

A CONTRIBUTION TO THE STUDY OF THE PATHO-
GENESIS OF THE BACILLUS PYOCYANEUS, WITH
SPECIAL REFERENCE TO ITS RELATION TO AN
EPIDEMIC OF DYSENTERY.

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The bacillus pyocyaneus has within recent years attracted attention owing to the results of experimentation with this organism, and also to the publication of a number of isolated instances demonstrating its relation to certain infectious processes in man.

The occasional blue or green staining of surgical dressings has been known for a long time, and the nature of the coloring principle was early ascertained by Fordos,* who was successful in isolating it from such dressings. The cause of the production of the pigment was not, however, discovered until much later, when Gessard,† after a number of unsuccessful attempts by several other investigators, was able to demonstrate that the coloring matter was manufactured by the bacillus pyocyaneus, which he succeeded in growing in pure culture for the first time. Subsequently to Gessard's discovery this bacillus was for some time regarded as a purely saprophytic micro-organism incapable of producing pathological lesions either in animals or in man. Ledderhose‡ was among the first to study experimental infections with the bacillus pyocyaneus, but the present conception of its etiological relations to the production of certain definite pathological processes is due to Charrin's§ admirable researches.

Charrin in his experimental studies of the organism upon animals was able to observe with considerable constancy a marked disposition toward a definite clinical evolution as manifested by the appearance of symptoms which resulted in the presentation of a fairly characteristic clinical entity. To this symptom-complex he gave the name "maladie

* *Compt. rend. Acad. des Sciences*, 1860, li.

† *La pyocyanine*. Thèse de Paris, 1882.

‡ *Deutsch. Zeitschr. f. Chirurgie*, xxviii, 1888.

§ *La maladie pyocyanique*. Paris, 1889.

pyocyanique." In rabbits, even when subcutaneous inoculation is resorted to, the systemic symptoms predominate, and it is in this animal that the disease is presented in its most typical form. The symptoms generally noted are diarrhoea, albuminuria, fever, and in the more chronic cases, cachexia and paralyses, which Charrin considers of a perfectly characteristic type, and in which the hind quarters are the ones most frequently involved. The paralysis is essentially spastic in nature. At autopsy the animals show congestion of the mucous membrane of the intestine and usually small hæmorrhages in the various viscera, but more constantly in the intestinal walls. Schäfer,* although he carried on his experimentation with the dog, arrived at results not unlike those obtained by Charrin. Cadéac,† shortly after the publication of Charrin's results, reported a case of spontaneous pyocyanus infection in the dog. Since this there has been an abundance of experimental evidence which is essentially confirmatory of the conclusions of Charrin, Ledderhose and Schäfer.

The bacillus pyocyanus has been found in the saliva and in sputum by Pansini‡ and Frick,§ who attribute the green color sometimes observed in sputum largely to this bacterium. It has also been detected in the sweat by Eberth¶ and Audouard.|| Abelous** found it in the stomach, and its isolation from wounds from time to time has been already mentioned. Its presence in suppurating wounds is rather infrequent, as shown by Jakowski,†† who was able to find it in his bacteriological examinations only twice in 200 cases of this nature. This same observer obtained it in almost pure culture from a fistula of the large intestine, and a second time from a fistula of the small intestine. Observations of Koch showed the presence of the bacillus in tuberculous cavities.

Investigators at this time generally believed that its presence and association with pathological conditions were only as a saprophyte. The conception of the bacillus pyocyanus as an etiological factor, which possibly might at times excite morbid phenomena, was reserved for

* Inaug.-Diss. Berlin, 1891.

† *Comptes rend. de la Soc. de biol.*, 9. s., ii (1890), 41.

‡ *Virchow's Archiv*, cxxii, 424.

§ *Ibid.*, cxvi (1889), 266.

¶ *Médecin. Centralbl.*, 1873, and *Virchow's Archiv*, lxxii (1875), 512.

|| *Journal de médecine de l'Ouest*, 1879.

** Thèse de Montpellier. 1888.

†† *Zeitschr. f. Hygiene*, xv, 475.

Gruber,* who obtained the organism from a case of middle-ear disease. The recognition of its power to produce pathological conditions has more recently received elucidation in the observations of a number of clinicians and experimenters.

