which I should like to mention, namely, Bright's disease. Of its great prevalence in this country there is now no doubt; but, although this is well recognised, there has not as yet been much done in the way of describing the clinical or pathological varieties which are met with locally. Such an investigation is necessarily the foundation upon which any solid work in connection with the elucidation of its etiology or with its treatment must rest, and I trust it may be taken up in earnest by some of our members.

Intestinal Parasites.—There is only one other matter to which I may refer and then I am done, namely, the question of local intestinal parasites and their influence upon health. The identification of the ancylostomum was made some time ago by our colleague, Dr. Ozzard, and we look for further information on it from the same quarter; but there are many others which are plentifully found, and we stand much in need of these being carefully catalogued and described.

I have thus in a most discursive way covered a considerable space; but I have only scratched the surface of the soil which lies open for cultivation with the certainty of large returns to the diligent worker. Trusting that such scratchings may give some indication for the deeper ploughing to follow, I bring them before you, and I feel confident that competent labourers to undertake the task will not be wanting.

A CASE OF DILATATION OF THE STOMACH ACCOMPANIED BY THE ERUCTATION OF INFLAMMABLE GAS.¹

By JAMES McNAUGHT, M.D., M.R.C.S.,
Newchurch, near Manchester.

THE case I am about to relate occurred in a factory operative 24 years of age. He is a tall and rather spare man, somewhat pale, but not anæmic. He gives a history of stomach trouble dating back four and a half years. At the beginning of the time he suffered chiefly from pain after eating, but for the last three years his greatest complaint has been of acidity and flatulency. He has occasionally but only rarely vomited, mostly after dinner, but never at any time has he brought up any blood, nor such copious quantities as would point to ectasia. During the last two years he has suffered most severely from flatulency and in connection with this the most remarkable feature of the case made itself evident. His work requires him to rise early, and on one occasion after striking a match to see the time, and when holding it near his mouth, an eructation of gas from the stomach took place. To his consternation the gas took fire, burned his face and lips considerably, and set fire to his moustache. On a subsequent occasion a similar accident happened. At the time I saw him flatulency was extreme and persistent from one meal to another, and he was also much troubled with rancid and sour eructations. His appetite was good, tongue broad and pale, and bowels regular. In examining the abdomen the subcutaneous fat was noticed to be less than normal; there was a deep depression running across the abdomen a little above the umbilicus, but below this there was evident distension and marked tympanites. The lower line of stomach dulness was about three inches below the navel on the left side, and from this point it extended in a curved line to the right, where it reached the level of the umbilicus. A semilunar area of dulness showed the presence of a considerable quantity of food in the stomach, and above this a highly tympanitic note was given extending up into the left hypochondrium. Occasionally a splashing sound could be well elicited, but on other days it was absent. There was a little, but not marked, tenderness midway between the umbilicus and the ensiform cartilage. It was evident from these signs that the stomach was dilated. The stomach tube was used on several occasions about five hours after meals, and quantities of fluid and *débris* of food varying from one to two pints or more obtained. At first it consisted of a soupy matter smelling exactly like sour yeast, and when it was allowed to stand, a layer of frothy stuff half an inch thick, like dirty yeast, formed on the top. This was full of bubbles of gas which could be seen forming and bursting as it stood in the vessel, while below there was a considerable quantity of clear fluid through which gas bubbles could be seen rising, and at the bottom there settled a sedi-

ment of grumous remains of food in a very fine state of division, resembling the sediment from pea soup. The fluid after filtration gave an acidity equal to 3.2 grammes of caustic soda per litre, and it was found to contain 0.55 gramme per litre of volatile acid, and 0.18 grammes of lactic acid per litre, the residue, equal to 2.4 grammes of caustic soda, being due to mineral acid or acid salts. A strong reaction was obtained with methyl blue and congo red.

