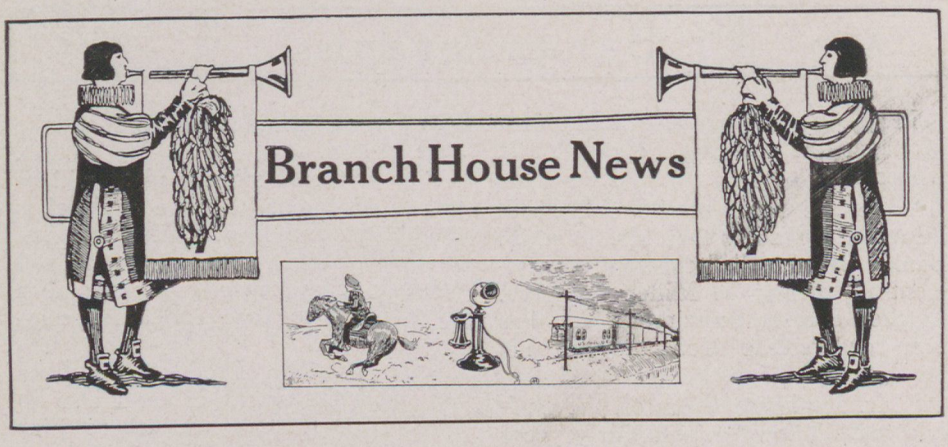
The O'Leary Produce Company are good customers of ours also in Little Rock, Arkansas, where they have long been established in business.

We have lately received the following interesting bit of news from Seattle, Wash., which was simply signed "Your Customer."

"I receive the *Dispatch* every month. Some news for your very good book is this: Mr. Frank Ball of Seattle, Wash., with Smith & Bloxom for twelve years is the best man to handle bananas they ever had. They are doing a fine business. Mr. Ball is going to take a vacation to California for the month of June and we all will miss him very much."

According to various newspaper reports forwarded us by our Mr. Walker of Hartford, Conn., the annual outing and clambake of the Boosters' Club of his City which was held this year on June 23rd at Riverside Park, must have been fully as enjoyable as the outings of this famous Club always are. The organization is composed of employees of the wholesale fruit and produce houses of Hartford, and from all accounts its members surely know how to have a good time.

The athletic events consisted of a nail-driving contest, a 50-yard dash for light and heavyweights, a donkey race and a hurdle race for women; and for the men, a 100-yard dash for light and heavyweights, a three-legged race, quoits and donkey race with a baseball game after the clambake.



We learn that our genial Resident Manager at the Butte branch is devoting much time lately in the effort (to quote from the master poet Byron) to "call back the tangles of his wandering hair." With what success he is meeting we have not yet heard, but our information is that he is working hard and refuses to be discouraged. Verily, "Hope springs eternal in the human breast." We further understand that Larry's favorite hymn is now—

"When the roll is called up yonder
I'll have my hair."

Resident Managers at Hartford, Montreal, Omaha and Charlotte please note.

We extend to Messenger E. P. Hauser of Dubuque, Iowa, congratulations. Mr. Hauser was married on May twelfth last to Miss Ragatz, also of that city.

Service

We cannot be too often reminded that strawberries come and strawberries go, but the BANANA will be with us forever. The System of perfection for the growing, transportation and distributing this fruit is a business within itself. It is hard to conceive the amount of work that has been accomplished to give the Fruit Dispatch Company its record for SERVICE.

We are at *your* Service, Mr. Dealer.

Last week Mr. J. C. Carpenter, Resident Manager for this Company at Buffalo, New York, paid us a visit. The Publicity Department was particularly glad to meet this good friend, who is such an unfailing contributor to "Fruit Dispatch."

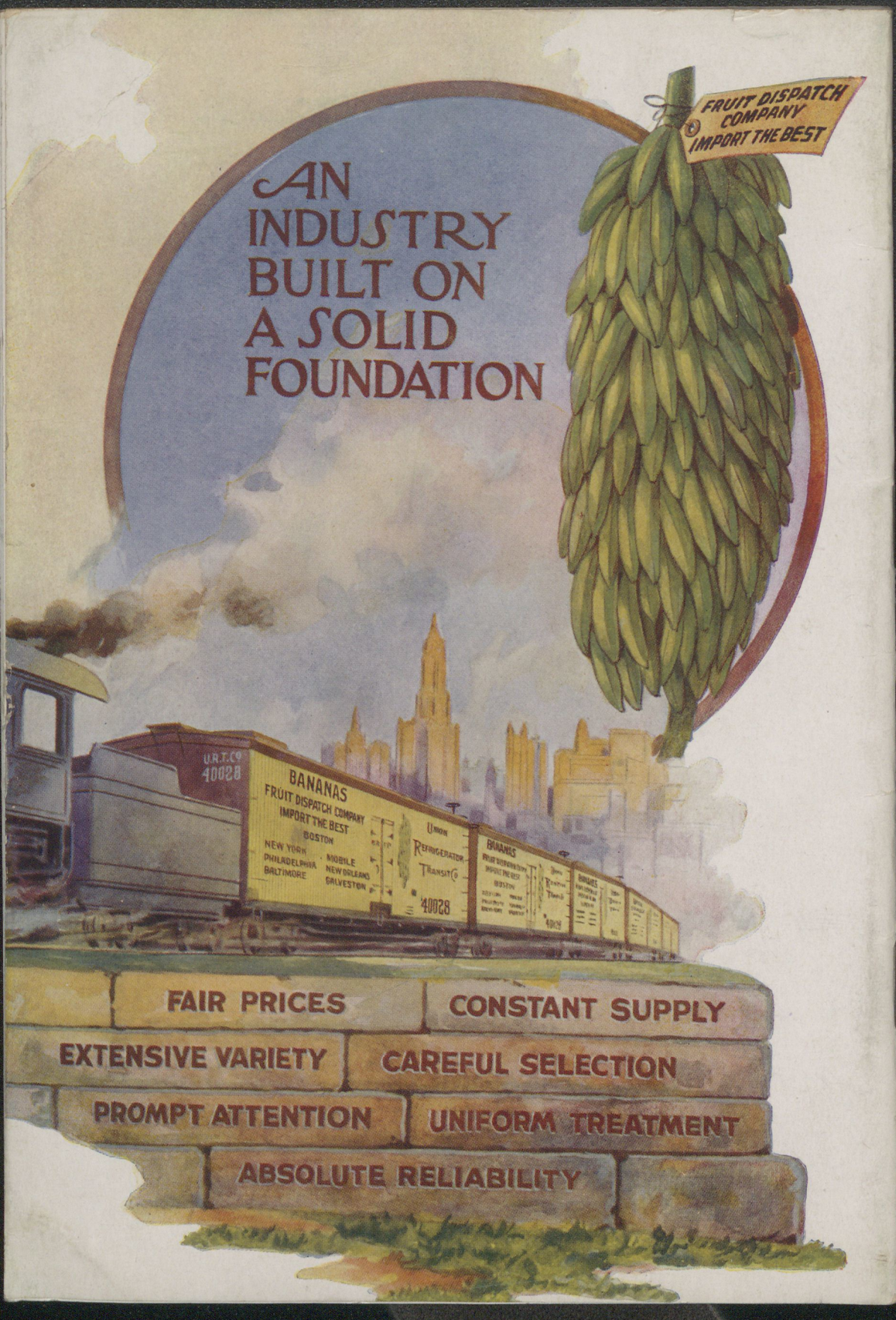
The members of the fruit and produce trade in general learned with deep regret of the death on June 1st, at Muskegon, Mich., of Mr. J. W. Fleming, Manager of the local branch wholesale house of M. Piowaty & Sons.

