

ON THE BACILLUS OF MORGAN NO. I¹—A METACOLON-BACILLUS

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INTRODUCTION

The bacillus of Morgan was first described in the years 1905 and 1906, when Morgan found it in stools from cases of summer diarrhoea in children. The investigations of Morgan were carried on by Morgan and Ledingham (1909), who consider this bacillus one of the main causes of the diarrhoea of infants.

According to the description of the English authors the bacillus of Morgan has the following characters:

It is a Gram negative bacillus of the size of a dysentery or colon bacillus. Ordinarily it is motile, but can occasionally show immobility. It produces acid and gas in media containing glucose, but does not ferment the other ordinarily used sugar media, such as lactose, maltose, sucrose and mannitol. It produces indol in beef broth, but does not coagulate milk or liquefy gelatine.

The production of gas in glucose may be so slight that it can only be observed in agar deep cultures and there may even be no production of gas at all.

Serologically, it was impossible to make a convenient classification of strains of this organism, as the English authors found heterologous strains inagglutinable in a serum produced with a typical strain. In sera from patients they occasionally found agglutination of the homologous strains in the dilution 1:40.

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The microbe was found fairly pathogenic to animals. Rats and monkeys acquired a fatal diarrhoea after feeding on agar slope cultures of the microbe.

The bacillus of Morgan has also been described from Denmark, where first Bahr and Øhrum, and later Bahr and Thomsen found it in stools from diarrhoea of infants. The Danish authors report certain characteristics which differ from the description of Morgan and Ledingham, such as frequent failure to produce indol; yet in spite of these smaller differences there is no doubt as to the identity of the English bacillus of Morgan and the Danish so-called Metacoli.

The Danish authors however classify the microbe in four subgroups according to the growth of the various strains in media not used by the English investigators (galactose, mannose, xylose, arabinose and adonitol). There is however the greatest probability that these subgroups are not of any great importance.

Later on the microbe is mentioned by Tribondeau and Fichet (1916) who found it in stools from clinical dysentery from the Dardanelles. The authors never found the various strains agglutinable in sera from the patients, from whom the strains had been isolated.

Logan (1916) found the bacillus in stools from children suffering from acute diarrhoea and in the stools of 2 out of 21 healthy children.

D'Herelle (1917) reported this microbe as the cause of dysentery, while German authors (Seligman, 1917, Jungmann and Neisser, 1917, Kindberg, 1917) found "atypical dysentery strains," that seem to be identical with the bacillus of Morgan.

Lastly this bacillus has been studied by Bang in Copenhagen.

SOURCE OF MATERIAL STUDIED IN THE PRESENT INVESTIGATION

The technique used in the isolation and study of the following strains has been the one used in the author's work on dysentery in Norway (Thjøtta, 1919).

Immediately after isolation the strains have been examined as to motility, growth in the various sugar media, production of

indol and agglutination in sera from rabbits immunized against typhoid, paratyphoid A and B and dysentery bacilli of groups I, II and III. Then sera were produced against the seven first of the Morgan strains, and each strain tested as to agglutination and complement-fixation in the homologous and heterologous sera.

It will be convenient to give a short résumé of the symptomatology of the patients, from whom the strains were isolated.

I. Acute diarrhoea. Stool fluid without mucous or blood. On plates many colonies of Morgan bacilli.

II. Man, forty-four years old. During the last years occasionally diarrhoea with blood in stool.

Some days before examination of stool, admitted to hospital, suffering from an intense attack of diarrhoea. Abdomen meteoristic. On examination in rectoromanoscop the mucous membrane of the colon appeared swollen, hyperemic and bleeding.

Plates showed numerous colonies of Morgan bacilli.

III. Man, thirty years old. The day before admittance to hospital severe pains in abdomen, diarrhoea, vomiting and cramps. Disease lasted one month, all the time showing a gastrointestinal or intestinal character. Stools of broth consistency, containing mucus.

Plates showed only few colonies of the typical Morgan bacilli.

IV. Woman, thirty years old. Had suffered from chronic diarrhoea for a long time. Discharged 6 to 7 bloody and mucous stools a day. Plates showed numerous colonies of Morgan bacilli. On examination later on, when the stool had become fecal and only contained traces of glassy mucus, there were no colonies of Morgan bacilli to be found in stool.

Patient died six months later from cancer of the colon. Cultures from the colon showed no Morgan bacilli.

V. Woman, forty-five years old. Chronic diarrhoea for two months. Numerous colonies of Morgan bacilli.

VI. Man, sixty-eight years old. In the last six months before admittance to hospital continual diarrhoea; 6 to 7 stools a day, containing big lumps of mucus and pus. Had grown very lean.

