normality a simple cystic condition of the ovaries. Histologically and cytologically these cystic ovaries differed from the normal cow's ovary in but one essential respect, namely, that they had no corpora lutea.

The case described presents for consideration certain definite and clear-cut results bearing on the problem of secondary sex characters. These are:

1. This cow had been a perfectly normal female and had performed all the reproductive functions, both primary and secondary, of the sex.

2. It later assumed certain of the secondary characters of the male, both in respect of structure and behavior, with perfect definiteness, and, so far as the characters concerned go, completeness. This change was, for example, at least as complete and definite as any of those described by Steinach[2] following castration and transplantation of gonads.

3. The gonads of this animal, examined subsequent to the change in secondary characters, were exactly like those of a normal cow, save in the one respect that the follicles were not breaking and discharging ova, but were forming follicular cysts or becoming atretic, and because of this no corpora lutea were formed.

(*a*) The interstitial secreting mechanism of these ovaries was absolutely normal, both in respect of number of cells, and the cytological characteristics of the individual cells.

(*b*) The germinal mechanism was perfectly normal up to the point where ovulation should occur. Then it failed to separate the ova from the ovary.

(*c*) The outstanding, and so far as we can determine the only significant, anatomical and physiological difference between the gonads of this abnormal cow and those of a normal one, consists in the fact that the former lacked any lutear tissue.

A detailed account of the case, with figures, will be given in the complete paper.

Raymond Pearl,
Frank M. Surface

[2] Steinach, E., "Willkürlich Umwandlung von Saügetiermännchen in Tiere mit ausgeprägt weiblichen Geschlechtscharacteren und weiblicher Psyche," *Pflüger's Arch.*, Bd. 144, pp. 71–108, 1912.

A NEW THEORY REGARDING THE FEEDING POWER OF PLANTS[1]

The feeding power of plants has been a subject of a great deal of investigation during the last half century. Undoubtedly mere casual observation of the growth of wild and cultivated plants led investigators long ago to surmise that there is a difference in the feeding power of different species of plants. Numerous carefully controlled experiments have repeatedly confirmed this idea. Of the important mineral elements needed by plants, sufficient phosphates in an available form are most often lacking in a soil. It is largely on this account that phosphates have generally been used in testing the feeding power of plants. Fortunately phosphates are also well adapted to this study. With the rapidly increasing use of phosphate fertilizers, the subject has become one of considerable economic importance, since it may be possible that with a proper selection and sequence of crops as regards their feeding power, the cheap insoluble phosphate fertilizers may be used with greater advantage.

It was formerly supposed that insoluble minerals were made soluble by plants through the action of various acids secreted by the plant roots. As is well known, later experiments, especially those by Czapex, have demonstrated that other than carbonic acid, plants normally excrete at the most, only minute traces of acids. There remains, however, no question that practically all plants excrete through their roots large quantities of carbonic acid. Lately some investigators have suggested that differences in feeding power may be due to differences in amount of carbonic acid excreted by the roots. Experimental data, however, lend little support to this view, and hence indicate that there must be something vastly more important in determining the feeding power of a plant. On reviewing the literature concerning the subject, and considering the data obtained in this laboratory, the writer was led to formulate the following hypothesis:

Plants containing a relatively high calcium

[1] Publication authorized by the director of the Wisconsin Experiment Station.

oxide content have a relatively high feeding power for the phosphorus in raw rock phosphate. For plants containing a relatively low calcium oxide content the converse of the above is true. A calcium oxide content of less than one per cent. may be considered relatively low. Corn, oats, rye, wheat and millet belong in this class. A calcium oxide content of somewhat more than one per cent. may be considered relatively high. Peas, clover, alfalfa, buckwheat and most of the species of the cruciferæ belong in this class.

The explanation of the above relation is made possible by means of the laws of mass action and chemical equilibrium. The reaction making the phosphorus in raw rock phosphate available to plants is one between carbonic acid and the tricalcium phosphate in the rock phosphate, which may be represented as follows:

$$Ca_3(PO_4)_2 + 2H_2CO_3 \leftrightarrows Ca_2H_2(PO_4)_2 + CaH_2(CO_3)_2.$$

As is well known if none of the products to the right of the reaction are removed from solution, the reaction soon reaches a state of equilibrium. If the di-calcium phosphate is continually removed but the calcium bi-carbonate only in part, then the reaction will continue a little farther, but also soon comes to a state of equilibrium due to the accumulation of the calcium bi-carbonate. When this point is reached, the further solution of the phosphate is prevented. This is the condition that obtains for such plants as are low in calcium oxide and hence do not absorb the calcium bicarbonate in the proportion to the dicalcium phosphate as given in the reaction. In such cases, the plants soon suffer for soluble phosphates. If both of the products to the right of the reaction are simultaneously and continually removed in the proportion given, then the reaction continues from left to right and there results a continuous supply of soluble phosphates along with soluble calcium bicarbonate. This is the condition that obtains, at least in part, with plants containing a high calcium oxide content, and hence such plants are strong feeders on raw rock phosphate.