Mr. Fleming had a wide circle of friends among the trade and was one of the most popular dealers in the State. The Muskegon branch is one of the oldest of the Piowaty chain of houses and Mr. Fleming had been in charge since its establishment, and had made a splendid success of it. The local branch was closed the entire day of the funeral and every other Piowaty house suspended business during the period of the services as a mark of esteem.

Too late for press last month we learned of the death on May 20th of Mr. Joseph Ferrero of Washington, D. C., in the sixtieth year of his age.

Mr. Ferrero was engaged in the banana business in Washington for thirty-five years.

He is survived by his widow and four children to whom we extend sympathy.


AN INDUSTRY BUILT ON A SOLID FOUNDATION
FRUIT DISPATCH COMPANY IMPORT THE BEST
BANANAS
FRUIT DISPATCH COMPANY
IMPORT THE BEST
BOSTON
NEW YORK
PHILADELPHIA
BALTIMORE
MOBILE
NEW ORLEANS
GALVESTON
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PROMPT ATTENTION
UNIFORM TREATMENT
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Sir Arthur Currie
with the compliments of
J. F. Lloyd

An Introductory Course in General Physiology

Lloyd & Scarth

An Introductory Course in General Physiology

By FRANCIS E. LLOYD
MACDONALD PROFESSOR OF BOTANY
McGILL UNIVERSITY

and

GEORGE W. SCARTH
LECTURER IN BIOLOGY
McGILL UNIVERSITY

Dedicated to
McGill University
on the occasion of its
One Hundredth Anniversary
1921

An Introductory Course in General Physiology

PREFACE

That the purpose of education is training of the mind and not the mere transference of information is a truism to some, perhaps many, university teachers. Those who agree will, I venture to think, also testify that the accomplishment of this purpose is not easily to be compassed. The student is constantly baffled, and there is his instructor who can so easily smooth the way ! In addition to the well conceived purpose, one must have a sympathetic mind but a hard heart else the strategy of the student will defeat one's own.

The present outlines of work, serving as an introductory experience in the field of General Physiology, have been elaborated gradually by the senior author, through many years with the aforementioned purpose as the guiding principle. Unfortunately, the exigencies of printing demand order, headings and wordings which spoil much of the joy of solving problems, but the result will be regarded complacently, doubtless, by the student.

The general plan will be apparent. Each study leads to a contrast of the non-living with the living. If more space is devoted to the former, it is rather with the purpose of guiding the student to the recognition of principles, and to give him a grasp of the method of the modern physiologist. If the student attains this end, he will find no difficulty in finding examples of application.

The senior author hereby acknowledges the devoted co-operation of his colleague in preparing the MS. Their joint obligations to physiologists past and present will be obvious.

20th September, 1921.

F. E. LLOYD

CONTENTS

SYNOPSIS I.

REVIEW OF BIOLOGICAL MATERIAL

READING: Bayliss, "Principles of General Physiology" pp 1-6. Thompson "Growth and Form," pp. 156-162.

The purpose of this exercise is in part to review one's knowledge of the cell, and in part to contemplate it as a complex of energy expressions. Viewing the living substance in this light, it is apparent that every detail of form and behaviour is of significance to the general physiologist.

"The microscopic structure which it seems to show is that of a more or less viscous colloid, or rather mixture of colloids, and nothing more." (Thompson, "Growth and Form," page 160.)

"……it appears……as a clear, colourless, jelly-like stuff, not showing structure, but nevertheless……" (Bayliss, "Principles of General Physiology," page 2.)

The point of view is indicated by the preceding quotations. It is assumed that the student is acquainted with the formal cell terminology. In reviewing the above organisms or parts of organisms, one should make accurate delineations of the cells, including all the contents, having particular respect to details of form and interrelations of parts, constantly asking why a particular form or position is assumed.

MATERIALS: Spirogyra, Vaucheria, Elodea, cells of onion bulb epidermis, pollen grains, etc.

One's attention is directed to the form of the nucleus, of protoplasmic threads, of chloroplasts, and on what it appears to depend; to the positional relations of various parts, viz. of the points of insertion of protoplasmic threads, of the nucleus, of the cytoplasm, of the chloroplasts, of the granules and of the vacuoles.

DIRECTIONS: Make sketches of the above showing the normal topography, indicating cytoplasm, nucleus, plastids, wall, vacuoles, having due regard for the relative dimensions. Pollen grains may be crushed also, when some idea of the character of the protoplasm may be gained.

Microscopic appearance of protoplasm. Consider the results of the above observations on protoplasm. Take a thread of Vaucheria, a syncytial form, and manage to squeeze out some protoplasm by cutting off the end of a filament in a very small drop of water, followed by pressure of the cover-glasss. Drops of protoplasm with inclusions (plastids) may be found. Note particularly the colourless and structureless appearance of the protoplasm.

SYNOPSIS II.

SURFACE TENSION

PHENOMENA OF FORM AND MOVEMENT.

READING: Bayliss pp 48-51. Pfeffer, "Physiology of Plants" p. 275 et seq. Jost, "Plant Physiology" pp. 537-540. Thompson, "Growth and Form", Ch. V.

The preceding observations on the form of protoplasm and of various included parts, suggest the probable significance of surface tension as a factor involved in determining form. The following experiments have been chosen for the purpose of directing attention to the physical expressions of surface tension offering analogies to protoplasmic behaviours, and to such protoplasmic behaviours themselves.

Many of the experiments are characterised by extreme simplicity, for which reason the student can underestimate their importance. It should be realised that it has been through the contemplation of these and similar experiments that the biologist has reached such understanding of the living stuff as we have. In general experiments have been chosen which have historical significance, and in these cases the authority has been cited, either the original citation being given, or one to which the student has easier access.

Success in achieving results from these and following experiments will depend upon painstaking observation, deliberation and contemplation. To quote Gilbert, of Gilbert and Sullivan: "Quiet, calm deliberation disentangles every knot".

A PHYSICAL BEHAVIOURS.

1. **Surface Film.** Float a needle on clean water, add a trace of soap.

2. **Minimal area.** A loop of copper wire, with a smaller silken loop suspended to the limb of the copper loop by three loose threads. A soap film is supported in the wire loop and variously broken (van der Mensbrugghe, 1866. See Bayliss, 48).

3. **Change of form and movement due to disturbance of surface tension equilibrium by factors external or internal.**

(a) To a drop (shape ? and why ?) of mercury lying in weak nitric acid a crystal of potassium dichromate is presented. Note behaviour of mercuric oxide toward the surface of the mercury. (Bernstein, 1900, see Pfeffer, III. 278). Also study surface currents when H_20 mixed with carbon is presented with drops of alcohol on bottom of petri dish.

(b) Oil (paraffin, castor, olive) on water. An oil which spreads on water (e.g. paraffin) may be made to collect by adding soap to the water. After collecting into a drop, or using another oil (e.g. Castor oil), movements herein may be induced by presenting soap or alkali or chloroform. A fine soapy silken thread is laid across a floating oil drop. (T. B. Robertson, see Thompson, 191-2).