The microscope showed enormous quantities of yeast and some sarcinae, with various remains of food. At first I was unable to detect any bacteria, but subsequent more careful examination of the clear fluid showed their presence in great numbers. The fluid extracted from the stomach a week later gave an acidity equal to 2.44 grammes of caustic soda per litre, and of this 0.26 gramme was due to volatile acid, and 0.4 gramme to lactic acid. One hundred and fifty cubic centimetres were put in a flask connected with a gas-collecting apparatus, and kept at a temperature of 100° F. In a few hours 40 cubic centimetres of gas came off, and when a light was applied it exploded with a loud report and burnt with a blue flame. Analysis of a portion of the gas subsequently collected, which I owe to the kindness of my friend Dr. Bailey, of Owens College, Manchester, gave

CO₂ — 56 per cent.

H — 28 "

CH₄ — 6.8 "

and residual air 9.2 "

That the inflammable gas existed in the stomach itself was put beyond question by pouring water into it in a thin stream through a tube and igniting the gas as it issued therefrom owing to the displacement. Only one experiment of this kind was made, as the result of the first was to produce a flame of dimensions alarming to both the patient and myself. The acidity of the stomach contents was carefully tested on many subsequent occasions, the details of which it would be tedious to give here. Suffice it to say that it varied from 2.4 grammes of caustic soda per litre to as high as 4.2 grammes. The volatile acid and lactic acid were proportionately greater when the acidity was less. Thus I find when the acidity was 4.1 grammes per litre the lactic acid was 0.3 gramme and the volatile acid 0.24, but when the total acidity was 2.55 grammes of caustic soda per litre the volatile acid was 0.72 gramme and the lactic acid 0.18 gramme. No doubt this depended partly on the food taken, but chiefly on the fact that when large quantities of HCl were present the formation of lactic acid and butyric acid by fermentation was hindered. I was at some pains to make certain the nature of the acid, because at first sight it seemed impossible that fermentation could take place in a medium containing so large a quantity of mineral acid. I found, however, that the quantity of mineral acid was never appreciably less than 2 per mille and generally much higher. The influence of the acid on the fermentation I shall return to later.

I had evidently to do with a case of stenosis of the pylorus and subsequent ectasia. The treatment was directed to removing the residuum of food from the stomach by means of the tube, once daily at least, and administering various antiseptic agents. At first his diet was limited to milk and Benger's food, fats and vegetables being excluded, and a mixture containing bismuth, carbonate of soda, and magnesium and carbolic acid in chloroform water was given him. Under this treatment he improved very much. The quantity of matter remaining in his stomach five or six hours after a meal was lessened to about half a pint, and the quantity of yeast steadily diminished till none was recognisable with the naked eye, though it was always found after cultivation. Examination of the remains of food showed that large quantities of starch grains were always left, and when he had, contrary to orders, partaken of flesh or egg, that no trace of these could be found. This diet was therefore altered; the Benger's food was stopped, lean minced meat with very little bread was given at dinner, eggs beaten up in milk or boiled were taken at breakfast or tea, and no fat or vegetables allowed. I next directed my attention to the question of preventing the fermentation by drugs. With the view of determining the agent which, while innocuous to the patient, was most effectual for that purpose, I made a number of experiments by adding definite quantities of salol, Sanitas fluid, carbolic acid, salicylate of soda, salufer and aqua chlori to the contents of the stomach placed in bottles connected with a gas-collecting apparatus and kept at a suitable temperature. A control bottle was used in every case. I found that half an ounce of Sanitas fluid to 8 ounces was useless and aq. chlori, the same (10 m to the ounce), salol in quantities of 4 grains to the ounce, and carbolic acid 3j to 3viij were only par-

¹ Presented in the Section of Medicine at the Annual Meeting of the British Medical Association held in Leeds.

