The Examination of the Faeces.
Macroscopic, Microscopic, and Bacteriological.

Thesis offered for the Degree of Doctor of Medicine

by

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The Examination of the Fæces.

The term "Fæces" is, in its strictest sense, applied only to that part of the food which remains undigested and unabsorbed during its passage through the alimentary tract, and is discharged from the bowel through the anus. In this thesis it will, however, be used in its more general signification, custom having led to the word being regarded as synonymous with "intestinal excrement," which includes, in addition to the remains of the food, a part, though not a large one, of the secretions of the intestines and their tributary glands, and in disease yet other constituents.

In pursuing the study of the subject taken for this thesis, it is impossible for one to avoid noticing how little is known of it at the present day, and how meagre

is the literature treating of it, considering the importance of results which might be looked for as a consequence of an intimate knowledge of the normal and morbid conditions of material which forms the waste products of the working of the digestive and absorptive apparatus of the body. The Urine, the only other collection of effete products presented in a form suitable for clinical examination, is examined both physically and chemically almost as a matter of routine, and when any excretion from the respiratory organs does exist in the form of Sputum, that is also subjected to close observation. Granting that the urine certainly does contain products from a range far wider than that from which the constituents of the faeces are derived, and offers the possibility of the discovery of deranged processes in any of several systems of the body; also, that in the case of the sputum we have always to deal with a pathological product, there can still be no doubt that if the examination of the faeces received a share of atten-

tion proportionate to the value of possible results, it would not be so neglected as at present in either hospital or general practice. This neglect does little credit to the medical profession, especially when we find that the reasons offered for it are invariably, that the subject is an unattractive or a disagreable one, rather excuses which are the outcome of the faulty sentiment of conventional opinion than solid reasons given by those seeking for whatever information it is possible to obtain, which may prove of use in aiding to cure disease or alleviate suffering.

The discomfort attending investigation of the physical and microscopic characters of feces is much less than is generally supposed. Apart from sentiment, the odour is the only disagreable feature met with, and this can be prevented by the use of simple precautions such as are adopted at the London Hospital,[1] where the stools are placed in large deep conical vessels, the mouths of which are covered with a thick glass

1. Ralfe. Clinical Chemistry. p 223.

plate. Even such precautions are as a rule necessary only when the stools are loose, and then a little ether sprinkled on the surface renders the method still more effective.

When firm faecal masses must be broken down in order to allow a more perfect examination, this is done usually by agitation in water, and it is worthy of mention that cold water only should be used for the purpose. The use of hot water may facilitate the process, but, according to my experience, produces a penetrating stench which is indeed intolerable. In microscopic examinations I have always placed a ring of Canada Balsam around the edges of the cover glasses before proceeding to examine the preparations, and if due care be taken in making these, no discomfort should arise from the presence of any faecal odour.

I will mention during the course of this thesis some observations of my own. The greater part of it, however, consists in a compilation from English and German

literature, most of the matter being gleaned from scattered articles in medical journals. Almost the only English author who has attempted an at all extensive treatment of the subject is Marcet[1], and his work, published in the form of lectures, belongs to the time of thirty years ago.

In Germany also, with the exception of isolated papers, the literature, although more copious than the English, belongs chiefly to the middle twenty years of this century, — Frerichs[2], Lehmann[3], and Lambdl[4] being the chief writers. Of more recent authors Rothnagel[5] is the most prominent. During the last few years considerable attention has been drawn to the subject of microorganisms in their relation to the intestinal contents, and on it several German workers are at present engaged. Hitherto the results of the work of these have been somewhat conflicting, and it can indeed not escape notice in comparing the assertions of earlier and later authors on

① Medical Times and Gazette. 1858. Vol 2.
② Wagner's Handwörterbuch der Physiologie. 1846
③ Mikroscopische & chemie Untersuch. der Fäces Gesund Mensch. 1852.
④ Prager Vierteljahrsschrift. 1859. Bd I.
⑤ Beiträge zur Phys & Path des Darmes 1884.

other departments of the physiology and pathology of faces, how many of the conditions formerly described as physiological are now considered pathological, and how many rules laid down to guide diagnosis, and how many assertions as to facts, have later been found valueless or of only qualified application.

During the last two years I have taken advantage of all my opportunities to examine stools where the ~~possibility~~ of finding pathological changes existed; also many others which were presumably normal. Most of my observations were made in connection with patients in the wards of the Edinburgh Royal Infirmary, under my own charge while I was Resident-Physician there, or under that of friends who kindly assisted me in obtaining material. In the case of fœtuses or infants, material was obtained through the kindness of Resident-Surgeons at the Royal Maternity Hospital and others. Through the kindness of Drs Woodhead and Bruce, I was enabled to examine the

intestinal contents from many cadavera submitted to them for post-mortem examination in the Pathological department of the Infirmary, and to carry on some work with regard to the microorganisms of the intestinal tract.

The subject matter which follows is arranged into three divisions: —

I. The general characters of Faeces, i.e. Amount, Physical Characters and Reaction.

II. The different Constituents of Faeces.

III. A special consideration of the Vegetable Microorganisms found in the Faeces.

The Chemistry of Faeces will not be entered into, except so far as is necessary for the explanation of other characters.

The General Characters of Faeces.

Amount. The amount of the faeces is, in health, determined by the quantity and kind of food taken and has no definite relation to the size or weight of the body. According to most authors, the average amount of faeces excreted daily by an average adult individual is about four or five ounces, but such an average is of little value when taken as a standard of comparison, since one person will differ much from another in regard to the quantity of his dejecta, according to the habits of each, and even the same man may vary considerably when placed on different diets. Certain parts of an ordinary mixed diet, comprising both animal and vegetable structures, are indigestible and must therefore pass into the faeces. Theoretically, in one in whom the digestive functions are properly performed, who takes his food in a suitable form, and who is careful to take no more than he requires, it is these indigestible parts alone which should be found in the dejections. As a matter of fact, however,

such a condition is never found to exist.

Careful observation shews that in all faces undigested although digestible material is present, and it must therefore be allowed that in the healthy it is usual either for more food than is necessary to be eaten, or that what is taken is not properly prepared by mastication or otherwise.

The amount of faces is comparatively greater, the more the food is composed of vegetable material, and probably it is partly on this account that in children the quantity is relatively more than in adults, allowance being made also for the greater consumptive inclinations of the young.

The number of stools passed in a day has not necessarily any connection with increased amount of faces. In some forms of disease, eg dysentery, although the number of stools may be great, the total amount of the material contained in them may be less than under normal conditions of frequency.

In disease, the amount of the faces may be increased while the amount of the food remains the same, owing to a

decreased activity of the digestive apparatus and in such cases the absolute amount of solids contained in them would also be increased. In other cases the increased amount may arise from decreased absorption of the food, such as may be caused either by structural alteration of the intestinal walls — atrophy, catarrh &c — or through increased peristalsis of the bowels by which their contents are hurried along them and insufficient time given for the process of absorption to be completed. In such cases, while both solid and liquid constituents are absolutely increased, the amount of liquid in them is relatively greater and the consistence of the stools softer. Yet another cause of increased amount is to be found in the presence of abnormal secretions or exudations, or of other abnormal ingredients such as blood, pus, the fluid from ruptured cysts &c. In all of these cases, also, the relative amount of fluid constituents is increased. In cholera this occurs to such an extent that only a few grains of solid matter

may be found in many ounces of the liquid evacuations.

Consistence and Form. The normal consistence of the faces of one beyond the age of infancy, is sufficiently firm to give a definite cylindrical form to each evacuation. The surface is moist and granular and the mass except towards either end is of uniform thickness. The presence of grooving, if this is longitudinal is a sign of some projection into the lumen of the rectum such as haemorrhoids, a polypus, or an enlarged prostatic gland. A certain flattened appearance accompanying the discharge of small lumpy masses has by some been considered sure evidence of stenosis in the lower portion of the large intestine due most usually to cancerous growth.(1) The correctness of this opinion is however extremely doubtful, as cases in which similar appearances have been present have been shewn by a post mortem examination to be free from stenosis of any sort.(2) If a

(1). W. Kenzie. Brit. Med Journal 1880. May 15.
(2). Rothmayer. Beiträge zur Phys & Path des Darmes. S. 78.

grooving is present & such as to divide the mass transversely into segments it is an accompaniment of increased consistence. In all probability several smaller masses have been formed in the colon and joined by pressure in its lowest part or in the rectum. A greater degree of the same condition is that in which the stool consists of several small, hard and somewhat rounded masses resembling the dung of sheep.

The consistence depends on the proportion of liquid in the faeces and is, to some extent, influenced by the nature of the food. It has been shewn[1] that an average mixed diet gives a proportion of 75% of water in the faeces, while with a purely flesh diet the proportion will range from 60-65%, and with a purely vegetable diet it may reach 85%. Where the residue of the food in the faeces consists of soft material such as the pulp of fruits or vegetables, fats or oils, some influence is of course exerted on the con-

1. Mund:- Real-Encycloped der Gesammten Heilk 1886 p. 62-67.

sistence of the evacuations. The amount of water taken by the mouth has little or no influence on the amount found in the stools, being all absorbed. The popular remedy of a glass of water taken each morning where a tendency to constipation exists probably owes all the virtues it may possess to the promotion of intestinal peristalsis.

Many of the pathological variations in consistence are best explained by a reference to the state in which the intestinal contents are found in the different divisions of the gut. In the small intestine the processes of absorption and secretion are so proportioned that its contents retain their liquid form. That absorption of fluid does go on in the small intestine is proved by the occasional occurrence of solid accumulations in it. Below the ileo-cæcal valve, however, the absorption is largely in excess of the secretion, & as a consequence the nearer the sigmoid flexure is approached the more solid do the intestinal contents become. It

is apparent that the longer the time during which the contents of the bowels are in passing from the pylorus to the anus, the longer are the absorptive agencies permitted to exert their influence, and it has been estimated that in a healthy individual the passage of matter through the small intestine takes about three hours, while that along the large intestine is four times as prolonged.① Independently, therefore, of different absorptive powers of the mucous membrane of the two divisions of the intestine, it might be expected that a greater amount of absorption would take place from the large intestine. From what has already been said, it follows that one great cause of increased consistence of an evacuation might be a diminished rate of intestinal peristalsis, while on the other hand increased energy of peristalsis tends to the production of looser stools. Increased peristalsis of the small intestine alone, will rarely cause the dejections to be loose

① Landois & Stirling. Vol I. p 334.

place even in health the intestinal contents at the ileo-cæcal valve are quite liquid and rendered solid by the absorptive action of the large bowel. Clinical evidence of this fact is afforded by the occurrence of griping pains and other sensations of increased intestinal movement, while the presence of an increased proportion of undigested food in the evacuations bears witness to a rapid transit through the alimentary canal, and yet the consistence of the feces is not less than usual. The soft consistence of the feces of infants is explained in part by the nature of their food, in part by its more rapid passage through the intestinal tract. There are other causes of lessened absorption in addition to increased peristalsis, and among them structural changes such as occur in catarrhal conditions, in atrophy of the mucous membrane and in extensive ulceration. It may be due, also, to obstruction in the course of the lymph stream from the intestine, either

from disease of the mesenteric glands, obstruction of the thoracic duct or disease of the heart or lungs leading to a retardation of the lymphatic as well as of the venous circulation.

Instead of through decreased absorption of fluid, the stools may become loose through abnormal entrance of fluid into the bowels, the most marked examples of this being Cholera-Asiatica and Cholera infantum. Various explanations of this exudation of fluid have been offered but none is satisfactory. A less degree of exudation may occur in disease of the heart, lungs, or liver where a so called backward pressure is exerted on the portal venous system. In catarrh of the intestinal mucous membrane, in addition to the increased secretion of water, the increased amount of mucus helps to cause a softer consistence of the feces, and to this fact is due in great part the happy condition of the stools in catarrh limited to the small intestine. Stille

other causes of loose stools are the discharge into the alimentary tract of large quantities of abnormal fluids such as the contents of ovarian or hydatid cysts or of large abscesses, or a profuse hemorrhage.

Colour of Faeces. The colour of human faeces is in the healthy adult usually a rich dark brown, but even in health it varies within considerable limits, depending on the food taken.