(c) Particles of camphor on pure water. (Explanation first due to v.d. Mensbrugghe, 1869, see Thompson, 212.)

4. **Agglutination.** To the water with floating camphor particles add a trace of oil.

5. **Ingestion.** Chloroform soluble and crude shellac presented to drops of chloroform under water; also a shellac-coated particle of glass filament; also a clean glass filament. (Rhumbler, 1898, see Bayliss, 1-6; Macallum, 27; Pfeffer, III. 278; Thompson, 463.)

6. **Complexity of form.** The surface of pollen grains (e.g. mallow) is coated with a resin which spreads on water, but which will not do so if e.g. acid is added. The resin extends from the pollen grains in fine threads which strongly stimulate the pseudopodia of Gromia (see Calkins, G.N. "The Protozoa", p. 91, illustration). Note the vacuolated appearance of the resin after spreading. Explain divergence from minimal (spherical) surface.

B. BEHAVIOURS IN PROTOPLASM.

MATERIALS: Spirogyra, Vaucheria, Chara, Elodea, Onion, Amoeba, haematocytes, leucocytes.

1. **Form.** The protoplasts of pollen grains may be set free from their containing envelopes. If first treated with strong acid (10–25%) they attain considerable consistency with alkali less. Note the form displayed. (The strength of acid and base used may vary with the kind of pollen used. Lloyd 1916).

The form taken by drops of protoplasm squeezed out through cut ends of internodal cells of Chara and the form of abstricted portions of vacuole. The form taken by extruded droplets of protoplasm of Vaucheria (Pfeffer, 3:299; Verworn, 94). The form assumed by swarm spores, e.g. of Oedogonium when set free from a cylindrical cell wall.

The form of vacuoles formed by action of chromates on cells of onion epidermis.

The form of vacuoles in various stages of development. Shown well in young tissues of Elodea, to be dissected from the terminal bud.

2. **Changes in form** through disturbance of equilibrium caused by changes in the environmental factors—heat, electric charge, solutes (alcohol, e.g.)—which among other things at least act on surface tension.

SPIROGYRA:

(a) **Heat:** Mount a few filaments of Spirogyra lengthwise on a slide in plenty of water. Examine for normality. Heat one end of slide over flame. Compare heated and unheated cells of filaments and trace all intermediate conditions. Particularly note form and position of nucleus and its surrounding cytoplasm. Make a series of drawings to show what has taken place.

Apparent changes in surface tension?

To find how far the observed changes have taken place in living protoplasm run dilute eosin over the slide (removing cover). After a few minutes wash and examine. The nuclei at heated end of slide should be distinctly stained. Compare unheated and especially intermediate cells. Since eosin does not penetrate living protoplasm what can you infer?

As a further test add a plasmolysing solution and compare the differential effect with that of eosin.

(b) **Electrical charge:** Subject Spirogyra filaments to one or more shocks from an alternating current and observe changes during several minutes therafter. (Other material—trichomes from leaves of Tradescantia, onion epidermis—behaviour of nucleus especially, etc.

(c) **Alcohol:** The "critical concentration" of ethyl alcohol was 11% by vol. corresponding surface tension being 0.666 that of water (Czapek, "On a method of direct determination of surface tension of plasma membrane in plant cells," p. 23.) Employ 3 concentrations, one above, one below and the third at ca. the "critical conc." Study exhaustively changes which take place in the various parts of protoplasm, recording as usual in drawings. Of course alcohol is used only as a single example; one might extend studies to large variety of reagents and obtained many unlooked-for results, e.g. weak alkalis, alkaloids, etc.)

Hæmatocytes. Their form, and changes occurring on external disturbances (heat alkali, saponin, alcohol, etc.)

3. **Movement, ingestion, phagocytosis.**

Amoeba and leucocytes may be studied.

Ref. Oertel, "General Pathology ;" Tait : "Capillary phenomena observed in blood

cells ;" Tait and Gunn : "The blood of Astacus fluviatilis"—Quart. Journ. of Exp. Physiol. XII., I.). Schaeffer A.A. (1920), "Amoeboid Movement."

ADSORPTION PHENOMENA.

For definitions and discussions see Bayliss, p. 54–;
Bechhold, p. 25–; McClendon, p. 62–; (erratum p. 64, line 18, for " increase " read " decrease ") ; MacLeod, p. 65–; Ostwald; Theoretical and Applied Colloidal Chemistry, p. 116–.

A **PHYSICAL BEHAVIOURS:**

1. **Surface concentration:** Take a weak solution of methylene blue (deep sky-blue) and add a very little saponin. Vigorously shake and separate foam by decanting. Shake up the decanted fluid similarly and again decant. Amount of foam on second shaking ? Add a drop of alcohol to foam in vessel No. 1 to dispel it (why does this happen ?) and note colour of fluid. Amount of foam on shaking in No. 2 and in No. 3, and why ? Effect of saponin on surface tension of water ?

Shake up a solution of albumin (egg-white). Remove foam and try to redissolve in water.

2. **Membranes resulting: Concentration membranes .**Using a piece of glass tubing as a blowpipe, blow bubbles of soap, saponin and of albumin. Permit the bubbles to contract (expel the air by surface tension) and note whether the bubble maintains its spherical shape. Observe carefully the surface by reflected light.

3. **Electrical adsorption.** (a) Dip pieces of filter paper in equally coloured solutions of Methylene blue (+ charge) and Indigo Carmine (− charge) or of Fuchsin (+) and Eosin (−) and wash.

Compare the loosening effect of saponin or alcohol on adsorbed dye as compared with pure H_2O. Explain.

(*b*) Carefully place a drop of each of the same and other stains on filter paper. Observe the different behaviours of the dyes. Add successive drops in the centre of the positions of the original drops, and note results.

(*c*) Allow a drop each of methylene blue and of, say, eosin, to evaporate from a glass surface, and attempt to redissolve in running water.

(*d*) **Selective adsorption of Ions.** If one ion is adsorbed the other remains in solutions. On filter paper place drops of acidified methyl orange, of alkaline Neutral Red, and of neutral Methyl Red.

Note varied adsorption of H and OH ions by the filter paper. Isoelectric point of cellulose ?

(*e*) **Adsorbed ions may reverse electrical charge.**

Place drops of Eosin and Methylene blue (in distilled water) on filter paper.
Repeat after adding a little NaCl to the dyes.
" " " " acid also.
Demonstrate filtering with charcoal, sand, etc.

B **BEHAVIOURS IN PROTOPLASM.**

MATERIALS: Vaucheria, onion, spirogyra, (paramoecium), frog's muscle, banana

1. **Concentration membranes.**

(*a*) The broken surface of protoplasm is supplanted by a membrane. Cut a filament of **Vaucheria** and record evidences of formation of a new membrane. Also evidence for membrane existing on uninjured protoplasm.

(*b*) Plasmolyse onion cells strongly and suddenly add water. In many cells the liquid inner protoplasm will rupture a solid external layer.

2. **Toxicity.**

The relative toxicity of the members of the alcohol series (methyl alcohol appearing to be an exception: difficulty oxydizable or other reason) follows, according to Kamm, the rule of Traube based on surface tension experiments, namely, $1:3:3^2:3^3$, etc., taking the physiological effect of ethyl alcohol as unity.