Diarrhoea continued in spite of treatment, and the patient died twenty-five days after admittance to the hospital.

Post-mortem examination: As only the examination of the intestine showed anything of interest only this part of the protocol will be cited.

All over the mucous membrane of the colon from caecum to rectum were found extended and numerous ulcers. The ulcers were in the main situated across the intestine, of a rather longish shape. They were ordinarily sharply contoured and had a clean bottom. All ulcers stretched down into the submucous membrane. Only the ulcerations in the rectum had the character of erosions. The healthy parts of mucous membrane between the ulcers were swollen, pale and oedematous. No considerable swelling of the glands.

From the stool and from the ulcers growth of numerous colonies of the typical Morgan bacilli.

VII. Man, twenty-one years old. Suddenly taken ill with severe abdominal pains, tenesmi and stools, containing blood and mucus ten to fifteen times a day. Often hemorrhages pr. rectum. Excessive prostration. Stools at last chocolate coloured, stinking, containing big necrotic fibres of tissue. Temperature about 38°C.

Death in emaciated condition on the eleventh day of disease.

Post-mortem examination: On opening the abdominal cavity the lower parts of the omentum were found discolored, slightly covered with pus and attached to the paries of the pelvis. In the small pelvic cavum were found 50 cc. of pus.

The outside of the small intestine was a little hyperemic in the lower parts, while the serosa of the colon was considerably injected, and fragile. In the mesenterium several swollen, excessive injected glands.

After opening the colon there were found considerable alterations of this intestine. Nearly all the mucous membrane had been dejected and in its place was found an immense ulcer interrupted here and there by small isles of membrane, that was blood coloured and excessively oedematous. The ulcers in many places bared the muscle of the intestine and even perforated it so that only the serosa remained. Very often the process was necrotic, but there were no veritable perforations of the intestine.

Often there were thick brown necrotic fibres (dejected mucous membrane) attached to the ulcerating intestine; or the bottom of the ulcers was filled with a purulent gangrenous and smeary covering.

From the feces and the ulcers were isolated numerous colonies of the typical Morgan bacilli and a strain of proteus.

VIII. Man, forty years old. Suddenly taken ill with numerous stools consisting of mucus, blood and pus. Temperature between 38 and 39°. After the first week of disease the stools became purulent, as if a large ulcer was continually discharging pus.

After one month of disease stools grew solid, and patient recovered.

During the whole disease there might always be cultivated typical Morgan bacilli from the feces and there were never found any other pathogenic microbes in the stools.

The Morgan bacilli disappeared when the stools grew solid.

IX. Man, twenty years old. Suddenly taken ill with severe attack of acute colitis. Stools numerous consisting mostly of pus and mucus.

Recovered after two weeks of illness.

Cultures from stools regularly showed masses of colonies of the Morgan bacilli.

MORPHOLOGICAL CHARACTERS OF BACILLI ISOLATED

All these strains were Gram negative bacilli. As to motility a disagreement was apparent between the first examination and an examination made a year and a half after the isolation from stools.

On the first examination strain I was found immobile, all the others distinctly motile. On the second examination, however, only one, strain III, of the first seven strains showed motility, while the others had lost this faculty completely.

The two last strains being isolated after that examination were only examined once and were found mobile.

CULTURAL CHARACTER OF BACILLI

All these strains were culturally typical Morgan strains immediately after the isolation. It must, however, be stated that strain IV showed itself atypical in as far as it produced slight acid in mannitol and sucrose after a growth of three days and did not produce indol in beefbroth. It did, however, ferment glucose with production of gas and acid and could serologically not be placed in any other known class of microbes. It was therefore considered as an atypical Morgan strain and studied together with the typical ones.

After the first examination the strains (with the exception of VIII and IX) were grown on artificial media up to one and a half years and then examined as to growth again.

It will be seen from table 1 that five of these strains continually fermented the sugars like typical Morgan strains, not counting a late fermentation of sucrose in strains I and V. Two strains, however (II and IV), had altered their characters so much, that they no longer could be considered Morgan strains, having lost the production of gas in glucose and acquired the faculty of producing acid in mannitol and sucrose. Culturally they had accordingly to be considered as dysentery-strains, a classification that was so much more natural as both these strains on the second examination had lost their motility as well.