The brown colour is due to a pigment, the same as the chief one in the urine — hydrobilirubin or urobilin — and which is derived from the pigments of the bile by a process of reduction[1] resulting from the action of an organic agent. In the intestine of the foetus this organism is not present and consequently the pigment of the meconium is that of the bile, in the form of biliverdin. For the first few days of extrauterine life, hydrobilirubin is not to be found, but with the

[1] Landois & Stirling. Vol I. p. 382.

other products of decomposition it shortly appears, at first along with unaltered bile pigments and later entirely replacing them.[1] Why the bile pigments are not more speedily replaced by it after the introduction of decomposing agents into the child's intestinal tract, might be explained by a gradually changing composition of the digestive juices, these being at first such as to prevent the organisms from exerting their peculiar action. This gradual change in the digestive juices has, however, not as yet been proved to occur, and meantime a more probable explanation is to be found in the quicker transit of the intestinal contents through the alimentary tract of the suckling than through that of an older individual.[2] In experiments conducted in starved animals, in whom the faeces must be entirely composed of material proceeding from the secretions of the alimentary tract

1. Vierordt. Physiol des Kindesalters, in Gerhardt's Handbuch.
2. Senator. Zeitschrift für Phys Chemie. Bd IV. p 7.

Hoppe-Seyler & Müller found that in them hydrobilirubin was absent or at any rate was much decreased in amount, and was replaced by biliverdin, presumably from the want of suitable nutritive matter for the ~~requisite~~ organisms requisite for the production of the former. (1)

The pigment, hydrobilirubin, is contained partly in solution in the intestinal fluids; partly it stains certain solid constituents of the faeces, among them most noticeably muscular fibres and the amorphous detritus which consists of certain salts of lime and magnesia and of remains of the food. The vegetable constituents are less readily stained.

In pathological conditions the presence in certain constituents of abnormal pigment as tested micro-chemically may be an aid in diagnosis. (2)

Faeces exposed to the air become darker in colour, and a similar result follows their long retention in the large

(1). Müller. Zeitschrift für Biologie 1884. p 339

(2). See under "Epithelium" - p.

intestine, as is to be observed in cases of constipation.

The influence of food in altering the colour of faeces is due to the introduction with it of what may be called accidental pigments. A flesh diet causes the colour to be darker, due probably in great part to the undecomposed haematin in the undigested muscular fibres①. Where a large residue of white or light coloured food material such as milk, fats &c passes into the faeces, a notable difference in shade of colour is caused. Hence the yellow or light brown stools of healthy infants or young children, and of invalids limited to a milk or farinaceous diet. Vegetables containing much chlorophyll cause a brownish green hue, and similarly many common articles of diet, of which claret and coffee may be mentioned as examples, give a peculiar colour to the faeces from the presence of their unchanged pigments. Many medicinal substances

① Müller. Zeitschrift für Biologie. 1884 pp 340-341.

such as rhubarb saffron, haematoxylin, and charcoal have a similar effect, whilst others, such as iron and bismuth, cause a special change of colour by the chemical action on them of some of the constituents of the intestinal contents and the formation of coloured compounds. In the case of iron a black and in the case of bismuth a greenish black discoloration is produced. Observations I have recently made with regard to bismuth shew that it is present in the feces in the form of dark crystals.① The green stools following the use of calomel are explained by its antiputrefactive influence, and the consequent discharge of bile-pigment unaltered as biliverdin.② In disease alterations in the colour of the stools may be caused by the diminution or absence of the normal pigment, or by the presence of abnormal pigment. Feces, like the urine are

① . See page 73.

② Buchheim. Quoted by Lauder Brunton, "Pharmacology. Ther & Mat Med" p. 615

paler in states of the system such as anaemia and rickets where the amount of pigment in the blood is lessened, a fact accounted for by the origin of the hydrobilirubin from the bile pigments and, therefore, ultimately from the blood pigments. A lessening of the secretion of the bile such as occurs in some cases of chronic hepatic disease, naturally results in a less formation of faecal pigment and in a lighter coloration of the stools, but of far more importance than such partial alteration in colour is such as is caused by obstruction of the common bile duct. The bile can then not enter the intestinal tract and in consequence, whatever pigment is found in its contents must proceed from the food or from the digestive juices other than the bile. It has been asserted [1] that in cases of obstructive jaundice the intestinal secretions are, like the other secretions

1. Allchin. Quain's Dict of Med. Article "Feces".

of the body stained with biliary pigment and in some cases to such a degree that a distinct tinge of colour is imparted to the faces. Most usually at any rate, any such tinge is absent, the faces being of a peculiar ash-grey or clayey colour and no trace of bile pigment can be obtained even by chemical tests. Cases of stools without pigment have occasionally been met with where there was no jaundice and no further reason to suspect obstruction of the bile ducts. Albrini[1] mentions such a case where the post-mortem examination shewed that faces, normally coloured in the greater part of the small intestine, were deprived of their pigment in passing over a diseased portion of the lower end of the ileum. Other cases are mentioned by Gebhardt and Bamberger[2] in which no satisfactory explanation

(1). Quain's Dict of Med.

(2). Quoted by Nothnagel. Beiträge zur Phys und Path des Darmes. p. 129 ff.

was forthcoming. Nothnagel[1] records cases where clayey stools were unaccompanied by jaundice and were apparently due to temporary obstruction of the common bile duct.

Abnormal pigmentation, excluding such as may be derived from food or medicine, proceeds almost exclusively from the presence of unaltered bile pigments or of blood in the stools. Unaltered bile pigments are not found in normal dejections, except in very young children. In the adult the application of Gmelin's test for bile pigments, in examining the intestinal contents, is negative below the cæcal valve, although in the ileum except in its lowest part a decided reaction is to be obtained.[2] If, then, unaltered bile pigments are found in the feces, it is apparent that some morbid condition is present in the small intestine preven-

(1) Beiträge zur Phys. & Path. des Darmes. p. 129

(2). Ibid. p. 156.

ting their conversion into hydrobilirubin. The most usual cause of this prevention is increased peristalsis such as is met with in intestinal inflammation of different degrees, or in some cases of ulceration, time thus not being allowed for the necessary chemical change. A recent observation (1) of Nothnagel shews, however, that although bile pigments may in some cases be found in the ascending colon, yet, if the large intestine is healthy, they will not be found in the stools. It may, therefore, be concluded that when unaltered bile pigments are found in the faeces of an adult there exists a morbid condition in at any rate a portion of both small and large intestines, those cases being of course excluded where its presence results from the use of calomel or other medicine. In certain cases of diarrhoea the stools are coloured a bright green and although various theories have been

(1). Beiträge zur Phys. & Path. des Darmes. p. 67.

advanced to account for them, there seems to be little doubt that they are due to the action of the strongly acid secretions of the diseased intestinal mucous membrane on bile pigments which have had no time in which to be acted upon by putrefactive agents. The pigment present in such cases is biliverdin.

In some instances the stools are not green when passed but become so on standing, perhaps in many cases through the action of the strongly acid urine which so frequently accompanies diarrhoea.

The discoloration of faeces through blood will be better discussed along with the other changes in the faeces resulting from haemorrhage into the alimentary tract.

Odour. The meconium is without odour. The odour of the faeces of suckling resembles very greatly that of sour milk and depends in great part on lactic fermentation of the food residue. In older individuals, also, the food affects the odour to some extent, but the

peculiar characteristic faecal odour is quite distinct. It results from the decomposition of albuminous material and is due to an unknown body, which has so great an affinity for indol and skatol that, until these were isolated and found to be themselves odourless, the faecal odour was ascribed to them.[1] Besides its natural production in the intestinal tract, it is formed during the putting of pancreatic tissue,[2] and also when caustic potash is heated in contact with albumen.[3] This peculiar substance is not present in the faeces until a mixed diet has been taken. It is not yet explained why it is absent from the faeces of sucklings, although the observations of Bienstock[4] throw some light upon the question. The micro organism described by him as the bacillus of albumen decomposition (Eiweiss-fäulniss

(1). Landois & Stirling. Text book of Phys. p. 402.
(2). Professor Rutherford's Lectures. 1882-83.
(3). Zeitschrift für Phys Chemie. Bd IV. p 371.
(4). Zeitschrift für Klin Med Bd VIII p 20

and which was found to cause a faecal smell when peptones and flesh-extract were infected with it, is not found in the faeces of sucklings.

The odour of the faeces differs in degree in healthy individuals. In some it is hardly noticeable, in others and in the same individual at different times it is strong and markedly disagreable. It is stronger on a flesh diet than on a vegetable diet. The peculiarly faecal smell is naturally lessened by the discharge of copious diarrhoeic stools, and in cholera it is not noticeable at all.①

In addition to the substance causing the characteristic faecal odour, the smell from faeces depends on volatile fatty acids,② the secretions of the large intestines,③ sulphuretted hydrogen if this is present,④ and on the diet, as some articles of food or medicine, such as beer and cod-liver oil, give a decided odour of their own.

① Eichorst. Phys. Untersuchungs Meth. Innere Krankh. p 239
② Landois and Stirling. p 405
③ Albelon Quain's Dict of Medicine. Art "Faeces"

In certain diseases such as typhoid fever and dysentery it is asserted that experience may lead to the acquiring of a power of diagnosis through the odour arising from the faeces.① although, perhaps, a rapid means of diagnosis it can hardly be regarded as reliable.

In some cases of ulceration in the intestine especially in many of dysentery, the odour is putrid. In obstructive jaundice and in chronic intestinal catarrh, the intensely disagreable odour which sometimes results is due to increased fermentative decomposition of fatty matter.

Reaction. The chemical reaction of faeces is most usually acid. The acidity depends on the acid fermentation of carbohydrates and the formation of acids as products of putrefaction in the large intestine②, and is therefore influenced by the food. When the food consists especially of vegetable matter or fats the acidity is greater

① Ralfe. Clin. Chemistry p 221.

② Landois and Stirling. p 405

than on a more purely flesh diet.

The contents of the stomach are acid but after entering the duodenum, the addition of the strongly alkaline[1] pancreatic juice renders them alkaline; the bile is neutral[1] and the intestinal juices alkaline[1] so that the reaction continues alkaline till below the ileo-cæcal valve, where the acid fermentation going on from the presence of microorganisms seems to be more than sufficient to counterbalance the alkalinity of the intestinal juice and as a rule that also of the material coming from the higher part of the bowels. A neutral or alkaline reaction of the faeces must not, however, be regarded as a necessarily abnormal condition. Indeed, it is only by considering that the constant presence in the intestinal tract of the microorganisms which give rise to the formation of acid entitles them to be regarded as normal constituents of the faeces, that we are able to assert the possibility of a normal

(1). Landois and Sterling. pp. 361. 399. 395.

acid reaction. In the meconium, however, even before the birth of the child, and so where the possibility of acid fermentation is excluded, the reaction is acid, and this must be explained on other grounds. It must, however, be remembered that in the fetus the condition of the secretions into the intestinal canal are not as in later life. The activity of the pancreas has hardly begun at birth and is not well established till about the fourth month of extra-uterine life or later, while the gastric juice is well secreted from the beginning of the fourth month of intrauterine life. ① In the suckling the smaller amount of pancreatic juice and the kind of food must have a considerable tendency in determining the sort and strength of the reaction.

In Pathological states in the adult, when the pancreatic juice is decreased or absent, an increase of acidity is often well marked and so

① O. Langendorf. Du Bois Raymond's archiv für Physiologie 1879.

due not only directly to the absence of the alkaline juice, but also indirectly, since in such cases the digestion of carbohydrates and the absorption of fats and fatty acids is affected, and the increase of their unabsorbed residue increases also the material capable of undergoing fermentative changes. Increased acidity resulting from obstruction to the flow of bile into the intestine is similarly explained by the increase of fermentable matter, and perhaps to some extent by the absence of a retarding influence the bile may exert on organised ferments.

In diarrhœa the reaction of the evacuations is usually alkaline unless acid fermentation be a marked accompaniment of the condition as is occasionally the case, especially in children. In ordinary cases the acid fermentation is lessened by the rapid transit of the faces through the large intestine. Where the intestinal secretion is much increased

it acts in the retention of the alkaline reaction, and so perhaps does sometimes the exudation of serum from ulcerated surfaces. In cases of dysentery the ammonia generated by putrid decomposition may render the stools alkaline.

The Constituents of Faeces.

Having now considered the more general characters of faeces, we proceed to turn our attention to what may be learnt by macroscopic and microscopic examination of their composition. It will be necessary to regard not only the mere fact of the presence of certain substances, but also the form and amount in which they ~~are~~ present themselves, and the relation which the individual constituents bear to each other, for, as we shall see, it is not only by the presence of abnormal constituents that indications of morbid states are given. Normal constituents may be present in abnormal quantity, and their amount mark

the degree of derangement of function, while the form in which they are found and the relation of the different constituents to each aid in determining the part of the alimentary tract which is diseased.

Probably the most valuable help to localisation of disorder is a determination whether abnormal constituents arising from the alimentary canal itself are intimately mixed with the food residue, or are distinct from it, or associated merely with the outer part of the dejections. As a rule, it may, in the first condition, be decided that they proceed from disease of the small intestine, in the other conditions from the colon or rectum. While certain materials, for example mucus and epithelium, (i.e. epithelium detached from the intestinal wall), are readily stained by the bile pigments, they are less easily affected by the faecal pigment, and hence some evidence as to their origin may be obtained, for it is clear that if they are pigmented and at the same time there is no reason to suspect

the presence of bile pigment in parts of the intestine in which it is not usually found, the evidence is in favour of them having proceeded from the small intestine.