Example: Toxicity of ethyl alcohol for Paramecium is 4.5%. What is, theoretically, the toxicity of e.g. n−octyl alcohol ? Ans.—1 x 3 x 3 x 3 x 3 x 3 x 3 or 729.

Formula $\frac{4.5\% \times 2.8 \text{ (to convert moles to grams)}}{729} = 0.20\%$.

The observed value, according to Kamm, was 0.03%. (Kamm. Oliver, The prediction of the physiological action of alcohols. SCIENCE.N.S. 54:55. 15 July, 1921, and in the current issues of Jour. of Pharmacol).

Experiments: Test pure methyl alcohol relative to ethyl alcohol, and to other alcohols so far as provided. Also acetone. Spirogyra or Paramecium, or other suitable material.

3. **Immunity.** For its relation to surface tension phenomena e.g. phagocytosis, agglutination and adsorption, see Oertel, " General Pathology ".

4. **Adsorption of pigments and stains.**

(*a*) Observe that colouring matter is held in haematocytes and plastids (e.g. chloroplasts) by adsorption. Evidence for this: (i) Treat haematocytes with water, or saponin in normal salt and (ii) plant cells containing chlorophyll, with alcohol. (Make microscopic mounts to see these experiments.) Observe carefully the stromata remaining after the release of the pigments. Mount haematocytes in solutions of dyes, in physiologically normal NaCl. Do they stain ? Heat slightly and note results.

(*b*) Expose living Spirogyra or other suitable material to weak solutions of dyes, e.g. methylene blue, eosin, Congo red. Does the cell wall adsorb these dyes ? Does the (living) protoplasm ? After staining place the filaments in water. Is the stain removed ? Kill in any other manner you may choose and test these dyes, noting result.

(*c*) The cut or broken surface of muscle and nerve fibres absorb certain dyes, e.g. neutral red, Congo red, which are not adsorbed by the rest of the surface—(electrolytes relieved at cut ends change the sign of charge on dye.)

If filaments of Spirogyra are allowed to lie in a solution of methylene blue, this pigment is adsorbed by a body in solution in the sap. Tannic acid is present. Pfeffer states that another body (albumin) is also present (Pfeffer, 1886). The above solution must be very weak, i.e. very light blue, the colour scarcely perceptible.

(*d*) Tannic acid is adsorbed by a cellulose-like body in certain cells. Tannic acid is soluble in water.

Treat tannin cells from the pulp of banana fruit with ferric chloride, and compare with result on adding reagent to tannin solution under the microscope. (Lloyd 1912, see Dekker, Die Gerbstoffe, 1913).

SYNOPSIS III

COLLOIDAL STATE

Colloidal Systems

Heterogeneous or discontinuous systems—Diphasia.

Make the following suspensions (resp. emulsions). Observe Tyndall (Faraday) effect.

1. External Gas Internal Liquid — cloud of steam (H_2O in air)
2. " " " Solid — smoke (carbon in air)
3. " Liquid " Gas—aerated water, foams: soap, gelatin, albumin, saponin.
4. " " " Liquid—emulsions e.g. oil in water. Alcohol solution of oil poured into H_2O; or disperse by shaking, stabilise by hydrophile emulsion (gum, acacia, soap).
5. " " " Solid — suspensions
   (i) Coarse suspensions; properties. Experiments with sand and beads in water.
   (ii) Ultramicroscopic examination of colloidal suspensions. Gold, carbon, gamboge, arsenious sulphide.
6. Ext. Solid Int. Solid — ruby glass: gold susp. etc.
   Emulsoids, Hydrophile colloids.
   Ext. liquid (H_2O) Int. solid with imbibed liquid (H_2O) or vice-versa: gelatin, agar, casein, albumin, gum acacia.

Properties of Colloids

A. PHYSICAL EXAMPLES

1. Diffusibility: The relative diffusibility of colloids and crystalloids:

Using a small dialyser (gut tied over flanged end of a glass tube) dialyse (Thomas Graham, Philosoph, Trans. 1861) a mixture of starch paste and of NaCl. Test the dialysate for both substances (iodine and AgCl.) Note that care is necessary in this experiment, aq. dist. being used throughout.

Repeat the above with egg-albumin instead of starch.

2. Phase relations; viscosity.

(a) **Demonstration.**

Physical properties of a mixture of sand, etc. and water.

(b) **The effect of the viscosity of the external phase on Brownian movement, and on sedimentation.**

Make suspensions of carmine (or other suspensoids) in gum arabic of different concentrations (from 5% downwards).

(1) Observe the amplitudes of Brownian movements microscopically. (Note that this is to be done also ultramicroscopically with smaller suspensoids.)

(2) Cf. amplitude of movement when the slide is heated to various degrees.

(3) Allow the preparations to stand to permit sedimentation, and note the rate at which this occurs.

(c) **The stabilization of a diphasic system; the viscosity of such a system.**

The preparations are to be made in vials or test tubes; vigorous shaking is made use of to produce the dispersions.

Disperse paraffin oil in alcohol? Is the emulsion stable on standing?

Add a little powdered $BaSO_4$ or other insoluble substance and repeat the shaking.—Stability?

Study the distribution of the solid particles with regard to the two phases as seen on the surface of the test tube.

Examine a portion microscopically. Explain how the solid powders promote stability of the emulsion.

(d) **Relation of phases in an emulsion complex; effect of change in surface tension; haptogen membranes.**

The emulsion obtained is to be fractionated for the purpose of getting portions for the separate tests to be made with pigments.

1. Disperse a small portion of paraffin oil in water. Is this stable?
2. Add a little gum arabic solution; note stabilizing effect.
3. Add successive small volumes of oil, and produce a dispersion of maximum viscosity, noting the increase in viscosity with the increase in the amount of the internal phase, also with degree of dispersion.
4. To a portion add a very little eosin, and note the fate of the pigment. Examine microscopically, l.p.
5. To a similar portion add a very little Sudan III, and proceed as under (3).
6. To the original emulsion add again successive volumes of oil and note that the emulsion finally breaks, the viscosity being lowered. After passing this point repeat (4) and (5).
7. Study microscopically, carefully comparing the four preparations, noting the distribution of pigments and the occurrence of compound fluid suspensoids, and that these are "protected" by "haptogen" membranes. Get clear conceptions of the various aspects of the complexes in the preparations.
8. Note two fold role of the gum acacia—in lowering surface tension and in forming these haptogen membranes.

3. Electric Charge

(a) The electrical charge of colloidal substances (ex. carbon susp.) will be demonstrated by cataphoresis.

(b) Flocculating effect of kations and anions of different valencies.

Make solutions of:

K_2SO_4 .1 molar as to K°, $CaSO_4$ .01 molar as to Ca°°, $La_2(SO_4)_3$ .001 molar as to La°°°. (Bayliss Intro. p. 178). To each add equal vols. of indian ink.

Compare the effect of polyvalent anions. Cf. also with positively charged colloid e.g. ferric hydroxide.

(c) A filtered 5% solution of albumin is (i) acidified with acetic acid. (ii) rendered alkaline with NaOH.

Precipitating effect of + & − colloids?

Amphoteric electrolytes. See also under Hydrogen Ion Concentration.

