bundle is transected, and while the auricle is fibrillating—a fact which demonstrates that all auricular impulses to it are impeded by such a procedure. As a consequence the ventricle assumes its own spontaneous slow and regular rhythm. Partial heart-block is readily induced by asphyxia, and, in conjunction with Dr. Mathison, I have utilized this fact to show that when a condition of heart-block is present, the production of auricular fibrillation, while disturbing the regularity of the ventricular contractions, fails to bring about the marked increase of rate which usually accompanies its onset in the normal animal. It may be similarly shown that when the auricle is fibrillating the production of partial heart-block reduces the rate of the ventricular responses (Figs. 5 and 6).

The clinical condition, auricular fibrillation, has been seen in association with heart-block of several grades; with partial heart-block in the curves of Dr. G. A. Gibson,⁶ by Dr. Mackenzie,⁸ and myself; in all these cases the ventricular rate was slow; and a case of auricular fibrillation has been recently reported in which complete heart-block in an epileptic and syphilitic subject was probably present.⁷ In this case the ventricle beat regularly at a rate of approximately 30 per minute.

We see, therefore, that the known ways in which the ventricular action may be retarded, whether the fibrillation is clinical or experimental, are of one type; in all instances heart-block is either probable or proved. What more natural than to suspect that digitalis acts in a similar manner when it produces ventricular slowing in the clinical condition? For digitalis has been found to induce heart-block experimentally,⁹ and clinically a similar action has been described by Mackenzie,⁹ and has been fully substantiated by a number of more recent workers.

The case for which I plead—that digitalis slowing is a result of heart-block when the auricle is fibrillating—is very materially strengthened when the following facts are considered: The type of case in which, with the normal or co-ordinate contraction of the auricle present, heart-block is readily provoked by digitalis administration, is the advanced rheumatic heart, and *a fortiori* the heart affected by mitral stenosis. It is a striking fact that of all cases of clinical auricular fibrillation, those which are of rheumatic origin, and *a fortiori* those affected by mitral stenosis, show the characteristic slowing of digitalis to most advantage. This is the type of case in which digitalis acts in so magic a fashion, and in which the rate of the ventricle is set by the dosage employed; it is the type of case in which the ventricular rhythm may be sometimes reduced to regularity, and in which the rate may be reduced to that consistent with a true ventricular rhythm.

On the other hand, there is the type of patient in whom no reaction ensues upon the exhibition of the drug. Now Mackenzie has shown that digitalis produces heart-block in those patients in whom a previous defect of conduction exists. The proposition I put to you is a parallel one, namely, that the ventricle is retarded in auricular fibrillation by digitalis when there is a pre-existing damage of the junctional tissues, a damage which is frequently demonstrable in cases of rheumatic heart affection.*

The complete evidence in support of this proposition will require time for its collection. We require observations upon patients in the early stages of the affection. It is requisite that it be demonstrated that a large proportion of the cases which react to digitalis had a deficiency of auriculo-ventricular conduction *before* the onset of fibrillation. I can offer the facts in regard to three cases¹⁰ only at the present time. In these three cases the heart-rhythm was observed before the onset of fibrillation, or during the intervals of rest between attacks. The cases were thoroughly tested with digitalis during the stage of fibrillation. Two cases, in which no previous defect of conduction could be demonstrated, failed to show a trace of reaction to the drug. The third case in which deficiency of conduction was clearly established reacted repeatedly and in the most typical manner.

The view suggested, therefore, is that the ventricular rate is retarded in clinical auricular fibrillation by the action of digitalis upon the junctional tissues, the functions of which are already in a depressed state; and this view

is put forward, together with an indication of the direction from which the evidence will come, which, if favourable, should convert what may be now regarded as a proposition into a well-established conclusion.

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VARIATIONS OF THE FERMENTATION PROPERTIES OF THE *B. TYPHOSUS*. *

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Lactose.

DR. TWORT has shown that the *B. typhosus* can be made to ferment lactose-peptone water. He found that two years' growth on lactose-peptone water was necessary to produce this strain. I have examined this new variety and find: (1) It is a genuine *B. typhosus*. (2) On plating on lactose it always gives rise to mixed plates of fermenting and non-fermenting colonies. Subculture of fermenting colonies on lactose plates gives again a mixture of fermenting and non-fermenting colonies, so that the character is always tending to disappear and requires constant growth on lactose for its retention.

If the atavistic non-fermenting colonies are retrained on lactose-agar slopes, after a variable number of subcultures they take on the fermenting power again. In this process of training, when the efficient fermenting strain is arising they show papillae-formation on the lactose, the papillae being very large and acid in reaction as indicated by neutral red.

