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

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by
Ernest Robertson, M.B., C.M. (1885).

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The Examination of the Feces.

The term "Feces" 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 denotation, 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
in 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 product of the working of the digestive and absorptive apparatus of the body. The urine, the only other collection of effete product 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 constituent of the feces 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 feces 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 one, or a disagreeable one, rather excuses which are the outcome of the faulty pre- timent 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 fevers is much less than is generally supposed. Apart from prelentiment, the odour is the only disagreeable feature met with, and this can be prevented by the use of simple precautions such as are adopted at the London Hospital, where the plows are placed in large deep conical vessels, the mouths of which are covered with a thick glass.

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 quite more effective.

When firm fecal 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 rim 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 fecal 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 jour-
nals. Almost the only English author
who has attempted an at all extensive
treatment of the subject is Marcet, and
his work, published in the form of lectures,
belong 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, — Friedrichs, Kochsaig, and
Lambold being the chief writers. Of more
recent authors Rothseidt is the most promi-

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other departments of the physiology and pathology of the face, how many of the conditions formerly described as pathological 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 patients or infants, material was obtained through the kindness of Resident Surgeons at the Royal Maternity Hospital and others. Through the kindness of Dr. Woodhead and Bruce, I was enabled to examine the
intestinal contents from many cadavers 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 Feces, i.e., Amount, Physical Characters and Reaction.

II. The different Constituents of Feces.

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

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

Amount. The amount of the feces 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 feces 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, in regard to the quantity of his dejecta, according to the habit 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 feces. Theoretically, in one in whom the digestive functions are properly performed, who takes his food in a palatable 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 shows that in all cases undigested although digestible material is present, and it must therefore be allowed that in the healthy it is unusual 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 feces 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 nutrition of the young.

The number of stools passed in a day has not necessarily any connection with increased amount of feces. In some forms of disease of dyspepsia, 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 diarrhea, the amount of the feces 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 decreased. 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, etc. — 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 constipation of the stools follows. Yet another cause of increased amount is to be found in the presence of abnormal secretions or excretions, or of other abnormal ingredients such as blood, pus, the fluid from ruptured cysts, etc. In all of these cases, also, the relative amount of fluid constituent is increased. In cholera this occurs to such an extent that only a few grains of solid matter
may be found in many cases of the
liquid evacuations.

Consistency and Form. The normal
consistency 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 accompanies
the discharge of small lumpy masses
has by some been considered evidence of
stenosis in the lower portion of the large
intestine due most usually to cancerous
growth. The correctness of this opinion
is however extremely doubtful, as cases
in which similar appearances have
been present have been shown by a post
mortem examination to be free from
stenosis of any sort.  

grooving is present to such an extent as to divide the man transversely into segments. It is an accompaniment of increased consistence. In all probability several smaller manes 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 manes resembling the dung of sheep.

The consistence depends on the proportion of liquid in the feces, and is, to some extent, influenced by the nature of the food. It has been shown that an average mixed diet gives a proportion of 75% of water in the feces, 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 feces consists of post material such as the hull of fruits or vegetables, fat, or oil, some influence is, of course, exerted on the con-

existence of the evacuations. The amount of water taken by the mouth has little or no influence on the amount found in the stool, 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-caecal valve, however, the absorption is largely in excess of the secretion, so 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 bowel, 
progressing from the jejunum to the cecum, 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. 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 constancy of 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 evacuations to be loose

price even in health the intestinal contents at the ileo-caecal valve are quite liquid and rendered so 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 excrections 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 it: more rapid passage through the intestinal tract. These are other causes of increased absorption in addition to increased peristalsis, and among these 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 streams from the intestine.
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 bowel. 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 lesser degree of exudation may occur in disease of the heart, lungs, or liver where so called backward pressure is exerted on the portal venous system in ealarrh of the intestinal mucous membrane, in addition to the increased permeation of water. The increased amount of mucus helps to cause a soft consistency of the feces, and later, faeces is due in great part the happy condition of the stools in ealarrh limited to the small intestine.
other causes of loose stools are the discharge into the alimentary tract of large quantities of abnormal fluids such as the contents of ovariae or hydatid cysts, or of large abscesses, or a profuse hemorrhage.

**Colour of Feces.** The colour of human feces 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 — hydrobilein — and which is derived from the pigment of the bile by a process of reduction resulting from the action of an organic agent. In the intestine of the fetus this organic acid is not present and consequently the pigment of the meconium is that of the bile, in the form of bile pigments. For the first few days of extrauterine life, hydrobilein is not to be found, but with the

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other products of decomposition is shortly appears, at first along with unaltered bile pigments and later entirely replacing them. Why the bile pigments are not more speedily replaced by it after the introduction of decomposing agents into the child's intestinal track, might be explained by a gradually changing composition of the digestive juices, there being at first such as to prevent the organisms from exerting their peculiar action. The 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 content through the alimentary tract of the suckling than through that of an older individual. In experiment conducted in starved animals, in whom the feces must be entirely composed of material proceeding from the secretions of the alimentary tract.
Stoppe-Seyler & Müller found that in their hydrobiliarubin 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 required organism requisite for the production of the former.

The pigment, hydrobiliarubin, is contained partly in solution in the intestinal fluids, partly it passes certain solid constituents of the feces, 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 pleased.

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

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


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 to a great part to the undecomposed haematin in the undigested muscular fibres. Where a large residue of white or light coloured food material such as milk, fat or fructans 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 clares and coffee may be mentioned as examples, give a peculiar colour to the faeces from the presence of their unchanged pigments. Many medicinal substances

such as phlobaphene, saffron, haematocystin, 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 special black discoloration is produced. Observations I have recently made with regard to bismuth show that it is present in the fæces in the form of dark crystals.\(^1\) The green stools following the use of calomel are explained by its antiperistaltic influence, and the consequent discharge of bile-pigment unaltered in bile- verdies.\(^2\) 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.