(d) Do emulsoids (gelatin) behave like suspensoids as regards precip. by traces of electrolytes.

Relation of phases as det. by H-ion concentration, see later—Syn. IV.

B. APPLICATIONS TO PROTOPLASM

MATERIAL: Onion epidermis

1. Colloidal Structure and Viscosity of Protoplasm.

(a) In cells of onion epidermis which has lain for some time in weak neutral red, study under h.p. and oil immersion lenses the protoplasm and included particles with special reference to streaming and Brownian movement. Study the effect of raising temperature and of various concentrations of ether, iodine, etc.

Consider: 1. The nature of protoplasm (i.e. its structure) as a diphasic (resp. polyphasic) system; cf. structure of fixed protoplasm as seen in prepared slide with that of an emulsion containing solid particles as in A. (c); its viscosity (on the viscosity of protoplasm estimated experimentally see Wm. Seifriz, Viscosity values of protoplasm as determined by microdissection, "23 times that of water". (Botan. Gazette 70, 360, Nov. 1920. Bot. Abs. 3: 1740.)

2. The diffusibility of substances through protoplasm. Are these fat-soluble or water-soluble? The role of lipoids in protoplasm. (Hansteen-Cranner E.S.R. 44: 821.)

3. The role of haptogen membranes in forming external limiting membranes.

4. The behaviour of cell colloids analagous to that of gum acacia.

(b) Review the experiments with Spirogyra in Syn. II, B from the point of view of changes in viscosity brought about by the external factors employed.

2. **Electric Charge.**

(a) Review II, B, as above.

(b) See also influence of hydrogen ion concentration on electric charge (Syn. IV).

ULTRAMICROSCOPY

GENERAL DIRECTIONS:

The dark field condenser (d.f.c.) is to be inserted into position. Inside stop is placed in the oil-immersion objective. Illumination is adjusted so that a hollow cone of light is obtained using uranium glass for guidance.

Place immersion oil on face of d.f.c. upper lens to fill space between this and slide.

A slide of proper thickness (ca I.5 m.m.) is placed on stage. A drop of fluid to be examined is placed in position. Cover with thin cover-slip.

Centre spot of light with l.p. objective.

Adjust I.9 m.m. obj.

At close of exercise remove inside stop from objective.

(A.) **Preliminary Practice** with physical materials.

Mount and examine suspensions provided, noticing Brownian movements, colour, definiteness of particles.

(B) **Studies of Biological Material.**

Ultramicroscopic examination of colloidal complexes.

Mount and examine squamous epithelial cells from the mouth, and note the bacterial flora accompanying them.

Milk. Cow's milk largely freed of butter fat.

(a) Observe character of casein suspensoids; amplitude of their Brownian movements, colour, brightness.

(b) Coagulation, add weak HCL.

(c) Coagulate a film on the slide with alcohol.

(d) Character of droplets (emulsoids) of butter fat (milk with more butter fat). Coagulation with HCL.

Compare their behaviour as compared with agglutinated erythrocytes.

Blood. Frog; mammal.

Observe especially the mutual behaviour of corpuscles, suspensoids, and the formation of fibrin threads.

Study the specific effect of saponin, and of ricin or abrin. Lymph, urine or other body fluids may also be examined, if time permits.

Bacterial suspensions.

Protoplasm. Spirogyra, onion or other suitable material.

SYNOPSIS IV

HYDROGEN ION CONCENTRATION.

LITERATURE: W. M. Clark: Determination of Hydrogen ions. Bayliss p. 187.

INDICATORS AND THEIR USE; BUFFER ACTION.

A. PHYSICO-CHEMICAL.

Super-clean glassware is an essential in all H-ion work.

H_2O in the following exercises always signifies boiled distilled water.

1. **Behaviour of Indicators.** (In this and the following exercises approximate titration may be done by drop measurements, checking, by c.c. measurements at end or critical points). To equal quantities of .1N NaOH in 4 separate tts. add two or three drops of phenolpthalein, neutral red, methyl orange and crystal violet respectively, and titrate simultaneously with .1N H Cl, added drop by drop from a pipette. After 10 c.c. or so have been added continue with strong (4 N) H Cl till no further change is observed.

Carefully record colours and colour changes in each case. Estimate in terms or normality of alkali or acid, the points at which the most distinct colour changes take place.

Which indicator and colour enable you to determine the neutral point (i.e. acid = alkali or, for comparison, pure H_2O).

2. **" Acidity " and H–ion Concentration.**

(a) **To determine the relation of the colour changes to acid concentration,** using different types of acid and eliminating alkali.

1. Make up a series of concentrations of HCl (a strong acid) viz., 2N, 1N, .1N .01N and .001N. To 10 c.c. of each, add a few drops of Crystal Violet. Note series of colours.

2. Repeat for one or two of same concs. with H_2SO_4, another strong acid. Do the indicator colours correspond ?

3. Do the same with 1N acetic acid (a weak acid). Result ?

4. Test a small measured quantity of 1N acetic acid with methyl orange noting

colour. Dilute with H_2O (fractionating, if necessary, to reduce volume) till colour changes to yellow. At what normal concentration of acid ?

Find the conc. of HCl at which the same change colour occurs.

Compare "acidity" as defined by titration with an alkali, and by colour of an indicator.

NOTE.—Strong acids differ from weak in degree of dissociation into their ions (in dilute solutions acids almost completely dissociated). It is the dissociated hydrogen ions that determine the colour of the indicator and not the total acid.

(b) **Acid Taste.** Determine on which of the factors mentioned in the last paragraph "acidity" of taste depends by comparing the total acid and the H ion concentrations of HCl and $HA\bar{c}$, that give equal or just perceptible acid taste (H-ion concentration compared by colour with methyl orange).

Correlate general chemical activity of acids with their degree of dissociation.

The same results apply to strong and weak bases as have been illustrated for acids—alkalinity is usually ascribed to hydroxyl (OH) — ions, but since the number of OH — in a watery solution always varies inversely as the H+ we can employ a scale of acidity and alkalinity which takes account only of H-ion conc. even in alkaline solutions. The scale is a normality one, as in total acid measurement: normal sol. = 1 gram-atom of H-ions in 1 litre solution. (Under what conditions would figure for Hion concentration and total acid concentration correspond)?

$$\text{The symbol pH commonly used} = \log \frac{1}{\text{H-ion conc.}}$$

Thus $[H]\ 10^{-3} = pH3$.

3. **Table of Indicators.**

Consult Bayliss p. 189. See also Ch. II. Clark (above cited).

4. **Buffer Action.**

1. **Phosphates (and acid salts generally).**

From the table det. the [H+] of .1N Na_2HPO_4 and .1N NaH_2PO_4.

Mix them so as to give [H+] of H_2O.

Now determine by titration with .1N HCl and .1N Na OH. the amounts required to shift the [H+] to that of the pure salts.

Compare the effect of infinites mal amounts of the acid and alkali on pure H_2O.

Consider the chemical reactions that produce this absorbing or "buffer" action.

2. **Salts of weak acids.**

(a) To equal quantities in t.t's of .1N Na acetate and of H_2O resp. add a few drops of Methyl Red Add a drop .1N $HA\bar{c}$ to H_2O tube and note colour. How much .1N $HA\bar{c}$ must be added to the Na $A\bar{c}$ to give the same [H+] ?