tially successful, but salufer in quantities of 1 grain to the ounce and salicylate of soda 4 grains to the ounce completely successful. I had previously tried administering hyposulphite of soda, but the result was great nausea and I was obliged to stop it. Salufer in 10-grain doses produced violent vomiting, but salicylate of soda was well borne; 15 grains of salicylate of soda were added to each dose of his medicine, and he was directed after washing out the stomach at night to pour in half a pint of water containing 30 grains of soda salicylate. Under this treatment he improved very much, acidity and flatulency became less and less, until at last he expressed himself as well. By examining the contents of the stomach from time to time, it was seen that the sarcinae were the first to disappear, then the yeast became less until none could be found with a microscope or on cultivation, but the fluid on being kept at a suitable temperature still gave off an inflammable gas. Finally, after about six months' treatment the quantity of residuum was reduced to from 6 to 8 ounces, and on many occasions fermentation experiments with this gave negative results. He gained 7 pounds in weight, and gave up medicinal treatment, but continued to wash out the stomach at least every other night. I saw him a few days ago, and found that he had begun to take liberties with his diet, and was eating largely of butter, or anything he fancied, and I was not surprised on emptying his stomach to find that the quantity of residuum had risen to a pint, and that this gave evidence of both yeast and butyric fermentation. Notwithstanding that, however, he continues regularly at his work, though he has now lost some flesh again, and manages to keep his gastric troubles in sufficient abeyance to be tolerable by washing out his stomach every alternate night.

Before entering into an account of some investigations concerning the causes and nature of the fermentation, it may be useful to give a brief summary of the literature of the subject. In the JOURNAL of February 13th, 1886, a case of eructation of inflammable gas is recorded by Dr. Beatson, of Glasgow, in which the face was burnt by its accidental ignition. In the JOURNAL for February 27th, 1886, Dr. Saundby, of Birmingham, gives references to several cases abstracted for the *Medical Record* of 1874. The first, by Schultze, is in the *Berlin. klin. Wochen.* for July 6th and 13th, 1874, and is an account of a case of Friedreich's of Heidelberg seen in 1865. The analysis of the gas gave CO_2 and H in about equal proportions, nearly 30 per cent., and there was also a trace of marsh gas. Popoff records at great length in the *Berlin. klin. Wochen.* for 1870, No. 38, 39, and 40, a case which occurred in the clinic of Professor Botkin, of St. Petersburg. A similar case was described by Frerichs in the same journal, No. 8, for 1874. Two others are mentioned as having been seen, and the gas analysed by Carius. Another case was recorded by Ewald in *Reichert and Du Bois's Archiv* for 1874, p. 217. In this case the analysis of the gas gave about 20 per cent. each of CO_2 and H, and from 2.7 to 10 per cent. of marsh gas. In a case reported by Heynsius, the gas contained in the vomited matter was found to be CO_2 and H. In the JOURNAL for February 27th, 1886, Dr. Scott Orr relates briefly a case of the kind, but no analysis of the gas was made. These are, so far as I know, all the recorded cases.

On comparing the results of analysis, it will be seen that the same gases were found in all, namely, CO_2 and H in smaller or greater quantities, and small quantities of CH_4 . In my case the quantity of CO_2 , 56 per cent., was nearly double that of the others recorded, the H, 28 per cent., being about the same, and the marsh gas 9 per cent. It will be at once noticed that the gases, with the exception of the marsh gas, correspond to those of butyric fermentation.

In a paper by Paschutin in *Pflüger's Archiv*, vol. iii, for 1873, Paschutin gives the proportions of gas obtained in butyric fermentation as 2.7 of CO_2 to 1 of H, and he says that no carburetted or sulphuretted H is formed. All the cases here given show CH_4 , and this is only to be accounted for by the presence of several ferments.