\(^2\) *Bruchheim*, quoted by Laura Brunton, "Pharmacoepidemiology. Der u. Med. Buch" p. 605
fafer in states of the system such as anemia and icterus, where the amount of pigment in the blood is decreased, a fact accounted for by the origin of the hydrobiliurubin from the bile pigment and, therefore, ultimately from the blood pigment. A leniency of the secretion of the bile such as occurs in some cases of chronic hepatic disease, naturally results in a leniency formation of fecal pigment and in a lighter coloration of the stool, 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 rule 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 that in cases of obstructive jaundice the intestinal secretions are, like the other secretions.
of the body stained with bile 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. Alcalini mentions such a case where the post-mortem examination showed 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 Grabhardt and Fasenberger in which no satisfactory explanation

1. [Reference]
2. [Reference]
was forthcoming. Rothenapel\textsuperscript{1} records cases where slapy 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 pigment or of blood in the stools. Unaltered bile pigment are not found in normal defecations, except in very young children. In the adult the application of Emelie's test for bile pigment, in examining the intestinal contents, is negative below the fecal valve, although in the ileum except in its lowest part a decided reaction is to be obtained. If, then, unaltered bile pigment are found in the feces, it is apparent that some morbid condition is present in the small intestine.

\textsuperscript{1} Beträge zur Phys. Path. des Darmes, p. 189.
\textsuperscript{2} Ibid. p. 157.
ling their conversion into hydrobili-
rubin. The most usual cause of this
prevention is increased peristalsis
such as is met with in intestinal in-
flammation of different degrees, or in
some cases of ulceration, time thus not
being allowed for the necessary chemical
change. A recent observation of Koth-
napf shows, however, that although-
bile pigment 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, there-
fore, be concluded that when unaltered
bile pigments are found in the feces
of an adult there exist a morbid con-
dition in at any rate a portion of
both small and large intestine, these
cases being of course excluded where
its presence results from the use of
chloroform or other medicine. In
certain cases of diarrhoea the stools
are coloured a bright green and al-
though various theories have been

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 pigment, 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 faces through blood will be better discussed along with the other changes in the faces resulting from haemorrhage into the alimentary tract.

**Odour.** The meconium is without odour. The odour of the faces of newborns 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 fecal odour is quite distinct. It results from the decomposition of albuminous material and is due to an unknown body, which has no great an affinity for iodol and phthalol that, until these were isolated and found to be themselves odourless, the fecal odour was ascribed to them. Besides its natural production in the intestinal tract, it is formed during the rotting of pancreatic tissue, and also when caustic potash is heated in contact with albumen. This peculiar substance is not present in the feces until a mixed diet has been taken. It is not yet explained why it is absent from the feces of poultries, although the observations of Biesbock throw some light upon the question. The microorganism described by lui as the bacteria of albumen decomposition (Eiweiss-fäulniss)

2. Prof. W. Rutherford's lectures. 1882-85.
and which was found to cause a fecal smell when peptones and flesh-extract were infected with it, is not found in the feces of sucklings.

The odour of the feces 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 disagreeable. It is plumper on a flesh diet than on a vegetable diet. The peculiarly fecal smell is naturally relieved by the discharge of copious diarrhoeic stools, and in cholera it is not noticeable at all.\(^3\)

In addition to the substance causing the characteristic fecal odour, the smell from feces depends on volatile fatty acids. The secretions of the large intestines, oil, phlegm, by drogues if this is present, 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.

2. Loundy and Stirling, J. 405
3. Achimie, Lecain, Out of Medicine. 1°, 4°
In certain diseases such as typhoid fever and dysentery it is asserted that experience may lead to the acquiring of a power of diagnosing through the odour arising from the faeces. 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 dysenteries the odour is putrid. In obstructive jaundice and in chronic intestinal catarrh, the intensely disagreeable odour which sometimes results from the increased fermentative decomposition.

**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 intestine, and is therefore influenced by the food. When the food consists especially of vegetable matter or fat, the acidity is greater.

2. Landow and Stirling. p. 465
than on a more purely flesh diet.

The contents of the stomach are acid but after entering the duodenum, the addition of the plentiful alkaline pancreatic juice renders them alkaline, the bile is neutral and the intestinal juices alkaline so that the reaction continues alkaline till below the ileo-colic 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 necessary 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

acid reaction. In the mechanism, 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 intra-uterine life. In the meantime, the smaller amount of pancreatic juice and the kind of food must have a considerable tendency in determining the form 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...

O. Lanzendorf: Der Bois Raymond's Archiv für Physiologie 1899.
due not only directly to the absence of alkaline juice, but also indirectly, since in such cases the digestion of carbohydrates and the absorption of fat and fatty acids is affected, and the increase of their unabsorbed residue increases also the material capable of undergoing fermentive changes. Increased acidity resulting from obstruction to the flow of bile into the intestine is peculiarly explained by the increase of fermentable matter, and perhaps to some extent by the absence of the retarding influence the bile may exert on organised ferment.

In diarrhoea the reaction of the evacuations is usually alkaline, when 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 food through the large intestine. Where the intestinal secretion is much increased
it and to the retention of the alkaline reaction, and so perhaps does sometimes the exudation of serum from ulcerated surfaces. In cases of dysenteric the ammonia generated by putrid decomposition may render the stools alkaline.

**The Constituents of Feces.**

Having now considered the more general characters of feces, 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, but 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 and to determining the part of the alimentary tract which is diseased.

Probably the most valuable help to localization 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 mucous and epithelium, (i.e. epithelium detached from the intestinal wall), are readily stained by the bile pigment, they are less easily affected by the fecal pigment, and hence some evidence as to their origin may be obtained, for it is clear that if they are fragmented and at the same time there is no reason to suspect
the presence of bile pigment in part of the intestine in which it is not usually found, the evidence is in favour of their having proceeded from the small intestine.

A more rigorous 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 in order to separate the ingredients from each other and the whole must then be pressed through a fine piece of porous paper. 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 feces have been washed, and which contains the part of them which is fine enough to have passed through the sieve, to stand till a沉淀物 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 fecal 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 fat, a solution of iodine and iodide of potassium for starch, etc., and it is well also to have solvents of fats for use in cases where there may be present in such amount as to conceal the other constituent.

Staining reagents are a useful aid in distinguishing epithelial structures or pus cells and to render micro-organisms more apparent. For the former purpose, Zeydlewski recommends a thin watery solution of eosin. I have found Pasmink brown of more use, and for staining bacteria etc., an aurine solution of gentian violet.