Martha† reports two cases of purulent otitis media from which pure cultures of the bacillus were obtained. It has likewise been cultivated from many other cases of otorrhœa, especially in children, sometimes in pure culture, at other times in association with other organisms, by Maggiora and Gradenigo,‡ Babes,§ Pes and Gradenigo,¶ Finkelstein,|| and others. Kossel,** in the bacteriological examination of 52 cases of purulent middle-ear disease, isolated it eight times, and in three of these cases was able to cultivate it from the blood. Charrin†† found it in a case of puerperal fever associated with a few streptococci and also isolated it from a case of chronic mastitis. Blumer‡‡ cultivated the organism in practically pure culture from a case clinically resembling diphtheria; Monnier§§ from the saliva in noma and also from a meningial exudate. Babes¶¶ reported a localized pyocyanous infection of the umbilical cord, while H. C. Ernst||| obtained the bacillus from the pericardial exudate during life from a case of tuberculous pericarditis. In addition to these cases of local infection, it has been demonstrated in an ovarian abscess by Barker,*** and the same writer has studied it in diphtheritic inflammation of the œsophagus, broncho-pneumonia, ureteritis, pyelonephritis, and intestinal ulceration, as well as in cases of general infection. In his paper Barker also cites two cases of hepatic abscess reported by Kruse and Pasquale. The micro-organism has been isolated from a number of cases of urinary infection by Jadkewitsch,††† Oettin-

* *Monatschr. f. Ohrenheilk.*, No. 7, 887.

† *Arch. de méd. expér.*, iv (1892), 130.

‡ *Ann. de l'Institut. Pasteur*, t. v.

§ Cornil et Babes. *Les Bactéries*, p. 486.

¶ *Gazz. med. di Torino.*, xlv (1894), 521.

|| *Charité-Annalen*, p. 346, 1896.

** *Zeitschr. f. Hygiene*, xvi, 1894.

†† *Loc. cit.*

‡‡ *Johns Hopkins Hosp. Bull.*, 1895.

§§ *Gaz. méd.*, Nantes, 1895.

¶¶ *Loc. cit.*

||| *Am. Jour. Med. Sci.*, cvi (1893), 396.

*** *Jour. Amer. Med. Assn.*, 1897.

††† Baumgarten's *Jahresbericht*, p. 355, 1890.

ger,* B. Motz,† and Le Noir,‡ who obtained it either in pure cultures or associated with other bacteria.

It is evident from the data at hand that the bacillus pyocyaneus is capable of causing a whole series of localized lesions, acute or chronic, of very different sorts, being in this respect not unlike the common pus cocci. The causative relation of this organism to such a large number of processes whose diversity is so considerable, as in the case of the pus cocci, is largely dependent upon the multiplicity of its sources of entrance into the body.

The ability of the organism to produce a general febrile process which may terminate fatally has been well demonstrated by the clinical and bacteriological observations of the past few years. Ehlers§ was the first to draw attention to this by the publication of an instance of general systemic infection. His views received confirmation from Neumann¶ and Oettinger,|| both of whom reported cases of this nature. Later Karlinsky** published an interesting observation of generalized pyocyaneus infection in which the bacillus was obtained in pure culture from the skin vesicles, spleen, blood and Peyer's patches. Monnier†† studied an interesting example of this variety of infection in a case of broncho-pneumonia with pleurisy, in which he isolated the bacillus of blue pus from the heart's blood, pleural exudate and from the consolidated areas of broncho-pneumonia. Kossel,‡‡ Krannhals,§§ Calmette,¶¶ Williams,|||| Finkelstein,*** Barker††† and the author‡‡‡ have studied other illustrative cases of general pyocyanic infection in children and in adults.

Recently Triboulet§§§ observed an instructive case belonging to this

* *Semaine Méd.*, p. 385, 1890.

† *Compt. rend. Soc. de biol.*, p. 128, No. 4, 1896.

‡ *Ibid.*, 1896.

§ *Hosp. Tid.*, Kjöbenh., 1890.

¶ *Arch. f. Kinderheilk.*, Hft. 1 and 2, 1890, xii, 1891.

|| *Loc. cit.*

** *Prager med. Woch.*, p. 231, No. 20, 1891.

†† See Legars. *Essai sur la maladie pyocyanique chez l'homme. Thèse de Paris*, 1895.