I have attempted the complete training of a large number of strains myself, and have only got one to the stage of very slightly fermenting lactose-peptone water in two days. I have not yet got red colonies out of it. This has required sixteen monthly subcultures.

Dulcitol.

I have shown † that *B. typhosus* requires about ten days to produce acidity in dulcitol-peptone water. The period can be readily shortened to one day by one to three subcultures on dulcitol media at monthly intervals. Normal *B. typhosus* produces neutral or alkaline colonies on dulcitol agar. About the fifth day, in one-third of the strains papilliform projections arise on the colonies, which become acid in a day or two. Subcultures from these papillae give rise to fermenting colonies. Other strains of *B. typhosus* give papillae about eight to ten days after inoculation. These do not acquire an acid reaction. Occasionally strains do not show papillae on this medium.

Plating on dulcitol agar daily from dulcitol broths of *B. typhosus* shows the history of the variation. It usually takes two to ten days to produce fermenting elements on dulcitol agar. Then, some time later, all the non-fermenting elements are killed off suddenly, and the broth contains only fermenting elements.

This new fermenting character tends to recede after its first selection, but if continuous growth on dulcitol is undertaken for two to three months, the character remains permanent. A strain so trained and selected about nine months ago gave on plating out within the last few days pure plates of fermenting colonies.

Thus apparently two years' growth on lactose selects out a strain acting similarly to a dulcitol strain selected in about a week. How long will a pure permanent lactose strain require for its selection?

Arabinose.

B. typhosus does not ferment arabinose on neutral red arabinose agar plates and ferments arabinose peptone water very slowly and irregularly. After three months'

* The view that digitalis acts by the production of heart-block was originally put forward in the *BRITISH MEDICAL JOURNAL* of November 2 th, 1909, and was more fully considered in *Heart*, 1909-10, i, 349.

† A paper read in the Section of Bacteriology at the annual meeting of the British Medical Association, London, July 29th, 1910.

† Penfold (1910), *Journ. of Path. and Bact.* vol. xiv., p. 406.

training on arabinose peptone water, I have succeeded in getting this fermentation in arabinose broths to occur overnight. On plating out at this stage, the plates may consist entirely of pure fermenters. I have not yet tested this character for permanency. All the three above-mentioned varieties agglutinate with a typhoid serum readily.

Glycerine.

Glycerine provides an illustration of another type of variation. Normal *B. typhosus* ferments glycerine. All the recently isolated strains examined, I have found on plating on glycerine agar to be pure fermenters. Three old laboratory strains I examined have shown, however, mixed plates of fermenters and non-fermenters. Subculture of each of these types has given rise to pure races of the respective varieties. After five subcultures on peptone water, these still retained their pure character. Probably this negative variation is due to the laboratory culture, and the loss occurs so slowly as not to show itself in the same red strain after so few as five subcultures.

It is rather remarkable that pure fermenting strains inoculated on glycerine peptone water take about three to four days to produce full acidity and eight months' training does not quicken this period. After one day the litmus is completely decolorized by the fermenting strains, but on agitation it regains its colour and only the faintest trace of acidity is seen.

I have not yet tested whether the non-fermenting strains can be readily retrained, but in glycerine litmus peptone water they do not show any signs of acidity after two or three weeks. Both strains give all the other fermentation and agglutination tests of *B. typhosus*. The agglutinability of the non-fermenting strain is, however, somewhat impaired.

Isodulcitate.

R. Müller has drawn attention to papillae-formation by *B. typhosus* on isodulcitate. This I have observed in all the strains I have examined. Subculture from these, gives rise to colonies no longer able to form these papillae, but growing much more luxuriantly on isodulcitate-agar. I found that subculture of these new colonies on peptone water thirteen times, failed to restore the papillae-forming power in any of the four strains so tested. This is apparently a mutation. Growth of *B. typhosus* on isodulcitate broth frequently does not produce acidity though it may do so as early as one week. By 1 to 3 subcultures at monthly intervals, all strains I have tested give acidity in forty-eight hours.

The above five variants of *B. typhosus* agreed with the normal type in all their other fermentation and general properties, that is, the fermentation variations seemed to arise without any concomitant qualitative variations in respect of other fermentation and general characters.

Unsuccessful Variations.

I have grown *B. typhosus* (12 strains) in peptone water, containing formates, for about eight months, in order to get a gas-forming strain, but so far without results. Adonite, erythrite, saccharose, amygdalin, and salicin have all failed to select out special strains, though they were used for about nine months in each case.