A mere inspection often yields valuable results by revealing the presence of matter in masses of comparatively large size or in large amount, whether undigested food, cast off tissues, blood, mucus, parasites or foreign bodies. When, however, any of these is suspected to be present and the obtaining of negative ~~evidence~~ is of value, or to render any examination complete, further measures are necessary. The faeces must be washed in water (1) in order to separate the ingredients from each other and the whole must then be passed through a fine sieve of some sort. A more thorough examination can thus be made of the coarser ingredients.

Although much information may be gained in this way at times, the use of the microscope gives a means of acquiring far more, since many of

(1) : See page 4.

the substances found are imperceptible to the naked eye, or perceptible only when present in large quantities.

One method of obtaining material for microscopic preparations is to allow the water in which the faeces have been washed, and which contains the part of them which is fine enough to have passed through the sieve, to stand till a sediment has been formed. This is examined after a given time and the supernatant fluid poured into another vessel to allow another sediment to subside. By repeating this process a series of preparations is obtained, in which substances of different specific gravities preponderate in the several preparations. For ordinary clinical work it will be found much more convenient to transfer directly to a cover-glass a small quantity of faecal matter, care being taken to avoid any of the grosser matter; this may then be diluted if necessary and mounted in distilled water or glycerine.

It is often necessary to have at hand chemical reagents for the purpose of microchemical testing, e.g. nitric acid for bile pigment, osmic acid for fats, a solution of iodine and iodide of potassium for starch, &c; and it is well also to have solvents of fats for use in cases where these may be present in such amount as to conceal the other constituents.

Staining reagents are a useful aid in distinguishing epithelial structures or pus cells and to render micro-organisms more apparent. For the former purpose Szypdlowski[1] recommends a thin watery solution of eosin. I have found Bismark brown of more use, and for staining bacteria &c, an aniline solution of gentian violet.

The description of the various constituents of faeces might be proceeded with as they would be met with in the course of a clinical examination, first macroscopic and then microscopic. It will however avoid repetition if mention

(1). Quoted by Eichorst in "Phys. Untersuch. Methoden".

of the macroscopic and microscopic characters of the several constituents is combined and these discussed in the case of each along with the causes of its presence, and the aid in diagnosis afforded by finding it.

Food Constituents. The ordinary food of an individual may contain animal or vegetable tissues which it is impossible to digest and which must therefore enter into the composition of the feces. Even, however, where the food is entirely digestible, as is that of the breast fed child, it is usual to find that some of the digestible food stuff escapes digestion; and on a complex diet such as a healthy adult would take, there are to be found in the feces both indigestible and digestible-but-undigested remains of food. In states of perfect health, when excess of food is taken the amount of food residue is increased. Under diseased conditions the amount of the residue of all or only some of the food substances

usually found may be increased or part of the food not usually found may make their appearance. In the condition known as lientery the whole of the food may in a few minutes after it has been taken pass throughout the whole length of the alimentary tract and be evacuated in an entirely undigested condition, owing to a very much abnormally increased rate of peristaltic action of the walls of the stomach and intestines. In other cases the presence of undigested food is due to the want of proper secretion of the digestive juice, either alone or in conjunction with increased peristaltic action. Since the lower part of the alimentary tract serves chiefly for absorption of already digested food, the appearance of large quantities of undigested matter points to an implication of the upper part of the bowel or of the stomach. A rare condition with a similar composition of the faeces is that where a direct communication exists between the stomach

or the upper part of the small intestine and the colon.①

The method in which the food is prepared before it enters the stomach has an important influence on the amount passing without change through the alimentary canal. The process of cooking serves to procure chemical changes substituting a more digestible for a less digestible substance or softens cellular envelopes which would otherwise offer a resistance to the entrance of the digestive juices; and mastication serves to give the food a finer form and one therefore requiring a much less time to enable the completion of the action on it of the chemical and other agents in the alimentary tract. Hence the eating of raw vegetables and fruits and imperfect mastication must be recognised as important factors in increasing the amount of digestible matter in the stools

The food may not be excreted in the

① Richards. Phys. Untersuchungs Methoden Innerer Krankheiten p. 240.

same form in which it was taken. It is easily comprehensible that digestion may have occurred and the food have been transformed into a soluble form, but that, owing to an increased rate at which it is propelled along the lower part of the intestines, no time may have been allowed for its complete absorption during its transit. In other instances owing to chemical or other conditions the changed food may be met with in solid forms, the most usual of which are the cryptals of Magnesium soaps or the fatty cryptals so often met with where incomplete absorption of fat has taken place.

The recognition of an increased residue of food in the faeces has important clinical bearing. The kind of food in the residue may point to the organ at fault; it at any rate an indication for such a regulation of the diet or for the use of such substitutes for the digestive juices as will prevent the loading of the digestive apparatus with material which is indigestible under existing circumstances

and the giving of which can therefore serve no good end. It is not necessary for clinical purposes that a chemical estimation of the different food constituents should be made, although this is important for scientific ends where greater exactness is required. For ordinary purposes a naked eye examination may reveal all the information that is needed; — the use of the microscope will certainly do so.

Besides affording direct indications toward diagnosis and treatment, the examination of the food constituents present in the stools, may prove of considerable value in other ways. It is not infrequently found, even in the course of work in hospitals where the best supervision of the patients exists, that the latter manage to evade the carrying out of instructions given for the purpose of limiting their diet in certain directions.

My own experience has acquainted me with this fact and forced upon me the importance of examining the

stools in suspected cases. I remember in particular the case of a boy suffering from chronic intestinal disorder who had been placed upon a milk diet but without any good result. The suspicion of surreptitious feeding was disarmed by the patients apparent candour and truthfulness, and by the failure of all attempts at detection. To ensure certainly the stools were carefully examined as a last resource, and the discovery of grape skins and apple pips, and, under the microscope, of an abundance of muscular fibres, was sufficient to prove the deception, and to enable means to be taken for its further prevention.

It may appear trivial to refer to the examination of the stools as a means of gaining information as to whether medicine has not been given in an unsuitable form, but instances are not so extremely rare where chance has led to the detection of the fact that pills, especially if part of an old stock, were being passed in

the intestinal dejections unaltered by their passage through the alimentary tract. Perhaps of more importance would be an examination in cases where it is doubtful if the medicine prescribed has been taken, and where this, intentionally or otherwise, contained ingredients which would cause discoloration of the faces.

The presence of digestible constituents of the food visible to the naked eye and in masses of comparatively large size such as pieces of meat, fruit &c, indicates as a rule little more than imperfect mastication: if they are visible merely from the agglomeration of small particles as in milk, fat &c, it is evidence merely of abnormally increased amount being present.

It is advisable that certain food constituents normally or abnormally present should be considered individually.

Of indigestible animal structures taken in the food, the most commonly

met with are fibres of dense white connective tissue, and elastic fibres. More rarely are found fragments of bone or cartilage or horny epithelium.

Of digestible animal substances muscle and fat always appear when taken to at least some extent, unless the amount of each in the food is very limited.

Muscle is met with in the form of fragments of the fibres. These are distinguished microscopically very often by the distinct striation they exhibit, but this does not necessarily remain. According to the degree to which their digestion has advanced, the fibres may be little changed, may present signs of fatty degeneration and only indistinct striation, or may appear as somewhat translucent masses with rounded edges and no signs of a definite structure. They are always stained of a bright yellow or yellowish brown colour except in cases where no bile is entering the intestine, but even

them they retain enough of their own pigment to distinguish them from similarly shaped masses. The presence of much muscle in the stools where no excess of flesh diet is taken, shews a deficiency either of digestive juices or of their special albumen-digesting ferments.

Fats are present in the normal stools of adults in only small quantity. In sucklings they form the greater part of the stool. The quantity present depends of course in some cases on the amount taken in the food, and is increased under conditions which increase the amount of the food residue as a whole, such as fevers or other disease leading to a diminution of the secretions of the digestive juices, increased rate of intestinal peristalsis &c. There are however special morbid conditions in which, apart from any variation which may occur from the above causes, the amount of fat becomes increased. Bright (1)

(1) Eichorst. Phys Untersuchungs Methoden Innere Krankheiten p. 246

seems to have been the first to make diagnostic use of the presence of an abnormal quantity of fat in the faces, thinking it arose from a morbid condition of the small intestine. This idea was later abandoned, when Kuntzmann assigned pancreatic disease as a cause of excess of fat in the stools and Claud Bernard's experiments on the dog had proved without doubt that a prevention of the entrance of pancreatic juice into the intestine might occasion this condition.(1) Following this experimental proof, the opinion became current that the pancreas was the only organ engaged in the digestion of fat, and pathological states in which much fat was found in the stools were therefore all referred to disease of this gland. Kerichs(2) experiments, however, proved that digestion of fat might be completed while the entrance of pancreatic juice into the intestinal juice was prevented, although

(1) Ziemssens Handbuch der Spec Path & Ther. Bd VIII. p 218.

(2) Virchow's Handbuch der Spec Path & Ther. Bd VI. p 676.

there was no doubt that when present its action aided the process. This fact has been confirmed by combined clinical and post-mortem observations. It has in addition been shown that in the cases where the greatest amount of fat has been present in the faeces, both liver and pancreatic secretions were affected, and that in some cases where disease was confined to the liver, a copious amount of fat was stite to be met with in the evacuations.(1) It would therefore appear that the part which these two glands play in the digestion of fat is not constant in different individuals. In some an obstruction of the pancreatic duct may cause the passage of much fat in the faeces, in others the bile suffices to render all fit for absorption, and in yet others, while the pancreas is working healthily, a fault in the biliary secretion alone may lead to fatty dejections. Apart then from other symptoms, no definite diagnosis can be

(1) Zuissens Handbuch der Spec Path & Ther. pp 220-224.

~~can be~~ made as to whether excess of fat in the faeces is due to a derangement of the liver or of the pancreas, or of both of them.

Cases of pancreatic disease have occurred (1) in which it appears that fat was excreted from some part of the intestinal tract. These cases were characterised by great emaciation, and in spite of no cause proceeding from the composition of the food, large amounts of fat were ~~discharged~~ from the bowel. In some of the cases fat was at the same time found in the urine. Post-mortem examination shewed disease of the pancreas. It has been suggested that in such cases the function of the pancreas is interfered with, and the absorption of fat, thus prevented is compensated by the taking up by the blood of fat stored in the adipose tissue of the body. Following on this, the blood in some cases becomes lipæmic, and the superfluous fat in it

(1). Zimmer's Handbuch der Spec Path & Ther. p. 221 &c.

is secreted from the intestinal mucous membrane.

Fatty substances in the faeces may be either fatty acids, neutral fats or soaps. Chiefly the two latter are found. The lime and magnesia soaps formed in the intestine are insoluble and therefore not absorbed and pass on with the faeces, forming part of the granular detritus seen on a microscopic examination. The neutral fats may be present in any of several forms. When the amount of them is so great that they are visible to the naked eye, they may appear either as lumps of solid fat or as a solid or semisolid layer covering the stools. Occasionally almost the whole stool may consist of them. Microscopically they are in my experience most usually seen as small droplets,[1] and less often in crystalline form; groups of acicular crystals arranged in stellate or more globular form.

1. Nothnagel says the crystalline form is the more common. Beiträge zur Phys. & Path. des Darmes. p 92.

The crystals may be mistaken for tyrosin unless chemical tests are used.①

Casein is occasionally found in considerable quantity in the faeces of sucklings, but these normally consist chiefly of fat. When present casein may be in the form of small round bodies②, of a size varying from that of a pea to that of a pin's head. They are always stained yellow, but the inside of one of the larger lumps not so deeply as the outside.

Of the vegetable constituents of the food also, certain are entirely indigestible, eg. epithelial structures, hairs, vessels, and probably cellulose, although Szydlowski asserts otherwise with regard to it.③ These vegetable structures are to be met with in the faeces of any individual fed on an ordinary mixed diet, and are easily recognisable. The most commonly met with are the hairs derived from the husk of wheat or of

① Zeitschrift für Klin Med. 1885. p 379. Oesterlein.
② Nothnagel. Beiträge zur Phys + Path des Darms. p 94.
③ Quoted by Eichorst.

oats. They are seen microscopically as long, white, refractile and crystal like bodies, tapering to a point at one end, at the other slightly bulbed, and a dark line running in their long axis, and marking a hollow channel serves in cases of doubt to distinguish them. They vary in size but are occasionally large enough to stretch across the field of a microscope with an ordinary high power objective (Hartnack 7). They are, further, of interest as being the elements of which is composed one form of intestinal concretion, which is met with especially in the North of England and in Scotland where oatmeal is extensively used as an article of diet.(1)

Only young vegetables, tissues are capable of entire digestion, and the cellular envelopes of older tissues, elements serves to prevent the action of the digestive juices on their contents, if eaten raw.