‡‡ *Loc. cit.*

§§ *Deutsche Zeitschr. f. Chirurg.*, xxxvii, 181, 1893.

¶¶ *Arch. de méd. navale et coloniale*, April, 1892.

|||| *Montreal Medical Journal*, July, 1894.

*** *Loc. cit.*

††† *Loc. cit.*

‡‡‡ *Philadelphia Med. Journal*, Sept. 17, 1898.

§§§ *Comptes rend. Soc. de biol.*, Oct. 22, 1897.

class in a child in which the systemic invasion was secondary to an impetigo and ulcerative ecthyma, from both of which lesions the pyocyaneus was isolated during life. The writer obtained from the laparotomy wound in a case of acute peritonitis the organism in pure culture and from the purulent peritoneal contents associated with a few colon bacilli. Cultures from the blood contained it in pure growth. From a case of acute pleuritis we also obtained it in pure culture. Jankewitsch's case* is a most curious example of the nervous type of infection with this micro-organism.

Many of these instances of generalized invasion presented symptoms not unlike those observed in the experimental forms of infection; indeed, the similitude in some of the cases is most striking. A pronounced hæmorrhagic diathesis was noted in the majority of these cases, manifesting itself either in the form of hæmorrhages into the skin or sometimes into the internal organs, particularly into the intestinal wall. Diarrhœa was not uncommon and congestion of the intestinal mucosa of considerable intensity was noted in a few of the cases.

The infrequency of infection with this micro-organism is well shown by the fact that Krannhals† in the investigation of 30 cases of general septic and pyæmic infections was not able in a single instance to demonstrate the presence of the bacillus pyocyaneus. In the systematic bacteriological examination in 800 consecutive autopsies at the Johns Hopkins Hospital, Barker‡ found but 11 cases in which there was infection with this organism, sometimes manifesting itself as an acute local, at other times as a generalized process.

The objections advanced against the pathogenesis of the bacillus pyocyaneus in man by Schimmelbusch§ in his critical article certainly can no longer be regarded as tenable with the important affirmative evidence in our possession at the present day—all clearly demonstrating a more or less marked capability of the bacillus to produce lesions in the human subject.

The epidemic of dysentery, the report of which is the chief purpose of this paper, was investigated for the New York State Board of Health. For the clinical features of the cases we are indebted to Dr. M. C. Wright, of Mt. Vision, N. Y.

General Features.—The epidemic occurred at Hartwick, a

* Loc. cit.

† Loc. cit.

‡ Loc. cit.

§ Volkmann's *Samml. klin. Vorträge*, N. F., No. 62, 1893.

small hamlet in Otsego county, New York. It was limited to 15 individuals, with 11 recoveries and 4 deaths. 14 of these were members of two separate families living about one mile from each other. Little or no communication existed between the two houses. The first patient was attacked August 23, 1897, and the epidemic continued during the remainder of that month and the whole of September.

The disease first appeared in the S. family, composed of seven members, who all suffered from the affection, to which three succumbed, a male aged 35 and two children aged respectively 19 months and 5 years. The others made a good recovery after a long and tedious convalescence. The disease appeared in the second family about three weeks after the first member of the S. family was taken sick, and likewise attacked seven individuals, of whom six recovered and one, a child four years of age, died on the thirteenth day of the disease. The fifteenth case, it is interesting to note, was the physician in attendance on the S. family. On his first visit he drank freely of water, and three days subsequently was taken ill with symptoms in every manner identical with those presented by his patients.

Clinical Features.—Following is a short history of the clinical features of each case as given me by Dr. Wright:

Case 1. Duam S., age 35 years. Taken sick August 23 with pain in bowels and diarrhœal discharges which soon became bloody. Great tenderness over colon and marked tenesmus. Passages very frequent, one about every hour until death. Temperature ranged between 99° and 102° F. Death September 10.

Case 2. Milo S., age 19 months. Taken sick on same day as the first patient. Frequent bloody passages and great tenesmus. Much abdominal tenderness and considerable vomiting. Temperature 100°-103° F. Death August 26.

Case 3. A. S., 2 years. Illness commenced August 27. Symptoms milder than in either of the two preceding cases. Temperature did not go above 101° F. The duration of the disease was about three weeks and was followed by complete recovery.

Case 4. Ella S., age 37 years. Disease began September 1 and continued for about two weeks. Tenesmus and pain along line of the colon. Temperature at no time higher than 101° F. Recovery.