It is impossible in the time at my disposal to enter fully into a discussion of the cases. In Popoff's torulae and sarcinae were found, but no mention is made of bacteria. As, however, butyric acid was present in the vomited matter in considerable quantity, the gas is attributed to that fermentation. Ewald found butyric acid present in the vomited matter, and noticed the presence of rods corresponding to Pasteur's butyric ferment. He carried on the fermentation outside the stomach and obtained inflammable gas, but is inclined to attribute the presence of the gas in the

stomach itself to its passage upwards from the intestine rather than its formation there. I made several attempts to carry on the fermentation in artificial mixtures inoculated from the contents of the stomach before I succeeded. Finally, I succeeded in carrying it on in a mixture of Benger's food and water. From this sterilised skim milk was inoculated, and a quantity of inflammable gas was obtained. Examination of the milk showed only few torulae, but it absolutely swarmed with bacteria, resembling the bacillus butyricus in appearance.

The milk, after fermenting some days, gave an acidity equal to 10 grammes of NaHO per litre, and of this 1.4 gramme was due to volatile acid. It smelt strongly of butyric acid. I had, up to this time, not observed bacteria in the fresh matter obtained from the stomach, owing to the great number of yeast cells, and the confusion caused by the remains of food. But, on carefully examining with a power of 350 diameters, the intermediate clear fluid formed after separation of the scum and sediment from some of the matter passed (with suitable precautions) into a sterilised flask, large numbers of very small thick rods in active movement were seen. With a higher power these were observed to be straight, or slightly curved, rods, and besides these were noticed a great number of oval spore-containing bodies in exceedingly active movement.

I endeavoured now to get rid of the yeast and to isolate the bacilli by cultivation on potatoes. In this way two kinds of yeast, the *saccharomyces ellipsoideus* and the *saccharomyces rosaceus*, were isolated. There was also a small active bacterium, giving rise to a bright yellow growth, and two other bacteria resembling each other closely in appearance, and consisting of long straight rods, sometimes joined together end to end, and both actively motile. Experiments were made to determine which of these gave rise to the fermentation with the development of inflammable gas. One of these rodlike bacteria produced no gas, and was, I think, the common bacillus subtilis. Finally I succeeded in carrying on the fermentation in Pasteur's fluid, which was inoculated from a grey dryish spot on a potato. The bacilli forming this growth consisted of straight rods varying in size, but most of them of considerable length, and containing according to their length two, three, or four spores, which stained splendidly with methyl violet. The spores took up so much of the rod as almost to resemble a chain of cocci when stained, but their active movements showed them to be contained in the rods. Besides these were numerous elliptical actively moving bodies containing each a spore, and also some free spores. A flask filled with Pasteur's fluid inoculated from this with a needle gave off gas freely after standing two days, and continued to do so for seven days. The gas was inflammable and burnt with a blue flame. It was not analysed. The fluid at the end of the time smelt quite sweet, and on distilling very little volatile acid, neutralised with a drop or two of soda solution, and amounting only to 0.061 gramme of NaHO per litre, came over. Anyone who knows the strong odour of butyric acid is aware that infinitesimal quantities can be recognised by the nose, and I am quite sure that at the end of seven days practically none was present. Microscopical examination of this fluid showed numerous long, straight, transparent rods, many of them connected at their ends by a transparent medium in twos and threes, and also a great many actively moving elliptical spore-bearing bodies. Some of the single rods bore spores at one end. The plasma of the rods stained distinctly with iodine. Nutrient gelatine inoculated from these often failed to show any growth, but in two cases I succeeded in cultivating it. The needle track showed a straight greyish growth, but there was small surface extension. There was very little tendency to liquefaction, though the gelatine seemed to be moister than at first and bubbles of gas formed in the needle track. Tubes of gelatine inoculated from the vomited matter itself soon liquefied completely, owing probably to the presence of the bacillus subtilis.