Vegetable tissues are not so easily coloured by bile as are animal tissues

(1). Marcet. Medical Times & Gazette. 1858. Lect III.

but may, all the same, be pigmented, retaining during their passage through the alimentary tract their own peculiar pigments. That this is possible is clear from the colour which coffee gives to the faces, or from the greenish hue arising after much green vegetable matter has been eaten. The yellow colouring of vegetable tissue, which is that most commonly met with on microscopic examination is due to chlorophyll.

Starch is not a normal constituent of faeces under a mixed diet. The only form in which it is found, except when the starch digesting processes are deranged or excess of amylaceous food has been taken, is, enclosed within cellulose capsules in the cellular contents of some vegetable tissue. It is recognisable when in the form of granules, by the characteristic concentric lamination these show, or it may be necessary to use for its detection a chemical test, such as the addition of a solution of Iodine, which if starch be present, tinges it blue. Sometimes when prepara-

tions of Iodine are taken internally blue granules are to be met with on microscopic examination of the faeces.[1]

Constituents not arising from the food. The object of the different secretions poured out into the alimentary tract being chiefly the supply of chemical substances, which may by their action on the food change it into such a form as is suitable for absorption, it is not surprising that so little of them should be found in the faeces.

Part of the bile is excretory and this along with a small amount of mucus, makes up almost the sum of the intestinal secretion not reabsorbed before the lower end of the bowel is reached. The biliary matter which is contained in the faeces is chiefly in a state of solution and beyond the colouring matter little comes under notice in the course of their physical examination. There are frequently seen under the microscope and more especially in meconium or

(1). Eichorst. Phys. Untersuch. Methoden. Innere Krankheiten p. 226.

the faces of young children, small, deep red or orange bodies of irregular shape. I have often observed when using a high magnifying power that among these bodies some had a definite rhomboidal form, though in all other respects similar to those surrounding them. They are all no doubt formed of bilirubin in a solid form.

The presence of cholesterine in normal faces has long been a subject over which authors have differently expressed themselves. The views at present most generally held are that it probably occurs as a constant chemical constituent, but not in the adult in such a form as to be visible on microscopic examination. Marcet[1] failed to get any indication of its presence even chemically in the faces of adults, and considered that it became converted into excretine. He found that this latter substance was not present in the meconium or the faces of young children, but that from

1. Marcet. Medical Times & Gazette. 1858.

them cholesterine could be obtained. All authors quoting their own observations found cholesterine in the intestinal evacuations, excepting meconium, not at all, or only very rarely visible under microscopic examination. In all the cases I have examined I have never seen it. It is quite possible that one not accustomed to the appearances usually seen when faces are microscopically examined might mistake for it, some of the fragments of triple-phosphate crystals so frequently met with. It has however occasionally been observed; in one case in the false membrane of membranous enteritis[1], & in others forming part of intestinal concretions.[2] It is a constant constituent of Gall-stones.[3] Hoppe-Seyler found that like other constituents of the bile not present under ordinary conditions, it appeared in the faces of starved animals.[4]

Any pathological significance of its occurrence has yet to be discovered.

① Rothnagel. Beiträge zur Phys & Path des Darms. p. 185
② Eichorst. Phys. Untersuch. Methoden zum Krankheiten. p 242
③ Ralfe. Clinical Chemistry. p 250
④ Müller. Zeitschrift für Biologie 1884. p 338.

During and after an attack of biliary colic, the stools should always be examined for gall-stones, and the finding and inspection of these will aid in the formation of a prognosis. Biliary calculi are usually of a yellow colour and of soft consistence. They vary in size from mere grains, to stones as large as a pigeons egg, and are usually multiple. When more than one has been present in the gall bladder, they show smooth facets, where they have been lying in contact with each other. It is said that, when, following a severe attack of biliary colic, large calculi are passed without much pain, there is a suspicion that the stone has been liberated from the gall bladder by the formation of a fistula into the intestine. (1)

Gall-stones, occasionally consist almost entirely of cholesterine, but not frequently, and usually when the patient are young children. (2) The other constituents, in addition to some organic mat-

(1) Schüppel. Ziemssen's Handbuch der Spec Path & Ther. Bd VIII.

(2) Ralfe. Clinical Chemistry. p 250.

ter derived from the mucus of the bile, are chiefly various salts of lime ~~and magnesia~~, and often there is also some iron, copper or manganese. The more of these latter metals there is, the darker is the colour and the harder the consistence.

Mucus is always contained in faeces to some extent. It forms a large part of the meconium, but beyond the first few days of life it exists in the faeces, under normal conditions, in such a form as to be imperceptible either to the unaided eye or through the microscope. When it is visible, as is frequently the case, the condition must be regarded as pathological. Mucus may be met with in several forms, according to the process on which it depends, and the portion of the bowel from which it proceeds. When it merely covers formed masses of faeces, mucus has had its origin in the lower part of the intestine.

Its presence may be due merely to the retention of faeces for a long time in the rectum, and the consequent

irritation of the mucous membrane. Where, however, the amount is such as to excite special notice, a more serious cause is usually to be sought, such as inflammation in the large intestine. Mucous polypi of the rectum also occasion its presence.(1) In some cases of dysentery the motions may consist entirely of mucus.

Mucus may appear as a clear, viscid, material, or be turbid owing to the presence of epithelium or pus mixed with it, or be blood stained as in conditions of acute inflammation, intussusception, and some cases of dysentery. When it proceeds from the lower part of the intestine it is seldom bile stained.

Where the stools are loose, the mucus must be more or less mixed with the other faecal ingredients, and when it arises from the small intestine, more intimately so, than when from the lower part of the bowel. In some cases of intestinal catarrh only the

(1). Lancet. Nov 29th 1884.

small intestine or upper part of the large intestine is implicated, and the microscopic examination of the faeces is then of use to aid in diagnosis.[1] Externally the stool may present no abnormal appearance, but the microscope reveals numerous small masses of bile stained mucus. In some cases washing the stools may yield bile-stained sago-like bodies consisting of mucus.[2] They are not of frequent occurrence, and indeed, trustworthy observers[3] appear inclined to assert that fragments of soft vegetable matter have been mistaken for mucus in many of the cases in which the stools have been reported as containing these bodies.

The theory of Bamberger[4] who first described them was, that they showed a preponderating affection of the follicles of the large intestine. Heubner[5] said that they were formed by the

(1) Nothnagel. Beiträge zur Phys & Path des Darmes. p 93.
(2) " p 99.
(3) " pp 96. 97.
(4) Virchow's Handbuch der Spec Path & Ther. 1855. p 217
(5) Quoted by Nothnagel p. 241.

accumulation of mucus in the follicles (?) of the large intestine, and another suggestion[1] was that they arose from the Lieberkuhnian follicles in follicular enteritis. It is doubtful if any of these views is tenable

Occasionally chronic cases are met with, (so-called Membranous Enteritis), where pieces of false membrane are discharged from the bowel, sometimes in the form of casts of part of the intestine. An examination shews these casts to consist chiefly of mucus.[2] No special severity of disease seems to be indicated by their presence and no satisfactory explanation of their occurrence has been offered. It has been suggested[3] that inactivity of the bowel allows the accumulation of mucus in the folds of the intestinal walls, and that these accumulations are rolled together and formed into a continuous cylindrical membranous

(1). Kelch. Quoted by Nothnagel.
(2). Nothnagel. Beitrag zur Phys. & Path. des Darmes. p 184.
(3). Marchand. Quoted by Nothnagel p 189.

structure. One case is recorded[1] in which complete casts of the large intestine were passed, one of which measured thirty-three inches in length.

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The occurrence in the feces of any of the tissues of the body, including blood corpuscles and leucocytes, is evidence of the presence of a structural lesion.

Blood and pus are not infrequently met with, also epithelium, but it is only rarely that part of other tissues are found. Polypoid tumours either mucous or lipomatous[2] are occasionally detached from the wall of the intestine and passed in the stools, sometimes, also, pieces of carcinomatous tissue.[3]

Wunderlich[3] had a case where a piece as large as a walnut was discharged.

In intussusception large portions of necrosed bowel may be passed. One case is recorded[4] in which the evacuated portion was three metres long.

① Medical Times and Gazette. 1867. Vol 2 pp 47.486.

② Eichorst. Phys Untersuch Methoden Innere Krankheiten. p 242 &c.

③ Leube. in Ziemssen's Cyclopedia of the Practice of Medicine. Eng trans. 1877. Vol III. p 435

Shreds or large pieces of the mucus membrane are sometimes discharged, the especial disease in which this occurs being the malignant tropical form of dysentery. According to Nothnagel[1] shreds of tissue although found in the stools in cases of dysenteric ulceration are never found in cases of catarrhal, typhoid or tubercular ulcers. Allchin[2] however speaks of their occasional presence in the stools of patients suffering from typhoid fever.

Epithelium. Among older authors[3] it was almost universally accepted that a certain amount of epithelium was to be found in the healthy stools of an adult. More recent observations have, however, determined that its presence, (except in the meconium and perhaps in the feces of sucklings) is pathological. Woodward and Rzyndnoski,[4] indeed, have asserted that even in disease of the intestinal

(1). Beiträge zur Phys & Path des Darmes. p 242.
(2). Quain's Dictionary of Medicine. Article "Stools".
(3). Allchin in Quains Dict of Med. Leube in Ziemssens Cyclopedia of the practice of Medicine. Vol VII. p 369.
(4). Quoted by Nothnagel.

tract its presence is by no means frequent, although the researches of others[1] shew that it is usual to find it in inflammatory changes of the mucous membrane.

In the meconium are found both squamous and columnar epithelium, the latter coming from the epithelial lining of the intestine, the former from the cutaneous surface through detachment of cells into the liquor amnii and the subsequent swallowing of these by the foetus while yet in utero. Squamous epithelium is not found in the evacuations of sucklings or older individuals except on the surface of large hard masses discharged after a period of constipation, and which have, during their passage mechanically separated some of the cells of the stratified layers of squamous epithelium just within the anus.[2] Its presence possesses further importance only in so far as the finding of similar epithelial cells may in certain cases aid in the diagnosis

1. Rothmayer. "Beiträge zur Phys. & Path. des Darmes" p. 105

2. Ibid. p. 101.

of Carcinoma of the intestine. According to Vierordt[1], the faeces of sucklings contain almost always isolated remains of columnar epithelium. When present in the faeces of adults it is constantly accompanied by some mucus[2]. It may have proceeded from either small or large intestine, a point settled to some extent as in the case of other constituents of the faeces, by noticing its distribution in the stools. The cells are separated from each other except in cases where large amounts of fluid have been present in the intestines, as in Cholera asiatica, Cholera infantum and some cases of typhoid fever[3]. In such cases large masses of cells still attached to each other are found, similar to those seen in the intestine on examination after death. The error of supposing that these masses were frequently to be met with in faeces, as also that of supposing epithelium to be an ordinary constituent of them, probably arose from the result of

(1). Gebhardt. Handbuch der Kinderkrankheiten. "Phys des Kindesalters".

(2). }
(3). } Nothnagel. Beiträge zur Phys & Path des Darmes p 103.

post mortem examination of the intestinal contents. The epithelium separates from its basement membrane at a comparatively short time after death.

The epithelial cells in the faeces show various appearances according to the degree of degeneration they have undergone. They may be unaltered, but more usually have lost their striated borders, while their contents are cloudy and among these may be seen fat globules; or the cells may be noticed as wedge-shaped, homogeneous, somewhat refractile bodies, the nuclei being irrecognisable in proportion as the condition is more advanced.

Nothnagel, who describes[1] this as the most usual form in which epithelium is met with, ascribes its occurrence to the withdrawal of the water from the cells during their passage through the large intestine.

The epithelium is not as a rule much pigmented. When deeply stained, Gmelin's reaction is usually to be obtained, and other symptoms point to a catarrhal con-

[1]. Beiträge zur Phys. u Path. des Darmes. p 104.

dition of the small intestine - In some cases of dysentery the shedding of epithelium is so great that it gives to the mucous discharges an opalescent appearance, similar to such as might be caused by the presence of pus. Epithelium forms a considerable part of the masses of false membrane passed in certain forms of enteritis (1)

Blood. The occurrence of blood in the stools is always pathological and although in many cases the result of comparatively trivial changes, its presence may in others be a real cause of gravest anxiety.

The appearance of stools containing blood varies considerably according to its quantity, its source, and the time elapsing between the occurrence of the haemorrhage and the passage of the blood through the anus. At times the dejections may consist entirely of blood, as when an aneurism ruptures into the alimentary tract, or when a large vessel is eroded during the progress of an ulcerative process; at other times the amount of bleeding

(1) Marcet. Med Chirurg Trans. 1858 vol 2.

may be so small that the presence of blood is not to be detected by the naked eye.