Do the above-described variations undermine the value of sugar tests? I think not. They show, however, their limitations—namely, that laboratory culture can vary them. Short laboratory culture on particular carbohydrates will change the type, and evidently, in the case of glycerine, subculture on ordinary nutrient agar will do it after a long period. Cultures fresh from the blood or excretions of typhoid patients, however, show an almost absolute conformity to type in respect of fermentation characters, whereas the agglutination tests, when applied to freshly-isolated strains, not infrequently break down. It seems to me, therefore, that, in the recognition of these organisms, fresh from the body, the fermentation characters take a pre-eminent position.

In conclusion, I should like to put in a plea for the value of the fermentation tests in elucidating the laws of bacterial variation. They are easily applied, and if once understood would probably explain many of the most difficult problems in connexion with virulence and other properties of micro-organisms.

A CASE OF DIAPHRAGMATIC HERNIA IN AN ADULT.

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MANY cases of congenital deficiency in the diaphragm, chiefly left-sided, in infants have been collected both in this country and abroad, but the instances of the subjects having lived to adult life are extremely rare, and therefore I feel that no apology is required for recording this case.

M. L., aged 26 years, married three years, no children. She was a seven months child, had acute rheumatism thirteen years ago, was always highly neurotic, was a school teacher before marriage, and had been passed as sound by the medical examiner. She never suffered from digestive troubles. She was always very thin and was in the habit of lacing rather tightly.

In August, 1909, she was examined for uterine and bladder trouble and found to have marked anteversion; nothing abnormal was found on palpation of the abdomen.

The patient became pregnant in November.

In March, 1910, she said she had not felt so well for years as she had during her early months of pregnancy.

On May 31st, 1910, she complained of feeling sick, and had "dragging" pains in her abdomen and back; at 3 p.m. she vomited.

On June 1st she was seen by me; her face was very flushed, the respirations 44; pulse 144, regular, low tension; temperature 100.4°. The heart's apex beat was in the fifth space, a little internal to the nipple line; the first and second sounds were normal. The percussion note over the front of the left side of the thorax was dull up to the second rib; above that it was hyper-resonant. The breath sounds were weak except at the third space, where they were bronchial. On the left side at the back there was dullness on percussion, weak breath sounds and diminished vocal fremitus up to the angle of the scapula; above that the percussion note was clear and the breath sounds bronchial; no adventitious sounds were audible anywhere over the left side of the thorax. There was considerable pain at the left costal margin. The patient was constantly eructating about half an ounce of clear yellowish fluid; the bowels acted well. The abdomen was occupied by the pregnant uterus of about seven months.

June 2nd. The patient had a restless night; the pain went away, but the eructations continued, the left back was quite dull on percussion, the breath sounds absent, and the heart's apex beat was in the epigastrium towards the right; aspiration was decided upon, but about 6 p.m. the child was born without any labour pains or warning; the placenta came away normally, and there was very little hæmorrhage. During the kneading of the uterus a large mass was felt in the left iliac and lumbar region; this was thought to be an ovarian cyst, but on examination per vaginam nothing could be made out, and the uterus was quite normal. The patient felt much more comfortable, so it was decided under the circumstances not to aspirate the thorax that night.

On June 3rd my colleague, Dr. Hine, saw the patient with me; the pulse was 144, the respirations 44, temperature 100°; the heart's apex beat was then found to be again in the fifth space, just to the left of the sternum; slight jaundice was noticed. The mass in the left side of the abdomen was freely movable and easily examined, and diagnosed as the spleen. The bowels acted well, the stool being like putty.

June 4th. The patient was markedly jaundiced, the liver edge was felt two fingerbreadths below the costal margin, the eructations continued, the fluid now being quite black; the left thorax remained the same, but the heart's apex beat was again to the right edge of the sternum. The thorax was aspirated in the fifth space at the posterior axillary border and 6 oz. of black fluid came away. The patient became cyanosed and the pulse very small and weak; it was decided not to proceed with the aspiration. The patient continued to vomit small quantities of black fluid throughout the night; she had intense pain on the left side by the costal margin for an hour before death, which took place the next day.

Post-mortem Examination—The autopsy was made twenty hours after death, at which Dr. Hine assisted me. The uterus was healthy and no larger than is natural after labour; the appendages were normal. The spleen was found five fingerbreadths below the costal margin and approaching the middle line; it was slightly enlarged. The stomach was enormously distended and partially filled with black fluid, about 3 quarts in all; the fundus was situated in the thorax, as far up as the second rib; the pylorus was in its usual position, there being an hourglass constriction where the portion of the stomach passed through the diaphragm, owing to a partial strangulation. In addition the whole stomach was rotated on its long axis; the great curvature was uppermost, the posterior surface being anterior and