The description of the various constituents of feces 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

of the macroscopic and microscopic characters of the several constituents is considered and then discussed in the case of each along with the causes of its presence, and the aid it affords in 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 it is that of the breast fed child, it is usual to find that some of the digestible foodstuff 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 a state of perfect health, when excess of food is taken the amount of food residue is increased. Under diseased conditions the amount of the residue or 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 precocity 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 undi-
gested condition, owing to a very much
abnormally increased rate of peristaltic
action of the walls of the stomach and
intestines. In other cases the pre-
sence 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 condition
of the faces is that where a direct com-
munication exists between the stomach,
on the upper part of the small intestine and the colon.

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 vegetable and fruits and imperfect mastication must be recognized as important factors in preserving the amount of digestible matter in the stool.

The food may not be excreted in the
pains from which it was taken. It is
easily comprehensible that digestion may
have occurred and the food have been tran-
formed into a soluble form, but that, owing
to an increased rate at which it is propelled
along the lower part of the intestines, no
line may have been allowed for its com-
plete absorption during its transit. In
other instances owing to chemical or other
conditions the changed food may be
met with in solid form, the most usual
of which are the crystalline of Magnesium
soap or the fatty crystals so often met
with when incomplete absorption of fat
has taken place.

The recognition of an increased residue
of food in the feces has important clini-
cal 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
substitutes for the digestive juices such
as will prevent the loading up of the diges-
tive apparatus with material which is
undigestible under existing circumstance,
and the group of which, even 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 stool, may prove of considerable value in other ways. It is not infrequently found, even in the course of work in hospital, 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
ploofs 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 purgative feeding was disarmed by the patient's apparent convalescence and truthfulness, and by the failure of all attempts at detection. To ensure certainty the stools were carefully examined as a last resource, and the discovery of grape seeds 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 stool, as a means of gaining information as to whether medicine has not been given in an unmentionable 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 scattered 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 ingredient, 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, etc., indicates, as a rule, little more than imperfect mastication: if they are visible merely from the apperation of small particles, as in milk, fat, etc., it is evidence merely of abnormally increased amount being present.

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

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 intestines, but, even
then they retain enough of their own pigment to distinguish them from plainly shaped masses. In presence of much muscle in the stools, where no loss of flesh diet is taken, there a deficiency either of digestive juices or of their special albuminoid digestive ferments.

Fat are present in the normal stool of adults in only small quantity. In suckling they form the greater part of the stool. The quantity present depend 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 fever or other disease leading to a diminution of the secretions of the digestive juices, increased rate of intestinal peristalsis &c. These however special morbid condition in which, apart from any variation which may occur from the above causes, the amount of fat becomes increased. Bright (1)

seems to have been the first to make diagnostic use of the presence of an abnormal quantity of fat in the feces, thinking it arose from a morbid condition of the small intestine. This idea was later abandoned, when Hunter shown pancreatic disease as a cause of excess of fat in the stool, and Claude 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 stool, were therefore all referred to disease of this gland. Krehl's experiments, however, proved that digestion of fat might be completed while the entrance of pancreatic juice into the intestinal juice was prevented, although

(1) Linnæus' Handbuch der Phle Patth & Ther. 1788, p. 314.
(2) Virchow's Handbuch der Phle Patth & Ther. 1876, p. 229.
there was no doubt that when present its action aided the process. This fact has been confirmed by combined clinical and pathological observation. It has in addition been shown that in the cases where the greatest amount of fat has been present in the feces, 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 apt 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 feces, in others the bile suffices to render all fat for absorption, and in yet others, while the pancreas is working healthily, a fault in the biliary secretion alone may lead to fatty defecations. Apart then from other symptoms, no definite diagnosis can be

(1) Ziemer's Handbuch der inneren Medizin, p. 220-221.
Can be made as to whether excess of fat in the face is due to a derangement of the liver or of the pancreas, or of both of them.

Cases of pancreatitis disease have occurred in which it appears that fat was excreted from some part of the intestinal tract. These cases were characterized 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 showed 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 prevented in compensation 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 lipemic, and the superfluous fat is it

is secreted from the intestinal mucous membrane.

Fatty substances in the feces may be either fatty acid, neutral fats, or soaps. Chiefly the two latter are found. The bile and mucus, soap formed in the intestine are insoluble and therefore not absorbed and pass on with the feces, 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 stool. Occasionally almost the whole stool may consist of them. Microscopically they are, in my experience, most usually seen as small droplets, and less often in crystalline form, groups of acicular crystals arranged in platelets or more globular form.

The crystal may be mistaken for tyrocid in certain chemical tests. 2
0
Cassie is occasionally found in considerable quantity in the form of
pucklings, but these normally consist chiefly of fat. When present
cassie may be in the form of small round bodies, of a size varying from
that of a pea to that of a snail's head.
They are always plained yellow, but
the outside of one of the larger lumps not
so deeply as the outside.

The vegetable constituent of the food also, certain are entirely undigested, e.g. epithelial structures, hair, vessels, and probably cellulin, although
Szydlowski assures otherwise with regard to it. 3 These vegetable structures
are to be met with in the faces of any individual fed on an ordinary mixed diet, and are easily recognizable. The
most commonly met with are the hairs derived from the flesh of loaves or of

3 quoted by Ecklows.
oat. They are seen microscopically as long, white, septate and crystal-like bodies, tapering to a point at one end, at the other slightly bulbous, 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 (Eadnach 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.

Only young vegetables are capable of entire digestion, and the cellular envelopes of older tissues 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.

but may, all the same, be pigmented, retaining during their passage through the alimentary tract their own peculiar pigment. That this is possible is clear from the colour which coffee gives to the face, 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.

Marrow is not a normal constituent of feces under a mixed diet. The only fume in which it is found, except when the plash digestion processes are deranged or excess of amylaceous food has been taken, is enclosed within cellular capsules in the cellular contents of some vegetable tissue.

It is recognizable when in the form of granules, by the characteristic concentric laminations 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, turns it blue. Sometimes when prepara-
tions of digestion are taken internally. Blue granules are to be met with on microscopic examination of the faces. Constituent, 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 faces.