In accord with other investigators the writer has found that the use of ammonium nitrate or sulfate as a source of nitrogen in quartz plant culture work, greatly increases the availability of raw rock phosphate to plants which are normally weak feeders on this material. In the light of the present theory this is very satisfactorily explained as follows: Calcium bicarbonate being much more soluble in a water solution of ammonium salts than in water alone, it follows that the addition of ammonium salts allows the preceding reaction to continue from left to right to a much greater extent than if water alone is present. The addition of a salt in which the products of the reaction are more soluble has the same effect to a certain extent as is obtained by removing the products of the reaction.

With the theory[2] here proposed it is possible to predict from the calcium oxide content of a plant whether or not that plant in quartz cultures will be a strong or weak feeder on raw rock phosphate. Under soil conditions there are many subsidiary factors that influence the availability of phosphates, and hence under such conditions the relative growth of a plant can not be taken rigidly as a true index of its feeding power for the limiting element which is supplied in an insoluble form. Seeming deviations from the theory may result under such conditions. It is possible that with proper restrictions the theory can be applied to the feeding power of plants in a broader way, involving the use of other insoluble plant-food materials besides rock phosphate, and the general theorem could then be worded as follows: The feeding power of a plant for an insoluble substance depends primarily upon two conditions, viz., (1) the solubility of that substance in carbonated water and, (2) whether or not the plant removes from solution all the products of the solubility reaction in the proper proportion, so as to allow the solubility reaction to continue indefinitely.

With the theory here presented the writer

[2] Since writing this article the writer's attention has been called to a recent publication in *Zhur. Opytn. Agron.*, 15 (1914), No. 1, 54, by F. V. Chirikov, who from entirely independent work from this, has come to practically the same conclusion as the one set forth in this paper.

believes that the feeding power of plants is satisfactorily explained, without the intervention of other acids than carbonic. Since the failure to establish that plants excrete notable amounts of other acids than carbonic, some investigators, as previously stated, have suggested that the differences in feeding power may be due to differences in amount of carbon dioxide excreted. A careful consideration of available data lends little support to this idea. It seems rather that it is the efficiency with which the carbon dioxide is used, and not the differences in amount excreted by different species of plants, that determines whether or not a plant will feed strongly on an insoluble material.

The writer has in preparation a detailed article dealing with the feeding power of plants and the availability of phosphates.

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THE SOCIETY OF AMERICAN BACTERIOLOGISTS[1]

SYSTEMATIC BACTERIOLOGY

Under the supervision of H. A. Harding

A Study of B. subtilis by Means of the Classification Card: H. Joel Conn.

One hundred and thirty cultures of the *B. subtilis* type, isolated from soil, have been studied by means of the classification card adopted by the society. The definition adopted for *B. subtilis* is: a large, peritrichic, spore-producing rod, facultative anærobic in the presence of dextrose, liquefying gelatine, and growing vigorously on ordinary media without chromogenesis, producing a membraneous more or less wrinkled growth on the surface of agar. Two questions have been considered: (1) Do the determinations called for on the card separate these 130 cultures into more than one species? (2) Does the same culture always give identical results upon repetition of the tests?

In answering the first question half of the determinations represented by the "Group Number" on the card were excluded because they are implied by the definition of *B. subtilis*. The determinations taken into account were the fermentation of sugars and glycerin, and the reduction of nitrates. The nitrate reduction determination gives quite clear-cut results and may serve to separate an infrequent nitrate-negative species from an abundant nitrate-positive species. The fermentation tests do not give such definite results. They suggest that the 130 strains do not differ from each other in fermentative powers, but give inconstant results with the present technique.

The second question was answered in the negative as regards the fermentation tests; the nitrate reduction test seemed more constant, but insufficient data is at hand to settle the matter.

These tests indicate that with our present technique different "group numbers" do not always indicate different species. One of the first steps needed in revising the card is to establish the best methods for making the various determinations.

Some Induced Changes in Streptococci: Jean Broadhurst.

Various relatively simple physical and chemical factors (such as changes in temperature and differences in artificial media) differ greatly from such agents as saliva, intestinal extracts, and pure cultures of other bacteria, in their effects upon the physiological activities of selected strains of streptococci. The physiological effects of the former, especially in the various test media containing the sugars and the related substances suggested by Gordon, are mainly of a negative or inhibiting type, and apparently temporary only.

The changes induced by the latter factors (saliva, intestinal extracts, etc.) are, however, markedly different. They are changes in kind not in amount of reaction; they are active and usually include new powers, not merely the inhibition or occasional stimulation of earlier powers or capabilities, and often indicate a complete rearrangement of the fermentative complex. These induced changes have, so far, been practically permanent.

A Study of the Correlation of the Agglutination and the Fermentation Reactions among the Streptococci: I. J. Kligler.

Bacteria have evolved so little along gross structural lines that it is impossible to differentiate members of the same genus on a merely physical basis. We therefore resort to the more delicate criteria of protoplasmic constitution and physiological activity, in which direction remarkable differentiation exists. Tests for the finer structural differences of these organisms are found in their behavior to differential stains, such as the Gram stain, and to the immune substances in-

[1] Abstracts of papers presented at the Philadelphia meeting, December 29, 1914.