TABLE 1
Result of second cultural examination

STRAINS	MANNITOL	MALTOSE	GLUCOSE	SUCROSE	LITMUS WHEY	INDOL
I	0 ¹⁻²⁵	0 ¹⁻²⁵	A + G ¹⁻²⁵	0 ¹⁻¹³ A ¹⁴⁻²⁵	0 ¹⁻²⁵	+
II	0 ¹⁻³ A ⁴⁻²⁵	0 ¹⁻²⁵	A ¹⁻²⁵	0 ¹⁻³ A ⁴⁻²⁵	0 ¹⁻²⁵	+
III	0 ¹⁻²⁵	0 ¹⁻²⁵	A + G ¹⁻²⁵	0 ¹⁻²⁵	0 ¹⁻²⁵	+
IV	A ¹⁻²⁵	0 ¹⁻²⁵	A ¹⁻²⁵	0 ¹⁻⁷ A ⁸⁻²⁵	0 ¹⁻² A ³⁻²⁵	+
V	0 ¹⁻²⁵	0 ¹⁻²⁵	A + G ¹⁻²⁵	0 ¹⁻⁵ A ⁶⁻²⁵	0 ¹⁻²⁵	+
VI	0 ¹⁻²⁵	0 ¹⁻²⁵	A + G ¹⁻²⁵	0 ¹⁻²⁵	0 ¹⁻²⁵	+
VII	0 ¹⁻²⁵	0 ¹⁻²⁵	A + G ¹⁻²⁵	0 ¹⁻²⁵	0 ¹⁻²⁵	+

0, no fermentation.

A, acid.

A + G, acid and gas.

Figures signify the day of the examination.

In litmus whey all the typical strains grew without production of acid, while one of the two dysentery like strains produced acid in this medium. All the strains produced indol in beefbroth on the second examination.

Thus it is obvious that the greater part of the Morgan strains have kept their fermenting faculties unaltered after one and a half years of growth on artificial media, while one typical strain had reverted culturally to the characters of the dysentery bacilli.

AGGLUTINATION TESTS

Immediately after isolation of the Morgan strains agglutination tests had been carried out in serum from patients III, IV, VI, VII, VIII, and IX with the homologous Morgan strain and with *B. typhi*, *B. paratyphi* A and B dysentery I, II and III and always with a negative result.

Sera had been produced by injection in rabbits of heated agar slope cultures emulsified in saline solution, and these sera had been tried against the homologous and heterologous strains.

TABLE 2
Agglutination tests
Lowest dilution; in first examination 1:50; in second 1:5

STRAIN	IMMUNE SERUM PRODUCED AGAINST STRAIN						
	I	II	III	IV	V	VI	VII
I	1600-1600	0-0	0-0	0-0	0-0	0-0	0-0
II	0-0	6400-6400	0-0	0-0	0-5	0-0	0-0
III	0-0	0-0	3200-3200	0-0	0-0	0-0	0-0
IV	0-5	0-5	0-5	6400-6400	0-0	0-0	0-0
V	0-0	0-10	0-0	0-0	6400-6400	800-0	0-0
VI	0-40	0-20	0-20	0-0	0-0	3200-3200	0-0
VII	0-0	0-0	0-0	0-0	0-0	0-0	1600-1600
VIII	0	0	0	0	0	0	0
IX	0	0	0	0	0	0	0

Seven months later the agglutination test was repeated to find out whether the growth on artificial media had altered the reaction or not.

The result of these tests are shown in table 2.

The first column of figures gives the result of the first examination, the second column that of the second one.

It will be noted that all the strains tested show a high agglutination titre in the homologous sera, but none or very low ones in the heterologous sera. Only strain V shows some degree of agglutination in a heterologous serum from strain VI, but this reaction is completely extinguished seven months later.

One year after this examination there were produced new sera, living bacilli being used for the injection. The result of this

third examination was exactly the same as that of the second test.

Thus it is obvious that the bacillus of Morgan neither causes the production of agglutinins in the serum of patients, in whose intestines the bacillus lives, nor are the various strains of this bacillus effected by the agglutinins of other similar strains.

FIXATION OF COMPLEMENT

Corresponding to the agglutination test cross examinations of the fixation of complement by the various strains and sera have been carried out.

The result is given in table 3.

TABLE 3
Fixation of complement

STRAIN	IMMUNE SERUM PRODUCED AGAINST STRAIN						
	I	II	III	IV	V	VI	VII
I	0.0001	0	0	0	0	0	0.1
II	0	0.0032	0	0	0	0	0.2
III	0.05	0	0.0001	0	0	0	0.1
IV	0	0	0	0.0001	0	0—	0.05
V	0	0	0	0	0.0032	0	0
VI	0	0	0	0.0016	0	0.0002	0.0125
VII	0	0	0	0	0	0	0.0016

The titres of complement fixation in homologous strains and sera are always high, while the heterologous strains and sera usually do not cause any absorption of complement. Only one strain, VI, is found to give a fairly high titre when tried with a heterologous serum from strain IV. Titres such as 0.2 and 0.1 are too low to be counted and can hardly be taken as a significance of any relation between strains.