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 faces 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

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 rhombooidal form, though in all other respects similar to those surrounding them. They are all no doubt formed of bismuth in a solid form.

The presence of cholesterol 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 as the adult as such a form as to be visible on microscopic examination. Mareet 1 failed to get any indication of it presence even chemically in the faces of adults, and considered that it became converted into excretory. He found that this latter substance was not present in the meconium or the faces of young children, but that from

them cholesterinie could be obtained. All authors quoting their own observations found cholesterinie in the intestinal evacuations, excreting 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 crystal so frequent met with. It has however occasionally been observed; in one case in the false membrane of membranous enteritis, in others forming part of intestinal concretions. It is a constant constituent of gallstone. Happe-Decker found that like other constituent of the bile not present under ordinary conditions, it appeared in the faces of sloved animals.

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

1 Rothuage. Beiträge zur Physiologie des Darms. p. 165
3 Ralfz. Clinical Chemistry. p. 258
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 pigeon's 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 bladder by the formation of a fistula into the intestine.

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

tie derived from the mucus of the bile, an chiefly various ball, 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 feces to some extent. It forms a large part of the meconium, but beyond the first few days of life it exists in the feces, 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 former manes of feces, mucus has had its origin in the lower part of the intestine.

Its presence may be due merely to the retention of feces for a long time in the rectum, and the consequent
irritation of the mucous membrane. When, however, it 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. In some cases of dependent the motions may consist entirely of mucus.

Mucus may appear as a clear, viscous, 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, catarrh, and some cases of dependent. Where it proceed 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 fecal ingredients, and when it arises from the small intestine, more usually so than when from the lower part of the bowel. In some cases of intestinal catarrh only, the

small intestine or upper part of the large intestine is implicated, and the microscopic examination of the faces is then of use to aid in diagnosis. Internally 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. They are not of frequent occurrence, and indeed, trustworthy observers appear inclined to arrest that fragment 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 who first described them was, that they shewed a preponderating affection of the follicles of the large intestine. Heubner said that they were formed by the

accumulation of mucus in the follicles of the large intestine, and another suppos-
tion was that they arose from the Lie-
berthal's follicles in follicular en-
teritis. 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 dis-
charged from the bowel, sometimes in
the form of casts or part of the intestine.

An examination shows these casts to
consist chiefly of mucus. No special
severity of disease seems to be indica-
ted by their presence and no satis-
factory explanation of their occurrence
has been offered. It has been sugges-
ted that reactivity of the bowel al-
low the accumulation of mucus
in the folds of the intestinal walls,
and that these accumulations are
rolled together and formed into a con-
tinuous cylindrical membraneous

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

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. Polyphoid tumours either mucous or lipomatosus are occasionally de-
tached from the wall of the intestine and paved in the stools. Sometimes,
also, pieces of carcinomatous tissue.
Kunderlech had a case where a piece as large as a walnut was discharged.
In micturition large portions of
recored bowel may be passed. One
case is recorded in which the evacuated
portion was three metres long.

1 Medecine Curie, and Gazette. 1887. Vol. 1, p. 47.
Thread or large pieces of the mucous membrane are sometimes discharged, the especial disease in which this occurs being the malignant tropical form of dysentery. According to Rothnagel, thread of time although found in the stools in cases of dysenteric ulceration are never found in cases of catarrhal, typhoid or tubercular ulcers. Allchvin, however, speaks of their occasional presence in the stool of patients suffering from typhoid fever.

Epithelium. Among older authors 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 pucklings) is pathological. Woodward and Rydellrostki, indeed, have asserted that even in disease of the intestinal...

4. Invited by Rothnagel.
tract its presence is by no means frequent, although the researches of others 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 peeling off of these by the fetus 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 strati-For some years this has been in use as a means of making the finding of similar epithelial cells in many certain cases easy in the diagnosis.

1. Rothague, "Beiträge zu Phy., Path. des Kindes" p. 105
2. 24th, 1807.
of carcinoma of the intestine. According to Nérovdt, the faces of pucklings contain almost always isolated remains of columnar epithelium. When present in the faces of adults it is constantly accompanied by some mucus. It may proceed from either small or large intestine, a point liable to some extent as in the case of other constituents of the faces, 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 accentiosa, Cholera infantum and some cases of typhoid fever. 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 faces, as also that of supposing epithelium to be an ordinary constituent of them, probably arose from the result of

1. Fehrland, Handbuch, der Anatomic des Kindes, "Path. der Anusen."


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 feces 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 refractive bodies, the nuclei being recognisable as proportion as the condition is more advanced.

Rotheqel, who describes 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 thickened. When deeply stained, nuclei's reaction is usually to be obtained, and other preparations point to a catarhal con-

tion of the small intestine. In some cases of dysentery, the shedding of epithelium is so great that it gives to the mucous discharge an opalescent appearance, similar to such as might be caused by the presence of pus. Epithelium forms a considerable part of the mucus of false membrane found in certain forms of enteritis.

Blood. The occurrence of blood in the stool 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 stool 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 piles. At times the defecations may consist entirely of blood, as when an aneurysm 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
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 pigment of the blood in faces will be
found to have undergone chemical change,
being converted into hematin, or if a
still more prolonged time is allowed
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 "melanous", which
is, however, now applied in a much more
general sense. The colour of faces con-
taining 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 haemor-
ghage proceeds. To determine this point
another consideration is also of great im-
portance, especially if the faces are firms
when discharged, viz. the relation in which
the blood is found with the other constitu-

cut of the discharges. As low as the upper end of the colon the intestinal content, are fluid and blood poured into the gut mixes intimately with the residue of the food. etc. When, however, the blood is discharged into the lower part of the bowels, which contains fecal 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 hemorrhoid, polypi of the rectum, or other causes of hemorrhage into the lower part of the colon the faces are covered with unchanged blood.

In cases, however, where the small intestine is the site of hemorrhage, the alkaline reaction of its content, being unfavorable to the rapid clotting of blood, the latter is found disseminated throughout the stool, and its color too is more or less altered, except where the quantity of it is extremely large. When the hemorrhage 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 fluid.

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 faces may be, the more intimately will it be mixed with the other ingredients.

Echorst denies, however, that it is possible to make any differential diagnosis between haemorrhage 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.