What do you infer as to the dissociation of a weak acid in presence of its salt ?

(b) Repeat with Na $A\bar{c}$ and HCl. Explain.

$HCl + NaA\bar{c}$ (both strongly dissoc.) $\rightleftarrows NaCl + HA\bar{c}$ (both weakly dissoc.)

(c) Repeat (for comparison) with Na Cl (salt of strong acid) and HCl.

Other weak acids—carbonic and boric.

3. **Proteins and amphoteric electrolytes generally.**

Determine how much acid and alkali are required to markedly shift the [H+] of gelatin solution. Compare with H_2O.

4. **Colour Standards.** While approximate determination of [H+] may be made by estimating colours and colour changes, accurate work requires standards for comparison. It is impossible to maintain standards of pure acid and alkali at a constant [H+] owing to the effect of CO_2 of atmosphere, solution of glass, etc. By using buffers to stabilise the [H+] this difficulty is largely obviated.

Prepared Buffer Standards Exhibited.

I.	H $A\bar{c}$ and Na $A\bar{c}$	(Walpole's)	most useful bet.	p.H.	3.5	and	5.5
II.	KH_2PO_4 and Na_2HPO_4	(Sorensen's)	" " " "		5.5	"	7.5
III.	Borax and Boric Acid	(Palitzsch's)	" " " "		7.5	"	9.5

For higher and lower [H+] H Cl or NaOH is mixed with various buffers.

5. **Exercises.** 1. Determine accurately by comparison with standards the [H+] of solutions provided.

2. Turbid or coloured solutions.

(a) Walpole's method.

Superimpose a tube of coloured solution over the standard and indicator; and superimpose the coloured solution and indicator over clear water.

Look down through equal depths.

(b) Dilution method; a well buffered solution has its [H+] little affected by dilution, e.g. urine. Determine [H+] of same.

B. PHYSIOLOGICAL

MATERIAL: Onion epidermis, Tradescantia hairs, root hairs, blood plasma, etc.

1. H-ion Concentration of Living Cells and Biological Fluids.

(a) Approximately determine by allowing suitable material (colourless onion epidermis, Tradescantia hairs, root hairs) to absorb neutral red from weak solution. Estimate the colour of the cell sap.

Note any significant differences.

To obtain cell sap in quantity tissues are first frozen and then crushed and subjected to pressure.

(b) Determine the [H+] of blood plasma.

2. Biological "buffers".

Attempt to raise the [H+] of blood plasma by addition of acid. Compare [H+] of equivalent acid in pure H_2O. Explain in terms of buffer action. Biological significance?

PHASE RELATIONS OF EMULSOIDS AS INFLUENCED BY H-ION CONCENTRATION.

LITERATURE Macdougal: Hydration and Growth. Carnegie Institute Pub. .297, etc. Lloyd: Trans. Roy. Soc. Can., 1917; Mem. Torrey, Bot. Club, 1918.

A. PHYSICO - CHEMICAL

1. Swelling.

(a) Place gelatin strips of measured length in petri-dishes covered by solutions of graded H ion concentration from .2N acid (HNO_3) to .2N alkali (KOH) (acid. 2, .02, .002, H_2O. .002 .02, .2 alkali.)

Measure during two hours. Estimate [H+] by indicators. Illustrate graphically.

Compare the effect on [H+] of solution and on the swelling of the gelatin when certain concentrations of acid and alkali are mixed with neutral salt (KNO_3 of equivalent normality)

(b) Repeat with squares of agar, measuring increase in thickness. (Of course. weighing more accurately records amount of imbibition).

2. Gelation

(*a*) Compare the rate of setting of gelatin with various H-ion concentrations:

Add about 20 c.c. of strong melted gelatin to about 5 c.c. of N, .1N, .01N, HNO_3, H_2O, .01N, .1N, and N KOH in a vial. Carefully note the order of setting, recording times taken.

Remelt the gelatin and find the [H+] of the various vials.

Illustrate graphically relation of time of gelation to [H+] cf. swelling. Compare the [H0+] of similar concentrations of acid and alkali in H_2O (see "buffers" above).

Where is the region of maximum gelation — isoelectric point?

(*b*) Repeat with agar.

3. **Flocculation.** Note effect of acid and alkali on transparency of the emulsoids (See under B)

B. PHYSIOLOGICAL.

MATERIAL: Pollen, onion. The materials used in the above experiments are bio-colloids of the two main types that occur in cells. Similar phenomena as exhibited by **living** cells themselves are exemplified as follows:

1. **Protoplasmic. Swelling** and **resultant growth.** Allow pollen to germinate in a series of H ion concentrations ranging from say 10^{-3} to 10^{-9}, using acetic acid and ammonia. Compare rates of growth of pollen tubes.

2. **Liquefaction and Gelation.** Subject onion epidermis to similar concentrations of [H+] and study phase relations as expressed by Brownian movement of particles or protoplasmic circulation.

3. **Flocculation.** With reference to Note to A. (4) see Oertel; "General Pathology" p 182, re Fischer on "Glaucoma of the Eye."

SYNOPSIS V

DIFFUSION AND OSMOSIS

LITERATURE:—Ostwald: (1) Theoretical and Applied Colloid Chemistry, 43; (2) Handbook of Colloid Chemistry, 210; Bechhold: 52. "The diffusion of dissolved substances through membranes" Czapek, Chemical Phenomena in Life, p. 45. Bayliss: p: 110. Jost's Plant Physiology, p. 17. Principal classical researches; W. Pfeffer, Osmotische Untersuchungun. Researches in Osmosis: Studies in cell—mechanics. 1877; Devries, Plasmolytic Studies. 1885. McClendon, 291. Livingston, Role of diffusion and osmotic pressure in plants. 1903.

A. PHYSICO-CHEMICAL.

1. **Factors influencing rate of diffusion.** This depends on:

(*a*) **The size of the diffusing particles.**

Two vials are partly filled with warm gelatin-weak solution. After it has set congo red (large molecules) and eosin or methyl orange (smaller molecules) of approximately equal molar concentrations are poured in. (All gelatin experiments stand 24 hours or longer). Compare rates of diffusion of the two dyes.

(*b*) **The concentration of the diffusing substance** (gradient of diffusion). Compare diffusion rate of a stronger solution of methyl orange than in (1).

(*c*) **The physical condition of the medium.**

Compare same concentration of methyl orange as in (1) in stronger gelatin.

(*d*) **Physical or chemical interaction of diffusion substance and medium.**

(1) Strong methyl orange and strong methylene blue are poured into vials partly filled with gelatin.

(2) Partly fill three vials with gelatin tinted with indicator (eg. neutral red) and pour in equal strengths of different alkalis NH_4OH, NaOH, KOH (low concentration).

NOTE:—Gelatin combines somewhat with alkalis and the more readily the stronger the alkali.

(3) Mix starch paste with gelatin and allow iodine in KI to diffuse through it. Note absence of gradient in colour. Why?

2. Periodical Precipitation: Liesegang rings.

Gelatin containing potassium chromate in solution is poured on a glass plate. After setting, a drop of silver nitrate is placed thereon. Note the occurrence of the rings in question. Two separate sets of these rings may be noted.

This experiment may be profitably varied by introducing the gelatin into a vial, and after setting, silver nitrate poured in. Cork and keep for future observation. (Bechhold, p.260.)