RÉSUMÉ AND DISCUSSION

Nine cases of diarrhoea or dysentery-form colitis are discussed. Two of these ended fatally and the post-mortem examination showed the existence of a severe colitis.

From these cases of intestinal disturbance typical strains of the bacillus no. I of Morgan were isolated, while it was impossible to discover the presence of other pathogenic germs.

Seven of these strains have been studied immediately after isolation as well as after one and a half years of growth on artificial media, and most of them altered their characters considerably during this time. Thus while only one strain was immobile on isolation, only one had kept its faculty of motility at the end of the examination. Further, two strains had lost their power of producing gas in glucose and had achieved the faculty of producing acid in mannitol and sucrose. As these strains had also lost their motility they could culturally no longer be recognized as belonging to the Morgan group, but had to be looked upon as dysentery strains.

Serologically there could not be detected any relation between these strains and other pathogenic microbes such as typhoid, paratyphoid A and B, dysentery I, II and III or colon bacilli. Neither was it possible to find any considerable relation between the various strains themselves, nor did any of the strains show the slightest agglutination in the serum from the patients.

The bacillus no. I of Morgan has hitherto as mentioned before been found and described by a few authors; but it has never been given the place in the bacteriological system where it really belongs.

In considering the question of the identity of this microbe we must first put another question: Is the bacillus of Morgan a microbe *sui generis* or does it consist of several biologically different microbes that only show the same cultural character? It is obvious, that this microbe is not such a well defined germ as the typhoid bacillus, and its characters are in a way not so fixed and stable, since they may alter during the saprophytic growth on artificial media. Yet the fermentative reactions of most of the strains are fairly characteristic even after a long period of saprophytic growth. If therefore one should consider only the cultural characters it is likely that one would look upon the bacillus of Morgan as a special kind of bacillus and put it somewhere in the neighborhood of the colon and the

dysentery bacilli. But if it be so it is a peculiar thing that it is impossible to find any serological connections between strains of the same kind, such as is the case with all the other pathogenic microbes of the intestinal tract. This point is of great importance.

Agglutination is of very little value when it comes to connecting different strains of the colon bacilli. As a rule there is no clear serological connection between colon bacilli from different persons, even if strains are tested that are culturally absolutely alike.

In a very large collection of colon bacilli from calves Christiansen finds that strains of one fermenting type are seldom affected by agglutinating sera produced with other strains from the same fermenting type and that the serological connections are as often found between strains from different fermenting types as within the same cultural type.

Thus it is the rule of the colon bacilli to behave as we have found the Morgan bacilli do. It is therefore natural to conclude that the Morgan bacillus is simply a *Bacterium coli* of a certain fermenting type. Consequently it would be better to give it the Danish name metacolon organism as this name points to the large group of the colon bacilli, while the name of Morgan bacillus gives the idea of a microbe of a certain special type.

The next question to deal with is this:

Is the metacolon bacillus pathogenic and does it cause such severe cases of colitis as those related in this paper? Or does it only occur as a simple saprophyte while the real cause is another, undetected microbe. If we consider the metacolon a pathogenic microbe able to produce a dysentery-form colitis it should be expected that the affected organism would produce antibodies against the homologous strain, especially since the rabbits on being treated with parenteral injections of the microbe very easily produce agglutinins and complement absorbing antibodies. This has, however, never been found to be the case in this investigation, and we cannot therefore bring forth any certain evidence of the pathogenicity of the microbe. It is

not enough that we find the microbe in cases of colitis, as there is nothing to prove that the intestinal flora may not alter considerably under the pathological conditions that take place in the intestines under a severe attack of colitis.

If there be pathogenic as well as non pathogenic specimens of this microbe we have owing to Christiansen's work on the colon bacilli no methods of detecting the pathogenic ones except the direct experiment as to pathogenicity. As the pathogenic colon bacilli show a high degree of diarrhoea producing effect in young calves, it is not unlikely that calves would be the best object for experiments as to the pathogenic action of the metacolon organisms. Such experiments have never been carried out, and for the time being there is nothing to prove that the metacolon organism is more than a saprophytic colon bacillus, that thrives especially well in an inflamed intestine.

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