② Eckhardt, "Die Unlungen, Medizinische 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 puridid 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 hemorrhage is in the lower part of the bowel and the blood has not remained long in the intestine. But 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, showing the beginning of disintegration. Often all that is recognizable 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 faces is advisable, according to Rothgajel, 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 faces in the form of crystals as is recorded in most texts books of clinical medicine. The most definite statement on this subject, that I have found,

are those of Jaekel. He found them not seldom in the face, especially in chronic intestinal catarrh, and further in numerous cases in which some day previous there had been intestinal hemorrhage. These were crystals of hemosiderin, the crystalline structure in most cases not being very clear. Especially well marked crystals he obtained in a case of hepatic cirrhosis. The crystals are hardly free and hardly enclosed in masses of mucus.

While engaged in examining microscopically the face 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 case of cancerous disease of the stomach accompanied by hemorrhage I found in both face and vomit numerous rhomboid crystals, some lying singly, others arranged in clusters. The larger were black in colour, the smaller and therefore more translucent, of a dark reddish brown. They were at first confounded with crystals of hematin. But their somewhat large size and regular crystallisation led me to seek some other explanation of their presence. I suspected the

*Almischen Diagnose der inneren Krankheiten.*
possibility of their being crystals of this 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 the opportunity of examining the stools. Experiments on healthy individuals showed my suspicion to be well founded. I found the same crystals in all cases in which I saw bismuth and afterward examined the stool with the microscope. I am not aware that the occurrence of bismuth in this form in the face 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 hemorrhage 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 feces, or foreign bodies through the intestine. Any acute congestion (severe inflammation) or chronic congestion (portal obstruction, intus-
perception to) may result in capillary hemorrhage, and general diseases in which hemorrhage occurs on other surfaces of the body, such as purpura, typhus, yellow fever, phosphorus poisoning etc., may lead to similar extravasations on the surface of the intestinal mucous membrane.

Many cases are recorded where intestinal hemorrhage has occurred occasionally owing to a suppression of the menstrual flow. Intestinal hemorrhage 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 vari- cause ulcers formed in hemorrhoids, the intestinal ulcers most commonly accompanied by bleeding 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, hemorrhage is infrequent, and excluding the ulcer

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just mentioned, those of typhoid fever and dysentery furnish by far the greater number of cases. In these haemorrhage is comparatively frequent but it occurs seldom in tubercular ulcers and very rarely indeed in catarrhal ulceration. The explanation Rothmayer gives for this inequality of proneness to haemorrhage is, that in tubercular ulceration the rate of its progress is comparatively slow, and the vessels thus formed 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 beside surrounded by an extremely hyperemic 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.

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

for death, it has been impossible to find on post-mortem examination any struc-
tural disease to account for it. Both
mangel records two cases of patient, 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 autol.
omy in many cases of death from Melena me-
nonaturum.  

To be expected that pus
would be a much more frequent patholog-
ic constituent of feces than careful obser-
vation shows to be the case, and when the
conditions of the intestinal mucous mem-
brane are considered, which lead to the
presence of pus in the discharges, and com-
pared 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 phlegm
is considerable, while in catarrh of the
intestine it is unusual for more than
a trace of it to be observed in the mucous

© Edward S. Whit. "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 meconium, 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 probably that any pus cells proceeding from their surface are disintegrated by the action of the intestinal fluid. 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) Nehut et al., "Bdete a nas Polé, 160th de Comite," p. 254D
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 shows to be composed of thickly crowded pus cells. 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 bowels of an abscess which has formed in its neighbourhood.

**Inorganic Constituents of Feces.** Of the inorganic constituents of feces certain are in the form of insoluble salts. Of these, those 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 plentifully in microscopic examination as yellow-stained material, granular or in irregularly corned or rounded forms.

\[\text{\textsuperscript{1} Johurek, p. 240}\]
Crystals of the triple phosphate of ammonium, lime and magnesia are met with in almost every stool examined.

Eischel declares they are never found in the fresh faces of pucklings of the purée in heat separated from them. At one time their presence in the stools was thought pathognomonic of typhoid fever but it is doubtful if they occur in the stools in this disease 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-pect" form, in various imperfect forms of these, 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 Rothenagel,\(^4\) he found them bile stained. They are of no known

ure in diarrhoea. Marxer 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 interlobar evacuations as ammoniacal compounds such as the phosphate. This suggestion arose from the result of Claude Bernard's experiment, where after being 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 stellated crystals.

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

In neither of my cases was this the case.
Charcoal crystals may occur, and are then found in pathological cases embedded in mucous. The folds in which they are contained are always alkaline.
Inorganic salt enters 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. So are extremely seldom, if ever, present in the stool.
Intestinal concretions are formed chiefly in the caecum or rectum. They vary in their composition. 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 feces. One case of this sort is described, where

within three or four weeks, thirty-two concrections were formed 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 fibrous organic matter. Other, 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 if Carbonate of Magnesia, chalk or Oxyde of Bismuth are habitually taken internally by the accumulation and concretion of these in the intestines. These caused by the accumulation of vegetable hairs and threads have already been referred to. Liebler mentions cases when they have been found in the human body, 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...

\footnote{Liebler. Eise Path Anat. NY Trans. Sect 171. p. 278}
\footnote{And p. 299.
occasionally in stools, belong to the
category of foreign bodies, since the food
pe 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 *, all belong to the bor-
derland between the two. Practically,
however, the distinction is of no impor-
tance whatever. Such bodies derive
their importance only from the possible
harm they may do, during their passage
through the intestinal tract, or by becom-
ing 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 this prises. 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: - snails, beetles,
flies, dominos, cigar-holders & co., coins, pins, and buttons are of less
seldom occurrence as foreign bodies in the stool.

Parasites. Parasitic organisms found in the feces 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 feces 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 diag
nosis.

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 certain occasions.

The Protozoa are represented by comparatively few forms. The Amoeba coli is met with in cases of dysentery; Paramecium (Balantidium) coli and Trichomonas intestinalis, Pyloricus, and Cercamonas intestinalis, a flagellate Infusorian, are also met with in pathological conditions such as intestinal catarrh, typhoid ulceration, and cholera. Rothnagel occasionally met with a form like the last of these, but without flagella, in various diarrheic stools. The relation of all these low forms of animal life to morbid processes in the intestines 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
which they are found have provided a soil suitable for their growth, but cases are reported where diarrhoea 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 these in great numbers has aggravated the intestinal disease.