3. Semi Permeable Membranes and Osmosis.

Three vials are $\frac{1}{4}$ filled with warm gelatin containing K_4 Fe Cy_6 dissolved. A layer of gelatin as cool as it will run is poured in up to $\frac{3}{4}$ vol. of tube.

After setting $CuSO_4$ of stronger osmotic concentration than the K_4Fe Cy_6 is added to one, of weaker concentration to another, of equal concentration to a third.

.84 gr. per litre $CaSO_4$ = .31 gr. p. litre K_4FcCY_6

From the position of the precipitation membranes (copper ferrocyanide) determine relative rate of diffusion of the two salts and of different concentrations of the same salt. Is the membrane permeable to the salts? to water?

Explain curvature of the membranes.

Understand permeability, impermeability, semipermeability, osmosis, osmotic pressure, toxicity, hyper–, iso–, and hypo-tonicity as exemplified in the above experiment.

4. Osmotic Pressure.

The direct measurement of osmotic pressure involves use of a semipermeable membrane. i.e. one which permits the diffusion of the solvent but not of the solute. This method can be used to demonstrate the phenomenon, but actual measurement is of extreme difficulty.

(*a*) Construct a simple osmoscope: Tie over the flanged end of a short glass tube a membrane. e.g. of gut or parchment paper. Partly fill this with a strong solution of sugar (molasses), to which a little copper sulphate has been added. Place in water to which a little potassium ferrocyanide has been added. Theoretically these added salts should be isotonic. Allow to stand for some time, recording the height of the column in the tube. Equalize initial pressures.

A duplicate of Pfeffer's osmometer will be shown.

(*b*) At the opposite edge of a wide drop of water on a glass slide, a small crystal of each of the above salts is placed. A copper ferrocyanide membrane is formed. Is this permeable to either of the salts? Vary this experiment by placing a crystal of one into a solution of the other salt in a test-tube, noting results. (Traube, 1867. Walden, 1892, see Bayliss).

(*c*) Repeat, substituting cobalt chloride and sodium silicate (a drop of the concentrated solution instead of a crystal, of course). (Leduc: Theorie physico-chemique de la vie, 1910.)

5. Artificial Cells.

Note that in contradistinction to the condition of para. 1. above if the stronger solution is enclosed in a membrane, the pressure must be exerted on its internal face in all directions. The practical difficulty of maintaining a semi-permeable membrane makes the demonstration on a large scale somewhat bothersome. Small crystals of cobalt chloride dropped into weak sodium silicate, however, afford precisely this condition on a small scale. This is duplicated in the mechanical aspect of a living cell, the plasmatic membrane of which is semipermeable to many substances. In fact, the cell may be used for determining, within certain limits, the concentration of solution of non-diffusible substances. (de Vries, cited above).

6. Osmotic Pressure of Colloids.

Using gut as a membrane determine the osmotic effect of a 25% solution of gum acacia. The experiment should be carried on till next period so as to distinguish the temporary (why?) effect of electrolytic impurities and the permanent (why?) effect of the colloid.

Compare osmotic expression of colloids v. crystalloids as regards (1) magnitude and (2) relation to permeability of membrane.

[The following section should be omitted until section B (Physiological) (1) to (13) has been completed.]

7. Anomalous osmosis — Positive and Negative.

McClendon: Chap. X. Small Jas: Textbook of Botany p.357; Bartell Journal Am. Chem. Soc. 1916 and 1920.

The following experiments illustrate the main types of disturbance of ordinary osmosis, based on the electrical theory.

(*a*) Set up an osmoscope with a membrane of pig's bladder or gut. To magnify the effect insert a narrow tube through a rubber cork into the wider tube.

On one side of the membrane place (M/2) citric or tartaric acid (Flusin 1908), on the other pure H_2O and allow to stand for two hours or longer.

(*b*) Repeat with a slightly hypotonic (e.g. equimolar) solution of sugar opposed to the acid. (The sugar partly neutralises the **normal** osmotic effect of the acid and being a non electrolyte has no "**abnormal**" osmotic effect of its own).

Set up similar experiments with

(*c*) Basic citrate (M/60) and **hypertonic** sugar, (.3M)

(*d*) NaCl M/30 and **hypotonic** sugar M/20

(*e*) $AlCl_3$ M/160 and hypertonic sugar M/20

Record the direction of osmosis in each case and any divergence from the normal Does the disturbing factor assist or resist ordinary osmosis?

The fact that abnormal osmosis may be positive as well as negative eliminates relatively lower penetrability or diffiusibility of sugar as the cause.

The points to be studied are.

(1) Relative speed of kations and anions. (Kations quicker in (1) & (2) anions in (3) & (4).

(2) Resulting polarity of the membrane.
How orientated + and − ?

(3) Permeability (pore size) of the membrane. Is it semipermeable to the reagents employed? (Test chemically e.g. with $AgNO_3$ for chlorides, indicator for acid). Could a truly semipermeable membrane become polarized.

(4) Electrical charge of the membrane + in (1) & (4) (why?) − in (2) & (3).

According to electrical theory induced charge on adjoining H_2O particles causes them to be attracted to one or the other side of the polarized membrane.

Influence of H-ion concentration on direction of osmosis Illustrate by diagrams the above conditions as they exist in each experiment.

B. PHYSIOLOGICAL.

MATERIAL: Red and white onion, carrot, beet, haematocytes, frog's bladder, leg and skin.

1. Rates of Diffusion of various Substances into Protoplasm.

(a) Put onion epidermis with colourless sap, into weak neutral red, Congo red and other dies, and allow to lie for some time. Note different rates of diffusion of dye into protoplasm. Cf. A.1.

(b) Using the cells that have their cell sap coloured by neutral red, test the relative rates of penetration of NH_3, Na, and K-ions (solutions must not be stronger than N-800). Cf. A (4)

2. Semi-permeability and Permeability.

(a) The cells of tissues which contain colouring matter in solution being used, it may be found that such pigments do not diffuse through protoplasm in the normal condition but do so when sufficiently abnormal (Semi-permeability; permeability ; change of porosity).

(b) KNO_3, cane sugar, etc., may be used to plasmolyse cells when alive. Other substances there are which may not be used, e.g. ammonia, alcohol, etc., Test and explain the results.

3. Osmotic Pressure, tonicity.

Using a strong solution (1N KNO_3) note that the plasmatic membrane contracts; reducing the concentration sufficiently permits restitution. Determine the exact con-

centration which does not affect the position of the membrane. Such a solution is "isosmotic" or "isotonic".

Determine the molar concentration which is isotonic in the case of cane sugar, glucose, NaCl, $CaCl_2$ potassium chromate and dichromate.

By plasmolysis de Vries calculated the "isotonic coefficient" of salts, taking $KNO_3 = 3$ as the standard. Give the coefficient for the above substances.

Consider relation of osmotic pressure (tonicity) to molar concentration and ionization.

4. Turgidity. Place a slender strip of living tissue (carrot, turnip, etc.,) in each of a series of solutions which range from marked hypertonicity to marked hypotonicity, and note the results.

Note that "turgidity" may be used to denote rigidity of tissues arising from other causes. (See under 'swelling', Syn. IV,)

5. Changes in Permeability; Toxicity.

(a) Treat onion epidermis with strong alcohol followed by water. Does 1/N KNO_3 now induce plasmolysis? Repeat with iodine in water solution.