I am sorry I have no slides of these bacilli to show you; but I sent what I had to a gentleman to examine and describe for me and he has unfortunately lost them. Suffice it to say that its appearance as obtained from the Pasteur's fluid closely resembled that of the *clostridium butyricum* as figured and described by Prazmowski. The points of resemblance were the size of the rods, the presence of spores in the ends of some of them, and also the fact that great numbers of elliptical spore-bearing bodies were amongst them, such as are well described and figured by that author. They also stained slightly with iodine, which is one of the characteristics of the *clostridium butyricum*. The bacilli further resembled the butyric ferment in fermenting freely

in the absence of air, as in a flask filled with Pasteur's fluid. But though thus closely resembling the butyric bacillus in appearance, there were some points of difference. One was their growth in gelatine. This was evidently a bad medium; only two out of several inoculations were successful, and, when successful, only a moistening, not liquefaction, took place. A second is the formation of spores in the rods when grown freely in air on the potato.

As previously mentioned, no butyric acid was formed in the Pasteur's fluid; and in a subsequent experiment, in which sterilised skim milk was, after inoculation, kept fermenting actively for twelve days, no butyric acid was detected by the smell and none was obtained on distillation, the acid developed being lactic acid only, yet the quantity of inflammable gas given off was very considerable. The gas was not analysed, but on ignition it burned with a pure blue flame, and in all probability consisted of H with CO₂. Present notions of the butyric fermentation, by which the development of CO₂ and H are accounted for by the splitting up of two atoms of lactic acid (C₃H₅O₃) into one of butyric acid with the development of two atoms of CO₂ and four of H, would necessitate the presence of sufficient quantities of butyric acid to be easily detected by the smell and chemically isolated, yet both the milk and Pasteur's fluid contained practically nothing but lactic acid, though large quantities of gas had been evolved. Of course these differences may depend a good deal on the method and conditions of the fermentation. When potato paste (2 ounces in 8 ounces of water) was inoculated directly from the matter obtained from the stomach, inflammable gas formed freely. The total acidity reached 6.24 grammes of NaHO per litre, and of this 4.28 grammes were due to lactic acid, the rest to butyric, from which the lime salt and the acid itself were obtained pure.

Another curious point about the fermentation is the very highly acid medium in which it took place. For instance, vomited matter, the acidity of which was carefully tested and found to be equal to 3.4 grammes of NaHO per litre, fermented freely when kept at a suitable temperature. The quantity of free HCl in this was ascertained both by ordinary methods of analysis and by adding definite quantities of the filtered vomit to a standard methyl blue solution, and comparing the colour change produced with that of the same solution to which different quantities of diluted HCl had been added. It has been shown conclusively by Klemperer, as had been previously pointed out by Ewald and myself, that methyl violet is not affected by acid albumen, but only by free hydrochloric acid, and as no other agent existed in the gastric juice likely to produce any colour change, any difference produced may fairly be attributed to free HCl present. In both of these ways the free acid was estimated at between 2 and 3 per mille, that is, it exceeded that of normal gastric juice, yet the fermentation proceeded in the fluid with great activity until the acidity reached 4.33 grammes of NaHO per litre. Now butyric fermentation is said in the textbooks only to take place in a feebly acid or neutral medium, yet here we have a fermentation proceeding actively in a medium which is not only highly acid, but the acidity due to one of the most powerful antiseptic agents—free hydrochloric acid. Of course this may be accounted for to a great extent by the quantity of ferment present relatively to the quantity of acid. It is evident that a stomach containing immense numbers of bacteria may set up and carry on effectively a fermentation which under other conditions would be impossible; but there remains still here matter worthy of further investigation by others whose time and means are better fitted for it than mine. I am inclined to think from the results of my investigations that this bacillus, though in many points closely resembling the clostridium butyricum, is not identical with it. Milk mixed with equal parts of 0.4 per cent. of HCl and inoculated with 1 drachm of vomit fermented freely; but, on testing, the milk gave no reaction with methyl violet, showing that the acid was not free, but combined with the albumen of the milk. Potato paste, 2 ounces mixed with 6 ounces of 0.2 per cent. HCl solution, failed to ferment, probably owing to the quantity of albumen present being too small to give sufficient nutritive pabulum for the growth of the organism. When the acidity of some vomited matter which fermented freely was raised from 2.7 grammes of HCl per litre, by the addition of a solution of 0.4 HCl to a little higher stage, the fermentation was completely stopped, though the microscope showed that the fluid still swarmed with active bacilli.