Very rarely some forms of Fasciola are found in man, and their oval shape might then lead to their being mistaken for the eggs of some species of worms.

The larvae of mosquitos, alive as well as dead, are occasionally found in the feces under circumstances showing that they must have traversed the alimentary tract.

Their presence must be considered accidental.

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

2. Leuckart, Parasites of Man, p. 156.
3. Leuckart.
unnecessary to describe here the life history of the different species or their general characteristics. Of the Cestodes the more commonly met with are *Dacia capulata*, *Dacia polynia*, and *Bothriocephalus latus*. It is right that the importance should be emphasized of a search in the stool for the head of any of the tape-worms for the removal of which anthelminthics have been given. Unless the head is found there can be no certainty that the source of trouble is removed.

Of the Nematoedes the most common are *Oxyuris vermicularis*, *Ascaris lumbricoides*, *Trichinella spiralis*, *Dracunculus duodenalis*, and *Trichinella spiralis*. Besides, the adult animal, the eggs of all these species, except *Trichinella spiralis*, may be found in the feces, also those of two *Nematodes* - *Doloma hepaticum* and *Doloma 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
inhabit which the latter reach the intestinal canal by ulceration affecting the vessels of the lower part of the colon. These two parasites are themselves very rarely met with in the faeces.

The eggs of Trichinella spiralis are not met with because they are hatched in the upper part of the small intestine and the embryos on being liberated at once bore into the tissues. The adult Trichinella may be met with in the above defecations during the first five or six weeks of the existence of Trichiniensis.

In many cases of Trichina in the small intestine the eggs are not found in the stool, apart from those contained in the first formation, since they are liberated only by the rupture of those that do not usually occur till they are disintegrated from the bowel.

The eggs of Trichina are spherical, and have a thick shell with radial mark-ups on it. Some of T. polonica are rather more spherical.

1. Backhaus' Parasitica of Man, p. 46.
cal and smaller than are those of T. sagreiata. The eggs of the remaining species already mentioned are oval. Those of Dintoma hepaticum are from two to three times the size of the others. Those of Bothriocephalus latus and Dintoma lanceolatum have usually a small inconspicuous lid at one end. The eggs of Ancarsis lumbricoides and Bothriocephalus 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 furnished with a plug of albumen.

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

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

Rhabditis pteronotus is the embryo of Ampullula intestinalis, an occasional

\[1\] Luckeart, Parasites of Man, p 114
parasitic thread worms, and is found in incredible numbers in the stools of those suffering from Coecum Chucas diarrhoea, which is occasioned by their presence.


The greater part of the last few pages on animal parasites is compiled from Leuckart's "Parasites of man". Inflex Translation.

The Vegetable Microorganisms of Feces.

A considerable part of the feces consist of micro-organisms, and the great interest which has of late years centred around these 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 alimental dejections was mentioned as early as the year 1719.

2. See footnotes in Berlioz's "Darmbacterien des Pansenbarren".
by Lemoine. Later observers 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 lower 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 microorganisms 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

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

Investigations were begun with a micro-
scopic investigation of stools in such a con-
dition as they would usually be in, when
taken for examination of other
contents; and a great advance was made
when the necessity was shown for precau-
tionary 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 bile cultures by
Möhr, some such means of isolating dif-
ferent species being especially necessary
where as in the fæces 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 intestine, follows as a natural sequence.

It might, however, be asked, "what advantage is to accrue from a knowledge of the microorganisms of the face?" In answer to such a question, it may be said that we might 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
pied 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 develop 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 in
individual forms of organism cause, would
enable proper treatment to be adopted when
harmful products resulted, which might
occasion disease through their absorption
into the system. An indication to
ward prophylactic measures is given
by the experiments of Koch with the
cholera bacillus, in which it was shown
that definite derangements of the alimentary
tract (increased acidity or alkalinity of
the stomach and proved intestinal per-
stalsis), predisposed to the development
of the germs in the intestines and produc-
ton of the disease.

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

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

In no microorganisms are to be found in a living fetus in utero excepting, perhaps, when it has been infected from the mother with the organisms of some specific disease, and so also in the oncoming 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 ano. 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 fall numerous organisms and their spores. The results of Fischler's 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. Fischler, "Die Darmbacterien des Faules" p. 111.
2. "Die Darmbacterien des Faules" 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 with the blood to some part of the intestinal wall and produce there a lesion leading to ulceration, e.g. some cases of intestinal tuberculosis.

It does not follow because certain micro-organisms are found in the feces 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 feces. As a matter of fact the species one does
find in the faces are limited in number, and those that are constantly found here are more restricted, and not those most commonly to be met with outside the body. This is explained by the fact that different species flourish under different conditions and 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 being constantly swallowed with the saliva and food. Most of the flora, however, which flourish in the mouth are absent from the face. 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. Talk indeed
proved 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 recognized that the gastric juice takes some part in limiting the number of species among intestinal organisms, and Koch's observation on cholera shows that, in regard to at any rate some pathological forms, a dilution of it through heavy superfluous feeding and their passage into the intestine after a plate allowing their development.

Still, too much emphasis must not be laid on the result of Falk's experiment as an explanation of why so comparative few forms do develop in the alimentary tract below the stomach, since the acid of the gastric juice is often much always much diluted, and at other times poor.

3. Ibid. p. 378.
in health reduced so much as to be scarcely recognisable. The destruction of microorganisms 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 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 the examination of the bacteria found in faeces differing in composition, shows that the species present are not the same. Search experimented on puppies. 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.

of nature during the life of each human individual. As the meconium gives place to the feces resulting from the use of milk as food, a change takes place in the form of bacteria present; a second change occurs when a varied 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 feces.  

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, just 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 microorganisms, has already being absorbed.

1 Burkh. "Die Darminfektionen," 2. Aufl., 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 bacterial vegetation is experienced by every one who has attempted publications 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 in his experiments on animals with the comma bacillus of cholera. Where the intestinal peristalsis is increased, other conditions remaining the same, both fewer species and fewer individuals might be expected to be found in the feces. On the other hand,
travel, a delayed peristalsis would produce
the opposite plate of matter.