Should sufficient time have been given the pigments of the blood in faeces will be found to have undergone chemical changes, being converted into hæmatine, or if a still more prolonged time is allowed a black sulphide of iron will have been formed. According to the degree of the chemical change, the colour of the blood may remain unchanged, may be of a dull reddish brown or of a black hue, the latter giving origin to the term "melæna", which is, however, now applied in a much more general sense. The colour of faces containing blood thus depending to some extent on the time allowed for chemical changes in the blood pigment, it is evident it may afford some aid in deciding from what part of the intestinal tract the hæmorrhage proceeds. To determine this point another consideration is also of great importance, especially if the faces are firm when discharged, viz. the relation in which the blood is found with the other constitu-

enti of the discharges. As low as the upper end of the colon the intestinal contents are fluid and blood poured into the gut mixes intimately with the residue of the food. &c. When, however, the blood is discharged into the lower part of the bowels, which contains faecal matter already in a firm or semisolid condition, it merely covers the outside of the material already there, while the innermost part of this contains no trace whatever of blood. Hence, in cases of haemorrhoids, polypi of the rectum, or other causes of haemorrhage into the lower part of the colon the faeces are covered with unchanged blood.

In cases, however, where the small intestine is the site of haemorrhage, the alkaline reaction of its contents being unfavorable to the rapid clotting of blood, this is found disseminated throughout the stool, and its colour too is more or less altered, except when the quantity of it is extremely large. When the haemorrhage is into the stomach, the changes in the blood pigment are still better marked

owing to a more rapid and complete action on blood by the acid of the gastric juice, than that exerted by the intestinal fluids. As this action is also exerted on the other constituents of the blood, it is formed into large clots, and these, passing onward into the intestine, do not allow a thorough mixing of all the blood with the food residue.(1) An exception is thus made to the general rule, that the higher in the alimentary tract the source of any of the ingredients of the fæces may be, the more intimately will it be mixed with the other ingredients.

Eichorst(2) denies, however, that it is possible to make any differential diagnosis between hæmorrhage from the small intestine and that from the stomach, by mere examination of the stools.

It is not always possible to determine on first inspection if blood is present in a stool. In many cases of abnormal pigmentation a doubt may exist as to whether it is due to blood or to some ingredient of the food

(1). Allchin. "Melæna", in Quain's Dict of Medicine.

(2). Eichorst. Phy Untersuch Methoden Innern Krankheiten.

or medicine. Of the latter the substances most commonly causing appearances which may be confounded with those due to blood, are bismuth and iron. Enquiry as to the giving of these may be sufficient to decide the matter, but in some cases it may prove of advantage to know, that where the colour is due to these substances, there is an absence of the viscid matter which always accompanies the presence of blood pigment. Charcoal also causes a dark colour when taken in large quantities. Its presence is easily detected by the use of the microscope.

In cases of doubt as to the presence of blood, most authors advise recourse to the microscope as a certain test. Microscopically examined faces containing blood may show red corpuscles in an unaltered condition if the source of the haemorrhage is in the lower part of the bowel and the blood has not remained long in the intestine. Not seldom the corpuscles are swollen, coloured only at one or two points, or are so altered as to be seen as perfectly spherical colourless bodies. In other cases, while their

biconcave form is retained, their contour has become irregular and their substance markedly granular, shewing the beginning of disintegration. Often all that is recognisable is a confluent, translucent, somewhat granular mass of yellowish brown colour. In such cases as the last, if the amount be small, the blood might easily be overlooked.

Microscopic examination of the faeces is advisable, according to Nothnagel[1], in cases of typhoid fever although their naked eye appearance may cause no suspicion of its presence. He has often found traces of blood from twelve to thirty-six hours before the occurrence of large haemorrhages, and would in consequence regard the finding of small quantities of it, as of both prognostic and therapeutic importance.

Blood-pigment may occasionally be found in faeces in the form of crystals as is recorded in most text-books of clinical medicine. The most definite statements on this subject, that I have found,

1. Beiträge zur Phys. u Path des Darmes. p 227.

are those of Jaksch.[1] He found them not seldom in the faces, especially in chronic intestinal catarrh, and further in numerous cases in which some days previous there had been intestinal haemorrhage.

These were crystals of haematoidin, the crystalline structure in most cases not being very clear. Especially well marked crystals he obtained in a case of nephritis.

The crystals are partly free and partly enclosed in masses of mucus.

> While engaged in examining microscopically the faces of suitable cases in the hope of finding blood crystals, I found what I believe might well prove a source of fallacy in diagnosing their presence. In one cases of cancerous disease of the stomach accompanied by haemorrhage I found in both faces and vomit numerous rhomboid crystals, some lying singly, others arranged in clusters. The large were black in colour, the smaller and therefore more translucent, of a dark reddish brown. They were at first confounded with crystals of hamin, but their somewhat large size & regular crystallization led me to seek some other explanation of their presence. I suspected the

[1] Klinische Diagnostik Innere Krankheiten p 153

possibility of their being crystals of some bismuth salt, this metal having been given in the form of the subnitrate in at any rate one or two of the cases where I had had the opportunity of examining the stools. Experiment on healthy individuals shewed my suspicion to be well founded. I found the same crystals in all cases in which I gave bismuth and afterward examined the stool with the microscope. I am not aware that the occurrence of bismuth in this form in the faeces has been previously noticed.

Blood found in the stools may arise from any part of the intestinal tract or from the stomach. While however, the site of the haemorrhage may as recounted above be approximately determined from the condition in which the blood is found in the stools, it is impossible without the aid of other symptoms or history to diagnose the cause of it. This may be injury applied through the walls of the abdomen, or due to the passage of rough calculi, hardened faeces or foreign bodies through the intestine. Any acute congestion (severe inflammation) or passive congestion (portal obstruction, intus-

perception &c) may result in capillary haemorrhage, and general diseases in which haemorrhage occurs on other surfaces of the body, such as purpura, pyaemia, yellow fever, phosphorus poisoning &c, may lead to similar extravasations on to the surface of the intestinal mucous membrane.

Many cases are recorded where intestinal haemorrhage has occurred vicariously owing to a suppression of the menstrual flow.

Intestinal haemorrhage is not uncommon in many disease of the vessels of the intestinal mucous membrane. Its most common cause is ulceration in some form and excluding such ulcers as those caused by aneurisms, and the more common varicose ulcers formed in haemorrhoids, the intestinal ulcers most commonly accompanied by bleeding[1] are the round ulcers of the duodenum, which however are of but rare occurrence. In proportion to the frequency with which intestinal ulceration (of all sorts) occurs, haemorrhage is infrequent, and excluding the ulcers

① Rothmayr. Beiträge zur Phys & Path des Darms p 226.

first mentioned, those of typhoid fever and dysentery furnish by far the greater number of cases. In these hæmorrhage is comparatively frequent but it occurs seldom in tubercular ulcers and very rarely indeed in catarrhal ulceration. The explanation Rothnagel gives for this inequality of proneness to hæmorrhage is, that in tubercular ulceration the pale of its process is comparatively slow, and the vessels therefore become well occluded before they are broken down. In typhoid ulceration on the other hand the process is comparatively rapid and it is yet more so in acute dysentery and the seat of the necrotic process is besides surrounded by an extremely hyperæmic mucous membrane.

In both catarrhal and tubercular ulcers, however, a small amount of blood can frequently be detected by the use of the microscope, when no sign of it is visible to the naked eye.[1]

In many cases where blood has been passed with the faces shortly be-

[1]. Rothnagel. "Beitrage zur Phy. & Path. des Darms." p 236

fore death, it has been impossible to find on post-mortem examination any structural disease to account for it. Rothnagel records two cases of patients dying from phthisis in whose stools blood was noticed just before death, and the post-mortem revealed no cause for it. The same result has attended the autopsy in many cases of death from Melæna neonatorum.①

Pus. It might be expected that pus would be a much more frequent pathological constituent of feces than careful observation shows to be the case, and when the conditions of the intestinal mucous membrane are considered, which lead to the presence of pus in the discharges, and compared with those of other mucous membranes such as the bronchial, a marked difference is observed. In bronchial catarrh the amount of pus found in the sputum is considerable, while in catarrh of the intestine it is unusual for more than a trace of it to be observed in the mucus

① Eustace Smith. "Diseases of Children" p 655

found in the feces. In regard to pus, therefore, the reverse is found of what holds good in regard to the finding of epithelium, which in intestinal catarrh is found comparatively copiously, in bronchial catarrh almost not at all.

Pus in the stools mixed in any considerable quantity with mucus, may be regarded as diagnostic of ulceration, and usually of ulceration in the lower part of the large bowel. It is frequently met with in dysenteric, syphilitic or carcinomatous ulcers. In the case of ulcers of the small intestine it is most probable that any pus cells proceeding from their surface are disintegrated by the action of the intestinal fluid.[1] They are occasionally found in typhoid and tubercular ulcers of the small intestine but only when these are accompanied by greatly increased intestinal peristalsis which shortens the time during which the cells can be exposed to the

[1] Nothnagel "Beiträge zur Phys. & Path. des Darms" p 240

action of the fluids of the intestinal contents. A very careful examination of the faces may occasionally lead to the finding of small, greyish-white lumps which a microscopic examination shews to be composed of thickly crowded pus cells. (1) The presence of such masses leaves no doubt as to the presence of ulceration.

Occasionally large quantities of almost pure pus are evacuated in consequence of the bursting into the bowel of an abscess which has formed in its neighbourhood.

Inorganic Constituents of Faces. Of the inorganic constituents of faces certain are in the form of insoluble salts. Of these three of lime and magnesia form the greater part. Much of both of these metals is combined with fatty acids to form insoluble soaps, which are seen plenteously in microscopic examination as yellow-stained material, granular or in irregularly cornered or rounded forms.

(1) Nothnagel. p 240

Crystals of the triple phosphate of Ammonia, lime and magnesia are met with in almost every stool examined. Ewerich[1] declares they are never found in the fresh faces of sucklings if the urine is kept separate from them. At one time their presence in the stools was thought pathognomonic of typhoid fever[2] but it is doubtful if they occur in the stools in this disease in any greater frequency than in others and they may indeed be wanting in them.[3] The crystals may be found in stools of a reaction, either neutral, alkaline or acid. They may be in well marked "Knife-rest" form, in various imperfect forms of this, or in irregular fragments of all sizes and shapes, or more rarely in a feathery form. They are, as a rule, not coloured by bile pigment, although in one rare case mentioned by Nothnagel[4] he found them bile stained. They are of no known

① Die Darmbacteria des Saeglings. 1886. p 24.
② Ewerich. Phys Untersuchungs Methoden innerer Krankheiten.
③ Nothnagel. Beitrage zur Phy. & Path. des Darmes p 82
④ Ibid. p. 84.

use in diagnosis. Marcet[1] found that in cases of dyspepsia very large numbers of the crystals occurred, and suggested that in some forms of dyspepsia excretory matter usually passed in the urine, is excreted in the intestinal evacuations as ammoniacal compounds such as the phosphates. This suggestion arose from the result of Claud Bernard's experiment, where after excision of the Kidneys of animals there was found an increase of phosphates in the faces.

Like the triple phosphate, neutral phosphate of lime is met with in the faces, though far less frequently, and similarly its occurrence is of no known importance. It is in the form of stellate crystals.

Oxalate of lime is occasionally met with. I have seen it in two cases. Nothnagel[2] says that when it occurs there is always much vegetable tissue in the faces, and the crystals lie close to this.

① Medical Times & Gazette. 1858. Vol 2. Lect III

② "Beiträge zur Phys. & Path. des Darms". p 85

In neither of my cases was this the case.

Charcot's cryptals may occur,[1] and are then found in pathological cases embedded in mucus. The stools in which they are contained are always alkaline.

Inorganic salts enter largely into the composition of biliary, pancreatic, and intestinal calculi. The first of these have already been considered. Pancreatic calculi are composed chiefly of calcium carbonate or phosphate. They are, however, rare and remain latent,[2] so are extremely seldom, if ever, present in the stools.

Intestinal concretions are formed chiefly in the cæcum or rectum. They are varied in their composition.[3] They may be composed of salts of lime and triple phosphate, with some fat and other organic matter, aggregated around some foreign body or portion of hardened faces. One case of this sort is described,[4] where

(1). Nothnagel. Beiträge zur Phys. u Path des Darmes. p 86

(2). Roberts. Quain's Dictionary of Medicine. p 1090

(3). Ralfe. Clinical Chemistry. p 250.

(4). Eichorst. Phys. Untersuchungs Methoden. p 242

within three or four weeks, thirty-two concretions were passed weighing in all two and a half pounds. Each had a cherry stone as a centre. Others consist more of fat in a yellow, waxy condition, mixed with some earthy phosphates and fibrinous organic matter. Others belong rather to the category of foreign bodies and are composed of various substances taken by the mouth as food or otherwise. They may be formed of Carbonate of Magnesia, Chalk or Oxide of Bismuth are habitually taken internally, by the accumulation and concretion of these in the intestines.(1) Those caused by the accumulation of vegetable hairs and husks have already been referred to. Liegler(2) mentions cases where concretions have been found in the human being, formed of shellac, also formed of feathers. In animals they are often formed of hair.