In this connection it is important to get a clear concept of the plasmatic membrane as having its permeability altered.

(b) To determine if toxic substances penetrate before they kill, or in weak non-toxic concentrations. Make a solution of sugar isotonic to the plant cells and then add a minute trace of strong alcohol or NH_4OH. Osmotic pressure is increased. Does plasmolysis take place?

6. Antagonism of Ions.

(a) Determine the molar concentrations of NaCl and of $CaCl_2$ isotonic with the cells of onion epidermis (i.e. the upper limits of hypotonicity). Using a mixture of these salts, is this mixture now equivalent in its physiological actions to that of either salt alone?

(Note. In the case of Spirogyra, Osterhout found that a mixture of 10 c.c. of .375 M NaCL (hypotonic) and 10 c.c. .195 M $CaCl_2$ (also hypotonic) was hypertonic. "Science n.s.34, 187, 1911). Increase in ionization is a factor to be taken into account.

(b) Thin slices of beet are washed in distilled water and are placed in equal quantities .1, .2, .3 and .4 N NaCl and in corresponding strengths of NaCl and $CaCl_2$ in ratio 9:1 for an interval of two hours. Note the amount of pigment which has escaped by colorimeter method (the environing solutions are poured into test tubes to same depth and colour compared). The slices are now placed in tap water with a small amount of $CaCl_2$ added, and are kept till following day.

Theoretical consideration.

The toxic effect of NaCl (Osterhout), antagonism of ions, physiological balance.

Refer to Syn. II, "Toxicity". How does lowering surface tension affect the concentration membrane on protoplasm? Result on permeability?

7. Osmotic Phenomena in Animal Cells.

(a) Haematocytes. Determine the isotonic solutions of NaCl, KNO_3 and $CaCl_2$, using crenation as an index of plasmolysis. (1/N solns. supplied).

Is the concentration identical for the three salts?

(b) **Squamous epithelium of frog's bladder.** Tease out frog's bladder so as to show the epithelium in profile. Irrigate with distilled water, and note the peculiar swelling of the membranes,apparently leaving the protoplasmic mass; followed by swelling of nucleus and cytoplasm; Brownian movement of particles in cytoplasm and in clear area.

Now irrigate with N KNO_3 Study the character of shrinkage, noticing buckling of membrane (if cytoplasm has not filled it out?) Observe also the behaviour of the erythrocytes, changes in shape, laking, etc.

(Note. It is not yet accurately known what the significance of all the above behaviours is. They deserve careful study.

(c) **Demonstration:** The gastrocnemius muscle of frog will be used to demonstrate the effects of sol'ns of different concentrations (salts).

8. Negative osmose. Test the relative efficiency of citric acid solution and pure H_2O in restoring the turgidity of plasmolysed cells.

9. Glandular action, Secretion, Excretion, Filtration.

(a) **Filtration.** Construct an artificial gland by hollowing out a piece of beet, or carrot, and introducing a strong solution of cane sugar. What is the dominating factor here?

Do sugar, salts, etc., escape however as well as water? A piece of tissue is washed and kept in distilled water in a vial, and the water later tested for sugar, NaCl. If red tissue is used, the colorimetric method may be used.

The factors concerned in glandular action are usually more complex than here illustrated. In addition to normal osmose (including evaporation), the osmotic pressure of colloids, negative osmose, manometric pressure and changes in permeability have also to be taken into account.

(b) Compare the relative efficiency of hydrostatic (manometric) pressure, and osmotic pressure including vapour tension in producing flow of water through a membrane.

(Dem.) A column of distilled water (say 4½ – 5 feet = mean arterial pressure of man) is supported in a glass tube by a strong membrane e.g. frog's skin. Measure the rates of exudation when the membrane is exposed externally to (1) distilled water; (2) the atmosphere, (3).3N KNO_3 (o.p. of blood) and calculate the rates due to the different forces separately.

(c) For the rôle of the osmotic pressure of colloids in preventing the escape of water from the blood vessels, and the use of gum acacia in intravenous injections to replace blood lost, see Bayliss Intro. p. 140.

10. Periodicity [Cf. A:1]. The lamination in starch grains, due to periodicity of growth (alternating water-rich layers). Dehydrate: no lamination.

How far the analogy holds as between the above is a matter of doubt. See however Bechhold (above cited), LeDuc ; Theorie physico-chemique de la vie, where other analogies are also mentioned.

SYNOPSIS VI.

DIGESTION. ROLE OF ENZYMES.

Lit. Bayliss, pp. 365-6, 372; Reynolds Green, "Soluble ferments and fermentation".

A. EXPERIMENTS IN DIGESTION OF STARCH

Food materials are presented to protoplasm generally in an insoluble, or if soluble, indiffusible (colloidal) condition. Digestion reverses these conditions. As a typical substance **starch** will serve.

1. Emulsoidal Solution.

Note that starch is insoluble in cold water but makes an emulsoidal complex in hot water. Heat a few starch grains in water on a slide and note the changed condition, using iodine to produce visibility in the miscroscope.

Large starch grains (potato or arrowroot) are placed in water on a slide and heated till swollen. Covere with a cover glass, run under diastase and observe the action on the grains.

2. Digestion.

Put some starch grains in a vial with a few c.c. of diastase for several hours, then examine to find evidence of attack of enzyme on starch in form of erosions.

Similar and extensive erosions may be seen in banana pulp if ripe. Compare cells of unripe and ripe bananas. Test small bits of pulp with Fehling's solution for reducing sugars.

3. Solubility Resulting.

Starch paste as an emulsoid is indiffusible. Test this by means of osmoscope, setting up a duplicate starch plus diastase. Place osmoscopes in shell vials with water. Test the dialysate after an interval for sugars, using a very small amount of Fehling's so as to avoid colour masking. An exceedingly small amount of sugar may be detected nephelometrically if the Tyndall effect is made use of. When positive results have been obtained, test for starch. Note red colour.

4. Stages in Digestion.

Pour some gelatin mixed with starch paste into a vial. After it has set add diastase and allow to stand for 24-48 hours. Note clear zone due to digestion of starch. The experiment may be varied by spreading a gelatin starch film on a glass slide and after it has set placing on it a drop of diastase solution. Diffusion may be observed after two hours. Iodine differentiates a violet zone between the completely digested and still unaffected starch. (Wijsman 1890. See Green "Soluble Ferments and Fermentation" p.59)

5. Diffusion of Enzymes.

Ferments are considered to be colloidal. Note however diffusion into gelatin occurs.

6. Temperature Relations.

Test the sugar reaction after the same period when mixtures of starch paste and diastase are kept at room temperature and 60°C respectively, all other conditions being alike.

Note that when heated to about 80°C. diastase loses its power.

The activity of ferments is minimum, maximum, and minimum at minimum, optimum (60°) and maximum temperatures respectively.

7. Inactivation.

In addition to effect of temperatures such as inactivate (kill) protoplasm, other reagents e.g. tannin and alcohol have been noted to have an inhibiting effect.

B. APPLICATIONS. (1) The general behaviour of ferments as such is well illustrated by diastase. (2) The conditions which necessitate digestion are duplicated. (3) Enzymes may be considered as approaching protoplasm in their characteristics.