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 indivi-
duals are found in liquid stool than
in solid.

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

The fact that one species may possess
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 fecal bacteria, and probably explaining in great part the varying and contradictory assertions of the investigators who have hitherto worked on the subject.

Of the various means available to distinguish different species, the earliest investigators used only the microscope; some of the later, especially Oenistock, 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, the 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. When 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 microorganisms 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 feces are altogether absent from the growths in various media. Another fallacy, not I believe, before pointed out, which may arise from too great a dependence on the result of cultivations, is due to the fact that species which have found no culti-
able conditions for their development in the intestine, may develop 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 develop in different parts of the intestine. The possibility has, however, been overlooked that conditions suitable for their development may not be met with till 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 these.

An enumeration of all the different species of vegetable organisms which have been found in normal or abnormal condition of the faeces 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, these organisms recognized by some as those alone to be met with normally differ entirely from those classified as such by others.

**Micrococci.** That micrococci are constantly present in feces all authors agree except Bierstock. They occur, however, in much smaller numbers than the rod-shaped forms of bacteria. Neufert showed that they occur more in the upper part of the intestine, while the rod-forms increase in numbers toward the lower part.

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2. Inited by Neufert, p. 29.
3. Compare Kothwegel & Bierstockes.
Erlich says that all the species of cocci (chiefly diplococci & tetracocci) occurring in the faces of pocklings are only occasionally present, although some of them were never wanting. No species of micrococci usually present in faces has as yet been described except the *Streptococcus coli* gravis of Erlich. This is wanting in the faces of pocklings but present in those of adults, and in the meconium. It is 1.2 μ long and 0.4 μ 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 cocci quickly liquefies it and forms colonies at first round, later indented, on the floor of a wide liquefactive funnel. In old cultures a white pediment is formed.

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

D. "Di Dermatobacterium di Pocklinum." 127

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1. 1877, p. 77.
but overgrown by small papillaceous scales.

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

_Bacterium Brunoii_ according to Roth, Nagel, and Falsch, the most frequently occurring of the bacteria found in faces, although they are not supported by others in their assertion. 3. _Brunoii_ is seen both in a movable and in gooslaa form. In the former it is seen as a small dumb-bell shaped organism, 2 μ long by 5 μ broad. Gooslaa at each end have been described. In its gooslaa 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 brownish green, later a deep citron colour.

On potatoes it causes a dusty grey slimy layer rapidly covering the cut surface of the potatoes. In liquid media it causes turbidity and its growth is accompanied

by a penetrating putrescent odour.

Proteus Vulgaris, is a moving rod form, 2 μ long and 0.4 μ broad. It occurs in other developmental forms among which are "drumstick" forms, thin threads, and free somewhat distorted pores. The whole development of this micro-organism has not yet been worked out but a suspicion exists from its assumed some of the above mentioned forms that it is the same as Beijerinck's bacillus of albumen decomposition. It gives a clove-like odour to its cultures. In plateine cultivation it causes liquefaction. Its deep colonies have an appearance as if they had come to a standstill after rotating on their own axes. Blood serum is quickly liquefied. On Potato a clear, yellow growth is formed, which has a star-like outline, is flat and has a glaucous surface.

Bacterium lactis aerogenes consists of a short rod, 1-2 μ long and 0.5-1 μ broad.

(1) "Beim Darmbakterien der Rauflüge," p. 74.
(2) Le papier.
(3) Pärlich - as above p. 59.
It has rounded corners so that the shorter individuals may appear oval or round. In some 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 motile or nonmotile. In gelatine a quick growth takes place, nonliquefactive, but forming round, compact, 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 potato, old, a formed a quickly growing layer of whitish yellow colour, of fluffy consistency, and chewing 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 bacteria lead to the formation of lactic acid.

It is always present, even if only in small numbers, in the faces of budding.
but occurs in greater quantity in the upper part of the small intestine (where is more milk sugar). It is absent from meconium and from feces resulting from a flesh diet.

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

2. ibid. p. 63.
early in gelatine, and liquefy it but forming colonies of which the deep have a radiating appearance, or show 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 hats, 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 concave arrangement can be made out. On Agar and on blood agar the colonies are not characteristic.

On young potatoes, a thick, juicy, glaucous layer is formed, of a yellowish-brown colour. Milk becomes clotted and of an acid reaction a few days after it is inoculated. 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 feces. It is doubtfully the same micro-organism as that Grieser has isolated from feces and considers the micro-organism of propionic acid fermentation.

Clostridium Butyricum, which is according to Hoehnfeld usually, and according to Dakech always in normal feces, is specially distinguished by its reaction to a solution of iodine and iodide of potassium, being colored blue by it. It occurs in several forms, developing the one into the other. One form consists of friable, granular micrococci in goopled masses, colored violet-red by the above solution; a second, of thin short rods pointed at one end and also stained violet-red.

1 Enrich, p. 145. 2 Ibid. p. 73.
3 "Beiträge zur Physiol. Path. der Darmen," p. 117.
These may contain spherical bodies as coloured by the solution. A third form consists in long threads with spheres, 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 sparingly when no starch or other vegetable matter is contained in the feces; when these are present the Chlorella 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 terms Nothnagel pays this species in the most abundantly occurring. He never found them in the intestine above the lower part
of the ileum. All attempts at artificial
cultivation of these have proved unsuccessful.
No other observers mention having found
this species. Eberich 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 plate
with such a solution as Rothmayer or
Jaksch used.

Bacillus pubilis also, according to Roth-
mayer and Jaksch is, of frequent, though
not constant occurrence in the faces, in
both firm and loose, normal and path-
ological conditions, and is easily recog-
nized from the presence of its large re-
fractile spores. It exists in the form of
rod, 6-8 μ long and 1 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
fusion. In gelatine it causes liquefaction

1 "Die Darmbakterien der Tiere", p. 28.
2 "Bakterien der Physiologie der Pflanzen", p. 113.
3 "Klinische Diagnostik zuwren Krankheiten", p. 128.
4 "Practical Insectary", Woodhead Bros, pp. 128-129.
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 faces mostly the rod-form is seen, sometimes the thread (cylindrical) form. The spores are few and pimple. Freidrich found B. pubilis constantly in the meconium a few hours after birth.