Foreign bodies. It is not always easy to decide whether some substances found

(1). Ziegler. Spec Path Anat. Eng Trans. Sect VII. p. 298

(2). Ibid p 299.

occasionally in stools, belong to the category of foreign bodies, since the food so often contains material which itself has no part in the process of digestion, and there is no strict line of demarcation between what is merely indigestible food and what is a foreign body. The seeds of berries, the stones of fruit, pieces of bone &c, all belong to the borderland between the two. Practically, however, the distinction is of no importance whatever. Such bodies derive their importance only from the possible harm they may do, during their passage through the intestinal tract, or by becoming impacted in some part of it and there setting up inflammation. The frequency with which they do this is not great, but the possibility of such consequences makes it of importance to examine the stools in cases where foreign bodies have been swallowed, in order to allay the anxiety which may have arisen. It is among lunatics and children that most cases occur, and many are the extra-

ordinary articles reported as having passed through the whole length of the alimentary canal, without occasioning any damage:- rosaries, breastpins, dominoes, cigar-holders &c. Coins, pins, and buttons are of less seldom occurrence as foreign bodies in the stools.

Parasites. Parasitic organisms found in the faces may be of either animal or vegetable nature. For the present we will confine our attention to the former, reserving the latter for later and more special consideration.

The importance of examining the faces in cases of disease of the alimentary tract suspected due to animal parasites has long been recognised. In such disease the symptoms are often obscure and the objective proof afforded by the finding of the parasites themselves or their eggs is alone capable of leading to a sure diagnosis.

A naked eye examination is all that is required to reveal some of the parasites:

their eggs and also the smaller organisms are seen only with the aid of the microscope.

Among intestinal parasites there are several species which are met with comparatively frequently. Many others have been found only on single occasions.

The Protozoa are represented by comparatively few forms. The Amaba coli is met with in cases of dysentery[1]; Paramaecium (Balantidium) coli and Trichomonas intestinalis, flagellated Infusorians, and Cercomonas intestinalis, a flagellate Infusorian, are also met with in pathological conditions such as intestinal catarrh, typhoid ulceration, and cholera.[2] Rothnagel[3] occasionally met with a form like the last of these but without flagella, in various diarrhoeic stools. The relation of all these low forms of animal life to morbid processes in the intestine is very doubtful. They probably owe their presence merely to the fact that the pathological conditions in

(1). Ziegler. General Path Anatomy. Eng Trans. p 344
(2). Leuckhart. Parasites of Man. Eng Trans.
(3). Rothnagel. Beitrage zur Phys & Path des Darmes p 107.

which they are found have provided a soil suitable for their growth, but cases are reported[1] where diarrhœa and other pathological conditions have ceased or been improved on the taking of such measures as would lead to the removal of the parasites. In such instances, while at first developing only because they have found a suitable soil, the later presence of them in great numbers has aggravated the original disease.[2]

Very rarely some forms of Coccidia are found in man, and their oval shape might then lead to their being mistaken for the eggs of some species of worm.[3]

The larva of insects, alive as well as dead, are occasionally found in the faces under circumstances shewing that they must have traversed the alimentary tract.[4] Their presence must be considered accidental.

The remaining intestinal animal parasites belong to the Vermes. It is

1. Zunker, quoted by Rothmayr. p112. Leuckhart. p 186.
2. Leuckart's Parasites of Man. p. 245.
3. Leuckhart
4. Cobbold. Quain's Dict of Med. Artict "Oestrus"

unnecessary to describe here the life history of the different species or their several characteristics. Of the Cestodes the more commonly met with are Taenia saginata, Taenia solium and Bothriocephalus latus. It is right that the importance should emphasized of a search in the stools for the head of any of the tape-worms for the removal of which anthelmintics have been given. Unless the head is found there can be no certainty that the source of trouble is removed.

Of the Nematodes the most common are Oxyuris vermicularis, Ascaris lumbricoides, Tricocephalus dispar, Dochmuis duodenalis, and Trichuria spiralis. Besides the adult animal, the eggs of all these species, except Trichuria spiralis, may be found in the faeces, also those of two Trematodes - Distoma hepaticum and Distoma lanceolatum which do not themselves inhabit the intestinal tract. The eggs of the former of these two species are discharged from the gall bladder or ducts which the worm itself

inhabits; those of the latter reach the intestinal canal by ulceration affecting the vessels of the lower part of the colon.[1] These two parasites are themselves very rarely met with in the faeces.

The eggs of Trichuris Spiralis are not met with because they are hatched in the upper part of the intestine and the embryos on being liberated at once bore into the tissues. The adult Trichinæ may be met with in the alvine dejections during the first five or six weeks of the existence of Trichinasis.[2]

In many cases of Tænia in the intestine the eggs are not found in the stools, apart from those contained in the proglottides, since they are liberated only by the rupture of these & this does not usually occur till they are ~~discharged~~ passed from the bowel.

The eggs of Tænia are spherical, and have a thick shell with radial markings in it. Those of T. Solium are rather more spheri-

(1) Leuckart's Parasites of Man. p 46.

(2) Cobbold. Quain's Dict of Med. Article "Trichinasis."

cal and smaller than are those of T. dentata. The eggs of the remaining Worms already mentioned are oval. Those of Distoma hepaticum are from two to three times the size of the others. Those of Bothriocephalus latus and Distoma lanceolatum have usually a small inconspicuous lid at one end. The eggs of Ascaris lumbricoides and Trichocephalus dispar are thick shelled and. the former are enveloped in an albuminous sheath which is usually coloured by the bile pigment. The latter have a perforation at each end provided with a plug of albumen.

The contents of the eggs are sometimes unaltered, while in others the process of yelk-division is going on, and even embryos may be seen in various stages of development. (1)

The elongated embryos of Oxyuris vermicularis may be found in the faeces as well as the eggs and adult worms.

Rhabditis stercoralis. is the embryo of Anguillula intestinalis, an occasional

(1) Leuckart. Parasites of Man. p 149

parasitic thread worms, and is found in incredible numbers in the stools of those suffering from Cochin China diarrhoea, which is occasioned by their presence.[1]

(1). Leuckart. Parasits of Man. p 126. —
The greater part of the last few pages on animal parasits is compiled from Leuckart's "Parasits of Man", English Translation.

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The Vegetable Microorganisms of Fæces.

A considerable part of the faces consists of micro-organisms, and the great interest which has of late years centred around micro-organisms in general as a cause or accompaniment of disease, has naturally led to an investigation of those long known to be present, even during perfect health, in the evacuations from the alimentary canal of man.

The mere fact of the existence of micro-organisms in the alvine dejections was mentioned[1] as early as the year 1919

(1). See footnote in Zuricki's "Darmbacterien des Säuglings" p. 2.

by Leeuwenhoek. Later observers[1] in the same field noticed them also, but their relation to the bodily economy was investigated with no thoroughness, and it was taken for granted that they exerted no influence on the digestive processes and owed their presence merely to the fact that in the intestinal canal they found conditions favorable to their growth.

As, however, in quite recent years it became known that similar low forms of life possess important functions; that some are capable of causing decomposition and other chemical changes; that others are probably the direct cause of disease, it became apparent how great might possibly be the role played by the living elements of the intestinal contents. The knowledge of the micro-organisms connected with the intestinal tract advanced and still advances with that of "germs" in general, and those who have devoted themselves to research in this special field of the intestinal

① Le Lenick "Darmbacterien des Säuglings" p 2.

excreta have achieved sufficient to warrant the hope of important results yet being obtained, although indeed it can not at present be said that our knowledge of the bacteria of faces is sufficiently complete to afford a new basis for the diagnosis and treatment of intestinal disease.

Investigations were begun with a microscopic investigation of stools in such a condition as they would usually be in, when taken for examination of their other contents; and a great advance was made when the necessity was shewn for precautionary measures against the entrance of organisms from the air into the stools between the time of their passage from the bowel and their examination.

A great gain of knowledge followed the introduction of plate cultivations by Koch, some such means of isolating different species being especially necessary where as in the faces many may coexist and of these some may have similar microscopic appearances, and others have

each several different forms according to the stage of their development.

Following on the isolation of different bacteria, the investigation of the life history of each, the conditions necessary for its active existence, its influence on various food materials or other contents of the intestines, follows as a natural sequence.

It might however, be asked, "what advantage is to accrue from a knowledge of the microorganisms of the faces?" In answer to such a question, it may be said that we ought expect to be helped in regard to the diagnosis, prognosis and treatment of many intestinal disorders. The finding in the stools, organisms known to be capable of producing pathological conditions of the alimentary tract, or which it is known depend for their presence on an abnormality in the functions of some one of its segments would be valuable evidence in diagnosis. The discovery in certain diseases of microorganisms whose presence was known to be associated with less favorable progress might well

aid prognosis, as does at present in cases of pulmonary phthisis, the discovery of the bacillus of tuberculosis in the sputum.

A knowledge of what pathological forms require in order to develope and therefore to exert their harmful influence, might enable therapeutic measures to be adopted, either as prophylaxis or cure, and a knowledge of the chemical processes individual forms of organism cause, would enable proper treatment to be adopted where harmful products resulted, which might occasion disease through their absorption into the system. An indication toward prophylactic measures is given by the experiments of Koch[1] with the cholera bacillus, in which it was shewn that definite derangements of the alimentary tract (lessened acidity or alkalinity of the stomach and slowed intestinal peristalsis), predisposed to the development of the germs in the intestines and therefore to the production of the disease.

The micro-organisms of the faeces depend on those present in the intestinal tract

[1] "Microparasites in Disease". New Sydenham Soc. p 375 ff.

and how and when they enter the latter is a question of primary importance in considering their clinical bearings.

No micro-organisms are to be found in a living foetus[1] in utero excepting, perhaps, when it has been infected from the mother with the organisms of some specific disease, and so also in the meconium expelled immediately after the child's birth none are met with. Almost immediately that the child is born, however, they are introduced into its alimentary tract, certainly by the mouth, probably also per anum. Each time that the child swallows, air is also taken into the stomach besides the secretions of the mouth, and with each of these must enter numerous organisms and their spores. The results of Escherich's[2] observations support the idea of an infection also through the anus.

At any rate, from within a few hours of birth vegetable organisms are found implanted in the contents of the intestinal

① Escherich. "Die Darmbacterien des Säuglings" p 11.

② "Die Darmbacterien des Säuglings" p 149

tract and continue to be represented there during the whole life of the individual, not by the same species continuously but varying according to different circumstances attending different periods of life. Besides the entrance through mouth or anus there still remains one other road for infection, that through the intestinal walls; and that infection may and does occur by it there can be no doubt, in cases where micro-organisms are conveyed in the blood to some part of the intestinal wall and produce there a lesion leading to ulceration, eg. Some cases of intestinal tuberculosis.

It does not follow because certain microorganisms are found in the faces that these are the same that would be obtained by an examination of each and every part of the alimentary tract. Were this so one might expect to meet with any of the innumerable species that are present in the air or food, on making an examination of the faces. As a matter of fact the species one does

found in the faces are limited in number, and those that are constantly found, are still more restricted, and not those most commonly met with outside the body. This is explained by the fact that different species flourish under different conditions & that some are destroyed by agents which leave others unharmed.

That the cooking of food destroys many organisms is certain, but that by this means the introduction of all into the alimentary tract could be prevented is impossible. The mouth itself serves as the site of growth of many organisms which, are being constantly swallowed with the saliva and food. Most of the forms, however, which flourish in the mouth are absent from the faces. At one time the acid of the gastric juice was held responsible for the future difference between the number of species among the bacteria and other organisms which must be swallowed, and those found in the intestinal tract and the evacuations from it. Falk indeed

proved[1] that the gastric juice, or rather the acid contained in it, had a distinctly harmful influence on many bacteria, killing most fully developed individuals although not affecting so much the vitality of the spores. It must therefore be recognised that the gastric juice takes some part in limiting the number of species among intestinal organisms, and Koch's observations[2] on cholera shew that, in regard to at any rate some pathological forms, a dilution of it through heavy superfluous feeding aids their passage into the intestine in a state allowing their after development.

Still, too much emphasis must not be laid on the result of Falk's experiment as an explanation of why so comparatively few forms do develope in the alimentary tract below the stomach,[3] since the acid of the gastric juice is after meals always much diluted, and at other times [illegible]

① Virchow's Archiv. Bd 93. pp 188-189.

② "Micro-parasites in disease". New Sydenham Soc. pp. 354-356.

③ Ibid. p. 378.

in health reduced so much as to be scarcely recognisable. The destruction of micro-organisms in the gastric juice could further offer no explanation of why at one time certain species are present in the faeces, at other times absent from them.