These facts show that this bacillus can grow in gastric juice of normal acidity and even in hyperacid juice. When present in

very large quantity it is evident therefore that it is not the acid of the gastric juice which prevents its development in the stomach in normal digestion. Most probably, as with the common yeast, the reason of its non-development in the normal stomach is that the food is rapidly got rid of before fermentation has time to take place. When, however, owing to stricture of the pylorus, starchy and saccharine matters are constantly retained in the organ, fermentation becomes possible, though secretion be normal. The remedy is to remove the residual contents of the stomach at least once a day, and to wash out freely with antiseptic agents such as I have suggested, whilst carefully regulating the diet and restricting it to such substances as pass most easily out of the stomach, and are least liable to fermentation.

In conclusion, I should just like to point out how desirable it is that a fermentation test should be added to those already in use in investigating cases of stomach disease. Almost all the symptoms of dyspepsia, such as flatulency, acidity, etc., have been hitherto chiefly accounted for by fermentation, but it does not seem to have occurred to anyone how easy it is to put that to experimental proof. If the food after a stay of four hours be removed from the stomach by a tube, previously well washed or steeped in carbolic lotion, into a sterilised flask of suitable capacity, and the latter be connected by means of an india-rubber cork and bent glass tube with a bottle full of water or mercury standing in a basin, it is easy by keeping this on the top of an oven or in a warm chamber, to see whether any gas is evolved. The acidity of the fluid may be tested at the beginning of the experiment, and at the end to determine whether any increase has taken place. In this way the presence or absence of such ferments as give rise to flatulency or acidity may readily be determined. If no gas be developed in twelve hours, the absence of such a quantity of ferment as will produce flatulency in the stomach may be regarded as certain, and if the rise in acidity be slight, or none at all have taken place, fermentation acids as a cause of the symptoms may be safely excluded. It is much easier to prove the absence of gas-producing ferments in this manner than by gelatine cultivations, and such a simple test can be easily used in every doubtful case. It has the advantage over microscopical examinations of giving more easily appreciated and conclusive evidence. There is always a good deal of doubt about the presence of yeast in small quantity when it is mixed, as it usually is, in the contents of the stomach, with all kinds of cells derived from the mucous lining of the stomach and upper parts of the alimentary tract, and with the various remains of partially digested food. Twelve hours' cultivation will serve to develop yeast cells to such an extent as to make a mistake impossible, and the same may be said of micro-organisms. A fermentation test will also show conclusively whether these are gas producers or simply belong to the different innocent forms usually found in the stomach. I have often employed this method, but without taking up too much of your time, I can only here say that it is remarkable in how few cases any gas is evolved.

THE ETIOLOGY OF RHEUMATIC FEVER, AND AN EXPLANATION OF ITS RELATIONS TO OTHER DISEASES.

By B. N. DALTON, M.D. LOND.

THE consideration of certain cases of rheumatic fever which had been under my care led me, some months ago, to form the opinion that this disease might be caused by breathing air contaminated by the emanations from sewers and drains.

Until I read in the JOURNAL of September 14th the report of the recent discussion on the relations of tonsillitis to rheumatism, I was not aware that this opinion was held by anyone else, and the evidence which I could adduce not being adequate to conclusively establish its truth, I had intended to seek for further proof before bringing the matter forward.

The statement made by Dr. Haig-Brown, in the discussion referred to, that the annual percentage of cases of rheumatism amongst the inmates of a large institution had been reduced from 4 per cent. to 1 per cent. of all cases of illness by improvement in the drainage, was so strongly confirmatory of my view, which I found he also held, that I began to write the present paper. Whilst writing it I have obtained so much further evidence in