Dienstock denies its presence in the faces 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 infecting 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 pitted, whose edges show formations of a "grape bunch" form. Both forms, although agreeing with each other, differ from B. pubilis, also in the method

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

**Breustock's small Bacillus**. This is a very small form, whose rod shape was made out only by the use of high magnification (Leuc. 1/2 be 5). Under lower powers it appears a microcococcus, 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 showed symptoms of general septic disease, and sometimes died. It occurred in three quarters of the cases that Breustock examined.

**Bacillus of Allgemeine-Decomposition**. (Bacillus der Einfäulnis), of Breustock. This species has a spine about one half the size of that of B. pubilis, and also slightly refractive. It changes into a rod, and this lengthens and then subdivides into extremely short segments, arranged in "rosey" form.

This arrangement is broken up and the

2. *Hvn. p. 15.*
Several segments develop 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 rod is impaired. In the faces only the middle stages are observed.

Peptone and flesh extract inoculated with this bacillus decompose, and give off an exquisitely fragrant smell. Experiment led Bütschke 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. If it is not met with in the faces of sucklings, finding apparently in milk-faces no suitable nutritive material.

The presence of a *Bacillus decomponens* carbohydrates is also mentioned by Bütschke, but it is not described by him.

<sup>1</sup> "Zeitschrift für Kleinere Medicin, 1878.
Spirilla 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 men
tion only two. - Parencæ & Yeast-cells.

Parencæ ventriculi was related by
Molerhoffer to be an almost constant com-
ponent of the faeces of children, but
it is hard to believe the correctness of
such a statement. I have had op-
portunities of examining the stool of
many patients in whose stomachs Pare-
enucæ were present most copiously, and
even in these it was rare to find the
Parencæ 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 parts: -

(1) Quoted by Shorter, p. 93.
(a) large individuals stained yellow (here),
(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 faeces.
It is less common than the others.

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

of the faces are smaller than those of Saccharomyces (Torula) Cerevisiae, and Roth- napek has called them P. Ellipsoides from their predominating shape. It 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 P. Cerevisiae. 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 settle 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 people suffering from thrush. According to Winterhofer, it is swallowed and found unchanged in the evacuations.

1. Quoted by Berch. p. 48.
We come next to consider what influence may be exerted on the bodily economy by the presence in the intestinal tract of these species of micro-organisms 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 these and any influence on the general system is rather supposed than determined.

They are organised ferment, 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 colour of the faces, and also various chemical substances such as indol, methyl, phenol &c. Of 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 product resulting from the fermentation caused by them. Priestley claims that his phrenal bacillus of albumen decomposition is the only one in the faeces causing decomposition of albumen. From its action result ultimately carbonic acid gas and ammonia, but intermediate products are peptone, bencin, hyrozein, phenol, indol, skatol and volatile fatty acids. Also the substances which are the cause of the faecal odour. *Pseudomonas rubelic* probably acts on the fats of the intestinal content and forms various acids and gases. It has been suggested that *Bacterium coli communis* exerts an action on the mucus secreed by the intestinal mucous membrane.

2. Laidow's *Phurling*, *Physiology*, p. 407.
decomposition into products which are reabsorbed. Such a function would correspond with the constant presence of the species in the feces, 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 body's economy. Do they work to its advantage or to its disadvantage? A benefit would result if their action rendered fit for absorption part of the food which would otherwise be lost as a source of nutrition. The bacteria 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 product (peptones), a beneficial influence would be exerted. Juice, 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 po
counterbalanced. If the suggestion mentioned above concerning *Bacterium*
coli communis be true, its action must be considered advantageous. *Bac-
terium lactis aureum* 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 Feces.** A consideration
of the causes mentioned above as regula-
ting the species of bacteria present in the stool, will show how great may be
the variations in species present where pathologica conditions exist in the in-
testinal canal, especially where abnor-
mal secretions or discharges enter it.

There are, however, several specific
bacteria recognized as the cause of di-
sease, which may be found in the
feces, and are deserving of special
notice.
First among them is the comma-bacillus ascertained by Koch to be the cause of Cholera, and accepted by many as such. 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 hannerphage or the presence of decomposed matter. The bacillus is one half to two thirds the size of the bacillus tuberculosis but thicker and flusser, 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 forms...
very active movements. It grows in blood serum and in nutrient gelatine in characteristic form. At first a small, pale, not quite circular droop appears, the contour of which is irregularly defined and has a rough or pellucid 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 cultivation is limited and agar-agar is not liquefied at all. On boiled potatoes, a light greyish 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 there kept moist. The growth stops when the
temperature is lowered to 16 °C, but the bacillus is not killed till 60 °C is reached. The growth ceases also if the air is excluded and is decreased if the media be at all acid. The bacillus has, according to Koch, no resting stage, but Hufnagel 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' plan of making microscopic 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 microscopic preparations are thus easily obtained.

Similar to the organism of Cholera

2. Hufn p. 133.
Ariatica is that found by Frith and Prior in the stools of children suffering from Cholera matritae. It is also comma-shaped but larger and thicker than the organism of true cholera. In gelatine cultures 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 cultures along the whole course of the needle, forming a pack-shaped opacity. In Cholera Ariatica this is rather in the form of a funnel.

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

cultivations. This was first done on Agar-agar plates. Laffers 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 rod at their ends. In bacilli plainly badly but Laffler's method is best.

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 grows well on blood sera, forming a whitish grey somewhat transparent layer.

*Bacillus tuberculosis* in mel with

2. Cohn's Bacteriology 1886. p.175.
in the feces in cases of tubercular ulceration, but it is possible that the individuals found may proceed from phlegm that has been swallowed, so that, before tubercular ulceration can be diagnosed from their presence in the feces other symptoms must be present. It is recognized by the use of the same special staining methods as are employed when it is sought for in other sites. These methods are now no commonly used, and it would be superfluous to describe them here.

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

2. Ibid., p. 444.
spores are often terminal. They show in their protoplasmic part that are little coloured. Red ends are tape-ternip.

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.