A more reliable explanation of the limited intestinal vegetation is to be found in the assertion that if ~~the~~ any organism does not find in the intestines a soil suitable for it, it must remain undeveloped. It is a well recognised fact that different organisms do require different nutritive material for their growth and development, and ~~this examination~~ of the bacteria found in faeces differing in composition, shews that the species present are not the same. Escherich experimented on puppies.[1] He gave during consecutive periods milk and flesh food, and following each change in the food was a corresponding change in the organisms of the faeces. A similar experiment is made in the course

[1]. "Die Darmbacterien des Säuglings" p. 111.

of nature during the life of each human individual. As the meconium gives place to the faeces resulting from the use of milk as food, a change takes place in the forms of bacteria present; a second change occurs when a mixed diet is begun. The difference of the bacteria can be made out even in different parts of one stool, when one part consists of meconium, the other of the first milk-faeces. ①

The same reason probably explains why the number of species is increased in many forms of disease where increased secretions, or abnormal products from a diseased portion of the bowel, are added to the intestinal contents; also, in part, why different organisms are found in different parts of the intestine. By the time the lower bowel is reached by the food remains, much material available in the upper part of the intestine as material suited for the nutrition of some forms of micro-organisms, has already been absorbed.

① Escherich "Die Darmbacterien des Säuglings" p. 21

There are other possible factors in causing the limitation of the number of bacteria in the feces. Among these may be mentioned the consistence of the evacuations. The influence of the consistence of nutrient media in limiting bacteriological vegetation is experienced by every one who has attempted cultivations on solid media. Its influence is, however, perhaps most marked as regards the rate of growth and therefore as regards the number of individuals of one species present.

Another factor is the length of time during which organisms and their spores are exposed to influences favorable to their development, as was shown by Koch[1] in his experiments on animals with the comma bacillus of cholera. Where the intestinal peristalsis was increased, other conditions remaining the the same, both fewer species and fewer individuals might be expected to be found in the feces. On the other

1. "Microparasites in Disease" New Sydenham Soc. p.

hand, a delayed peristalsis would produce the opposite state of matters.

The number of individuals of any species present will of course depend on various circumstances: — the amount of nutrient material present that is suitable for its growth; the presence of other forms able to flourish themselves at the expense of other organisms; &c. The consistence of the stool has a marked influence. Many more individuals are found in liquid stools than in solid.

In the case of micro-organisms having more than one developmental form, the forms present in the faeces will depend on the peculiarities of the individual species and the conditions affecting it that exist in the faeces themselves.

The fact that one species may possess several distinct forms for several periods of its life history, and the fact that many functionally distinct species possess identical microscopic appearances or modes of growth on solid media &c, occasion the greatest

difficulties met with in deciding what species really are to be reckoned as intestinal or faecal bacteria, and probably explains in great part the varying and contradictory assertions of the investigators who have hitherto worked at the subject.

Of the various means available to distinguish different species, the earliest investigators used only the microscope; some of the later, especially Biensock, have depended too much on the results of culture in different media. It is necessary that a proper value should be given to each method before completely unanimous results can be expected.

Some bacteria may be readily distinguished by peculiarity of form or arrangement as seen under the microscope with the use of proper magnifying power. When, however, one form may belong to either of more than one species, other methods are necessary to identify it. For scientific purposes this would be always necessary to be done; for practical clinical work

the necessity would depend on the amount of the difference in function and capabilities of the species concerned. Where similar species have closely allied physiological action and differ only in some unimportant detail, the recognition of the form would be sufficient.

Among the methods at our disposal for the further differentiation of micro organisms may be mentioned first the use of special staining reagents. These are available however in only a limited number of instances.

Cultivations in various media afford a means of differentiation more frequently but their value must be regarded as secondary to that of microscopic examination. Many species found in microscopic preparations of faeces are altogether absent from the growths in various media. Another fallacy, not I believe, before pointed out, which may arise from too great a dependance on the results of cultivations, is due to the fact that species which have found no suit-

able conditions for their development in the intestines may develope in the cultivations. It is allowed that organisms and their spores can pass through the stomach with vitality remaining, also that some of these can develope in different parts of the intestine. The possibility has, however, been overlooked that conditions suitable for their development may not be met with tile they are inoculated on the artificially prepared nutrient media.

Further methods of differentiation consist in noticing the chemical changes the microorganisms are able to effect in different substances, and the results of inoculation of animals with them.

An enumeration of all the different species of vegetable organisms which have been found in normal or abnormal conditions of the faces would be an immense and unprofitable labour, on account of the great number of forms which have been isolated on

by once or twice. For the assertion of the almost constant presence of some species under normal conditions, and of the occurrence of others in special pathological conditions, there is sufficient authority in the writings of different authors. These species are described below. It must, however, be pointed out that all authorities on the subject are by no means unanimous as to what species are usually present under normal conditions. Indeed, those organisms recognised by some as those alone to be met with normally differ entirely from those classified as such by others (1)

Micrococci. That micrococci are constantly present in faces all authors are agreed except Bienstock. They occur, however, in much smaller numbers than the rod-shaped forms of bacteria. Neucki (2) showed that they occur more in the upper part of the intestine, while the rod-forms increase in numbers towards its lower part. —

(2). Quoted by Herter. p 29.

(1). Compare Nothnagel & Bienstock.

Escherich[1] says that all the species of cocci (chiefly diplococci & tetracocci) occurring in the faces of sucklings are only occasionally present, although some of them were never wanting. No species of micrococcus usually present in faces has as yet been described except the Streptococcus coli gracilis of Escherich.[2] This is wanting in the faces of sucklings but present in those of adults and in the meconium. It is in size ·2μ long and ·4μ broad, and is usually arranged in long S-shaped or spiral chains of 6-20 individuals when grown on gelatine. On Agar short chains are formed and on potatoes or old gelatine growths these are not found. They are not moving.

Inoculated on gelatine the coccus quickly liquefies it and forms cohesive at first round, later indented, on the floor of a wide liquefactive funnel. In old cultures a white sediment is formed.

On Agar the growth is sparse and superficial. Blood serum is not liquefied

① "Die Darmbacterien des Säuglings" p 27

② Ibid p 79

but overgrown by small opalescent scales.

On young potatoes a flat colony of small white granules is formed. Inoculations on animals were without positive results.

Bacterium termo is according to Gothnagel[1] and Daksch[2], the most frequently occurring of the bacteria found in faeces, although they are not supported by others in their assertion. B. Termo[3] is seen both in a moving and in zooglaa form. In the former it is seen as a small dumb-bell shaped organism, in size 1μ long by .5μ broad. Flagella at each end have been described. In its zooglaa form it occurs as short straight rods embedded in a clear transparent jelly-like mass. In gelatine cultivation it soon liquefies the medium and colours the fluid formed, at first a bright fluorescent green, later a deep citron colour. On potatoes it causes a dusky grey slimy layer rapidly covering the cut surface of the potatoes. In liquid media it causes turbidity and its growth is accompanied

① "Beiträge zur Phys. & Path. des Darmes" p 113.

② "Klinische Diagnostik Innere Krankheiten". p 128.

③ "Practical Mycology": Woodhead & Hare. pp 126.128.

by a penetrating putrescent odour.

Proteus Vulgaris[1] is a moving rod form, in size 2μ long and 4μ broad. It occurs in other developmental forms among which are "drumstick" forms, thin threads and free somewhat ~~cornered~~ spores. The whole development of this micro-organism has not yet been worked out but a suspicion exists from its assuming some of the above mentioned forms that it is the same as Beinstocks' bacillus of albumen-decomposition[2]. It gives a clinging odour to its cultures. In gelatine cultivation it causes liquefaction. Its deep colonies have an appearance as if they had come to a stand-still after rotating on their own axis. Blood serum is quickly liquefied. On Potato a clear, yellow growth is formed, which has a star like contour, is flat and has a glancing surface.

It does not liquify Agar.

Bacterium lactis aerogenes[3] consists of a short rod, 1-2μ long and .5-1μ broad.

① "Die Darmbacterien des Saugling" p. 74.

② See page.

③ Escherich - as above p. 57.

It has rounded corners so that the shorter individuals may appear oval or round. In most there is a central constriction and especially in old gelatine cultures it resembles a diplococcus. In some there are round parts not staining well but spore formation is doubtful. In milk they often form short chains. They are motionless.

In gelatine a quick growth takes place, non-liquefactive, but forming round, concave, succulent, glancing colonies, whose extension ceases after a few days. Their surface is homogeneous. The deep colonies form spheres and soon reach their largest size. On potatoes (old) is formed a quickly growing layer of whitish yellow colour, of pappy consistence and shewing bubbles at the periphery. On young potatoes a dry light yellow growth forms.

In milk, in solutions of milk sugar, cane sugar or grape-sugar, even without access of air, the bacterium lead to the formation of lactic acid.

It is always present, even if only in small numbers, in the faces of suckling

but occurs in greater quantity in the upper part of the small intestine (where is more milk sugar).[1] It is absent from meconium and from feces resulting from a flesh diet.

Bacterium coli commune[2] is polymorphic. Its smallest forms are as broad as long, about .5μ in diameter. From this are all gradations to a clearly oval form with well rounded corners, or to cylindrical rods, constructed or not of an average size of 2.3μ long by .4-.6μ broad. In gelatine it reaches a larger size and has a more decidedly rod form. In many stools it appears mostly as plender, double rods, all of the same size. They have slow movements, the anterior of the two rods moving from side to side and onward, the posterior following the anterior as it advances. Decided spore formation has not been observed but often there are in the rods badly stained round parts. B. coli commune grows

① "Die Darmbacterien des Foetus". Escherich. p 114.

② Ibid. p 63

easily in gelatine, not liquefying it but forming colonies of which the deep have a radiating appearance, or shew a differentiation into a clear homogeneous periphery and a dark irregular centre. The superficial colonies are not limited as are those of Bacterium lactis aerogenes. They form white patches, with a dry dull surface and round or irregular contour. The thickness of these decreases from the centre, which is often occupied by a papilliform projection. In some the growth is thicker and softer and a concentric arrangement can be made out. On Agar and on blood serum the colonies are not characteristic. On young potatoes a thick, juicy, glancing layer is formed, of a yellowish brown colour. Milk becomes clotted and of an acid reaction a few days after it is innoculated. The bacterium does not grow in milk or in a solution of milk sugar if the air be excluded. It can however grow under such condition in a solution of grape sugar.

Bacterium coli commune is found only in small amount in the upper part of the intestine or may be quite wanting there, but is abundant in the lower part and in the faces. (1) It is doubtfully the same micro-organism as that Brieger has isolated from faces and considers the micro-organism of propionic acid fermentation. (2)

Clostridium Butyricum, which is according to Hofmann (3) usually, and according to Jaksch (4) always in normal faeces, is specially distinguished by its reaction to a solution of Iodine and Iodide of Potassium, ~~keep coloured blue by it~~. It occurs in several forms, developing the one into the other. One form consists of fine, granular micrococci in zooglaea masses, coloured violet-red by the above solution; a second, of thin short rods pointed at one end and also stained violet red.

(1) Emerich p 145. (2) Ibid p. 93.

(3) "Beiträge zur Phys & Path des Darmes" p 117.

(4) "Klinische Diagnostik Innere Krankheiten" 1889. p 125.

There may contain spherical bodies not coloured by the solution; a third form consists in long threads with spores, the latter not being coloured, while the rest of the threads take on a dark blue colour when the Iodine solution is added to a preparation containing them. Most individuals of this species, however, occur in the form of large rounded or oblong cells like those of yeast, differing however in their mode of multiplication and staining blue with the above mentioned solution. According to Nothnagel they occur only sparsely when no starch or other vegetable matter is contained in the feces; when these are present the Clostridia are abundant. The depth of the blue tinge they take with the Iodine solution seems also to be in proportion to the amount of vegetable remains present in the feces.

Next to Micrococci and Bacterium termo Nothnagel says this species is the most abundantly occurring. He never found them in the intestine above the lower part

of the ileum. All attempts at artificial cultivation of them have proved unsuccessful.

No other observers mention having found this species. Escherich[1] could not although he specially looked for them. I have myself failed to find in the faces any organisms taken on a violet or blue stain with such a solution as Nothnagel or Jaksch used.

Bacillus subtilis also, according to Nothnagel[2] and Jaksch[3] is of frequent, though not constant occurrence in the faces, in both firm and loose, normal and pathological conditions; and is easily recognised from the presence of its large refractile spores. [4] It exists in the form of rods, 6-8 μ long and 2 μ broad, furnished with flagella. Its growth is rapid. Long threads are formed and in these highly refractile spores appear. The spores are set free and from them the bacilli are developed. It also multiplies by simple fission. In gelatine it causes liquefaction

① "Die Darmbacterien des Säuglings". p 28.
② "Beiträge zur Phy. & Path. des Darmes" p 113.
③ "Klinische Diagnostik innere Krankheiten" p 128
④ "Practical mycology". Woodhead & Hare pp 125-126.

and a white deposit is formed in the liquefied portions. On potato it forms a moist translucent jelly-like film of glistening appearance, and which spreads rapidly.

In the faeces mostly the rod-form is seen, sometimes the thread (leptothrix) form. The spores are few and simple. Escherich[1] found B. subtilis constantly in the meconium a few hours after birth.

Bienstock[2] denies it presence in the faeces at all, and asserts that there are two forms resembling it found, which differ from it, however, in having no spontaneous movement and in their cultures, the one growing in gelatine tubes from the course of the injecting needle in all directions in the form of a mesentery, in which are yellowish white streaks, the other forming a surface growth, at first smooth, later uneven, whose edges shew processes of a "grape-bunch" form. Both forms, although agreeing with each other, differ from B. subtilis also in the method

① "Die Darmbakterien der Faces" p. 21.

② Zeitschrift für Klinische Medicin. Bd VIII. p 10.

of rod formation from the spores. Both these forms are, according to Biernstöck, constant in faces.

Biernstöck's small Bacillus[1]. This is a very small form, whose rod shape was made out only by the use of high magnification (Zeiss. 1/12. Oc 5). Under lower powers it appears a micrococcus, no difference between its length and breadth being then apparent. It grows in artificial media extremely slowly and its growth is not characteristic. Animals inoculated with it shewed symptoms of general febrile disease, and sometimes died. It occurred in three quarters of the cases that Biernstock examined.

Bacillus of Albumen-decomposition[2], (Bacillus der Eiweisfäulnis), of Biernstock. This species has a spore about one half the size of that of B. subtilis, and also strongly refractile. It changes into a rod, and this lengthens and then subdivides into extremely short segments arranged in "rosary" form. This arrangement is broken up and the

1. Zeitschrift für Klinische Medicin Bd VIII. p 13.
2. Ibid. p 15.

several segments develope into long threads, which again divide into long rods, and at the end of these a spore is formed, becoming free later. All these stages of development are not necessarily seen, as spores are formed only when the nutrition of the rods is impaired. In the faeces only the middle stages are observed.

Peptone and flesh extract innoculated with this bacillus decompose, and give off an exquisitely faecal smell. Experiment led Bienstock to regard it as the organism specially concerned in the decomposition of albumen. He suggests that different successive stages of its development stand in a definite relation to different phases of the decomposition process. It is not met with in the faeces of sucklings, finding apparently in milk-faeces no suitable nutritive material.

The presence of a bacillus decomposing carbohydrates is also mentioned by Bienstock[1] but is not described by him.

1. Zeitschrift für Klinische Medicine "Bd VIII p 15"

No spirillar forms of Bacteria are described as having been met with in the faeces under normal conditions.

Of the numerous species of micro-organisms (non-pathogenic), occasionally met with in normal faeces, it is necessary to mention only two. – Sarcinae & Yeast-cells.

Sarcina ventriculi was related by Widerhofer[1] to be an almost constant constituent of the faeces of children, but it is hard to believe the correctness of such a statement. I have had opportunities of examining the stools of many patients in whose stomachs Sarcinae were present most copiously, and even in these it was rare to find the Sarcinae in the excreta, unless, indeed, after the use of purgatives or following on diarrhoea from some other cause.

When I did find them in the faeces the clusters contained fewer individuals than did those in the stomach, except in one or two instances. They were often to be divided into three sorts: –

(1) Quoted by Yeriche. p 93.

(a) large individuals stained yellow (bile), (b). small individuals stained of a light brown, and (c) small unstained individuals. Any cause for these different appearances I always failed to find. The first and third forms, I often found also in the vomit, and they appeared to be individuals of a different age. The small brown-stained form I have met with only in the faces. It is less common than the others.

Yeast cells are frequently present in faces, both normal and pathological, but only sparsely except in pathological conditions. They occur in greatest quantity in the strongly acid stools of children.[1] They are often coloured yellow and are stained a dark mahogany brown on the addition of a solution of Iodine and Iodide of Potassium[1]. They are to be distinguished by the peculiar budding process they show and their general arrangement into small groups. The yeast cells

[1]. Jaksch. "Klinische Diagnostik" 1884. p. 129.

of the faces are smaller than those of Saccharomyces (Torula) Cerevisiæ, and Rothnagel has called them S. Ellipsoideus from their predominating shape. He has, however, met with large yeast cells in a case of typhoid fever when there had been no possibility that the patient had taken any beer or other source of S. cerevisiæ. The only possible error in the recognition of yeast cells in the faces, would be the confounding of them with Clostridium butyricum. The reaction to Iodine would dispel any doubt.

It is more convenient to mention here the occurrence in the faces of Oidium albicans, although it is probably a pathogenic microorganism. It occurs occasionally in the stools of sucklings suffering from thrush - According to Widerhofer[1] it is swallowed and passed unchanged in the evacuations.

1. Quoted by Ewald p. 10.

We come next to consider what influence may be exerted on the bodily economy by the presence in the intestinal tract of those species of microorganisms just described.

In order to know anything of a possible influence they may have it is requisite that we should first possess a knowledge of their action on the constituents of the intestinal contents, for organisms present in normal conditions of the intestinal tract can exert any influence only indirectly. Unfortunately we know little of the action of any of them and any influence on the general system is rather supposed than determined.

They are organised ferments and as such cause decomposition of certain constituents of the food residue and of the intestinal secretions, among the products of which are the intestinal gases (in part), the acids formed especially in the lower part of the bowel, the colouring matter and the source of the odour of the faces, and also various chemical substances such as indol, skatol, phenol &c. As to which organisms are concerned in

producing special chemical substances found in the faeces, little is known and the action of most of the above enumerated organisms has yet to be investigated. Clostridium butyricum and Bacterium lactis aerogenes have names pointing to the chief of the products resulting from the fermentation caused by them. Weinstock claims that his special bacillus of albumen decomposition is the only one in the faeces causing decomposition of albumen. From its action result ultimately[1] carbonic acid gas and ammonia, but intermediate products are peptones, leucin, tyrosin, phenol, indol, skatol and volatile fatty acids. Also the substances which are the cause of the faecal odour. Bacillus subtilis[2] probably acts on the fats of the intestinal contents and forms various acids and gases. It has been suggested[3] that Bacterium coli commune exerts an action on the mucin secreted by the intestinal mucous membrane,

① Weinstock. Zeitschrift für Klinische Medicin. p 35.

② Landois & Sterling's Physiology. p 401.

③ Escherich. Die Darmbacterien des Säuglings p. 145

decomposing it into products which are reabsorbed. Such a function would correspond with the constant presence of this species in the faeces, independent of the composition of the food, and also in the meconium; also with its presence especially in the lower part of the intestinal tract.

Following on this mention of what is known of the function of each species, comes the question of their relation to the bodily economy. Do they work to its advantage or to its disadvantage? A benefit would result if their action rendered fit for absorption parts of the food which would otherwise be lost as a source of nutrition. The bacillus of albumen decomposition would appear to act on albumen escaping the action of the digestive juices, and in so far as these are converted into soluble products (peptones) a beneficial influence would be exerted. Since, however, its action is continued to convert peptones already formed by the digestive juices into

less useful substances, it is doubtful whether all the good it may do is not so counterbalanced. If the suggestion mentioned above concerning Bacterium coli commune be true, its action must be considered advantageous. Bacterium lactis aerogenes acts on milk sugar and, since it converts this valuable substance into gases and lactic acid, its influence cannot be considered favorable.

Bacteria in Pathological conditions of the Fæces.

A consideration of the causes mentioned above as regulating the species of bacteria present in the stools, will shew how great may be the variations in species present where pathological conditions exist in the intestinal canal, especially where abnormal secretions or discharges enter it.

There are, however, several specific bacteria recognised as the cause of disease, which may be found in the fæces; and are deserving of special notice.

First among them is the comma-bacillus asserted by Koch to be the cause of Cholera, and accepted by many as such.[1] It is most easily found in the evacuations during the first two days of the disease and in cases which are acute and uncomplicated by hæmorrhage or the presence of decomposed matter. The bacillus is one half to two thirds the size of the bacillus tuberculosis but thicker and plumper, and has a slight curve. Two may be joined together forming if the curves are turned the same way a semicircular form, if in opposite ways an S-shaped form. Threads of a spiral form are often found and on this account Koch regards it as not a true bacillus but as more of the nature of a spirillum. In meat infusion it grows rapidly and luxuriantly, as it does also in other fluids, especially in milk, which, however, it does not curdle. In liquid media it shews

[1] "Microparasites in Disease". New Syd Soc. 1886.

very active movements. It grows in blood serum and in nutrient gelatine in characteristic form. At first a small, pale, not quite circular drop appears, the contour of which is irregularly defined and has a rough or dentated appearance. The growth soon becomes granular and as the colonies get larger, the granular appearance becomes more distinct, so that each forms a mass of highly refractile granules. The gelatine liquefies later and the bacteria sink deeper forming a funnel shaped recess in the middle of which the colony is recognised as a small white point. The extent of liquefaction in gelatine cultivations is limited and agar-agar is not liquefied at all. On boiled potatoes a light grayish brown, transparent layer is formed. Almost pure growths are found in the intestine in acute cases and the same during the first two days if the evacuated material is placed on earth or linen and these kept moist. The growth stops when the

temperature is lowered to 16°C, but the bacillus is not killed till −10°C is reached. The growth ceases also if the air is excluded and is lessened if the media be at all acid. The bacillus has, according to Koch, no resting stage, but Hueppe[1] has succeeded in finding spores. The action of it on the body is explained by the production in the intestine of poisons, which are absorbed. In examining a suspected stool it would be advantageous to use Schottelius'[2] plan of making microscopical preparations. He inoculates broth with material from the suspected stool and allows it to stand for 12 hours at a temperature of from 30° to 40°C. If the cholera bacillus is present it develops rapidly in the broth, especially at the surface, and microscopical preparations are thus easily obtained

Similar to the organism of Cholera

① Jallsch. Klinische Diagnostik p. 132

② Ibid p 133.

Asiatica is that found by Finkler and Prior[1] in the stools of children suffering from Cholera nostras. It is also comma shaped but larger and thicker than the organism of true cholera. In gelatine cultivations it grows much quicker than this. The growth too is uniformly round and sharply defined at the edges, besides having mostly a brown colour. It liquefies the gelatine very quickly and at the same time as this is occurring an intense, penetrating rotten odour is given off. The liquefaction occurs in test-tube gelatine cultivations along the whole course of the needle, forming a sack-shaped opacity: In Cholera Asiatica this is rather in the form of a funnel.

In typhoid fever[2] also a special bacillus is to be found in the faeces, but it is impossible to recognise it from mere microscopic examination, as it does not take on peculiar staining and has no distinctive form. It must be isolated by plate

1. Zeitsch. Klinische Med. p. 136 ff. Crookshank p 141.
2. "Microparasites in Disease". Saffky. p 256 ff. Zeitsch p 137.

cultivations. This was first done on Agar-agar plates. Gaffky describes it as a rod form of bacteria, one third the length of the diameter of a red blood corpuscle, but occurring sometimes in the form of longer threads, composed of several segments. Both these forms are motile.

It is about three times as long as it is broad, and the ends are rounded. At times spores are to be seen in the rods at their ends. The bacilli stain badly but Löffler's method is best [1].

On gelatine, non-liquefactive whitish growths form, which are seen by the aid of a low power to consist of numerous colonies of a yellowish-brown colour. It can be cultivated on potatoes but the growth is hardly visible to the naked eye. It [2] grows well on blood serum forming a whitish grey somewhat transparent layer.

Bacillus tuberculosis [3] is met with

① Baumgarten "Klinische Diagnostik." 1887. p 136.

② Crookshank "Bacteriology" 1886. p 195

③ Baumgarten. l.c. p 137. & Koch "Microkokken in Wund" p 190

in the faeces in cases of tubercular ulceration, but it is possible that the individuals found may proceed from sputum that has been swallowed, so that, before tubercular ulceration can be diagnosed from their presence in the faeces other symptoms must be present. It is recognised by the use of the same special staining methods as are employed when it is sought for in other sites. These methods are now so commonly used, that it would be superfluous to describe them here.

It is suspected that yellow fever[1] and also some forms of dysentery[2] are due to special forms of bacteria which are present in the intestinal tract, and search for these bacteria has been made in the faeces. The form found in yellow fever which is most probably specific is a short bacillus resembling that of typhoid fever, and whose

(1). Cornil & Babes. "Les Bactéries." pp. 452-453.

(2). Ibid p 444.

spores are often terminal. They show in their protoplasm parts that are little coloured. Their ends are tapering.

No special form of bacterium has as yet been satisfactorily proved to have a connection of a specific sort with dysentery in any of its forms.