Case 5. Alice S., 5 years old. Taken sick September 7 and died on

the third day of her illness. Tenesmus marked and passages very bloody and frequent.

Case 6. Mrs. Duam S., 30 years. Taken sick September 10 with frequent passages (about 15 to 20 per day); tenesmus; temperature not over 100° F. Tenderness over large bowel was very acute, especially over cæcum. Vomiting quite frequent during first week. Recovery after 12 days' illness.

Case 7. Mrs. Van B., 50 years. Disease commenced September 14 and lasted about three weeks. Symptoms similar to those observed in Case 6, vomiting being perhaps still more severe. Practically no fever. Recovery after a very long convalescence.

Case 8. Mr. G. A., 20 years of age. Taken sick September 14 with diarrhœa, which quickly became bloody. Temperature on 15th reached 104° F., with a pulse rate of 120 to 130. For the first three days the condition was very critical, but after this improvement was slow but progressive, so that by the fourth week he was practically well.

Case 9. Mrs. W., about 28 years. In this case the symptoms were essentially those observed in the preceding cases, except that the clinical manifestations were less intense. Recovered in about two and one-half weeks.

Case 10. Mrs. W., 34 years. This patient had been nursing the S. family for a few days during their illness and shortly after returning home was in turn taken sick. The symptoms were severe for two days, but a marked amelioration followed shortly thereafter, so that by the end of the second week she had recovered.

Case 11. Florence C., aged 8. Sickness commenced September 17, and the symptoms continued for seven days. Attack very mild. Diarrhœa but no blood in stools. Recovery.

Case 12. Mr. C., 40 years of age. The sickness was ushered in with a chill. Diarrhœa for two days. Stools then became bloody. Marked tenesmus was present in this case. Frequent vomiting during first week. The disease lasted about six weeks, which was longer than in any of the other cases. Convalescence has been exceedingly slow.

Case 13. Maud C., 4 years. Illness began on the 24th of September and continued for twelve days. Frequent passages containing more or less blood, reaching often as many as 20 in a day. Vomiting and tenesmus very marked. Temperature not over 101° F. Hæmorrhage from the gums occurred in this case on the tenth day. Death on October 6th.

Case 14. Amos C., about 9 years old. Taken sick on September 26. Clinical picture practically same as in the other mild cases, except that patient passed more blood. Recovered.

Case 15. Dr. W., the physician to the S. family, was taken ill about September 1 with symptoms of a mild character, but of the same nature as those observed in the majority of the cases. Symptoms persisted for about nine days, when recovery took place.

It is seen, then, that all of the cases presented certain symptoms in common, so that the clinical pictures in the several instances bear a striking resemblance to each other. The onset was acute and the disease was ushered in sometimes with a chill, otherwise always with diarrhoeal symptoms, which soon changed to those of a dysenteric type, characterized by frequent watery passages containing a greater or less amount of blood. Tenesmus and tenderness over colon were quite marked in some cases. Temperature was high in one instance (Case 8, 104° F.), but in the others it was never higher than 102° F. The duration of the disease in the different cases was quite variable, but the average was about three weeks for the non-fatal cases. One patient died on the third day of her illness. Vomiting, although not present in all cases, was, nevertheless, a marked symptom in many of the cases, particularly those presenting the more severe forms of the affection. An interesting and suggestive point which was noted about the physical appearance of the stools, but not mentioned in the histories, was the frequently distinct green color of the passages. This color became most evident after exposure to the air, and only rarely was it noticed at time of passage, and in these cases it was but faintly marked. Calmette in his studies had noticed this and explained it as due to oxidation of the pyocyanine contained in the intestinal dejecta. No autopsies could be obtained upon any of the fatal cases.

Hygienic Surroundings.—The two habitations are situated in each instance very favorably with relation to the formation of the surface of the soil, but the immediate surroundings and habits of each family are in every manner suggestive of an extremely low degree of hygienic morale, and close inspection and examination confirmed this in every way. In each family the well for the supply of drinking water is situated in close proximity to the kitchen door and is more or less imperfectly covered over with timber and earth. The soil over the well and immediately adjoining ground was covered by a layer of decomposing vegetable and animal detritus of offensive odor.

These substances were derived mostly from the kitchen, as it is the habit in each family to rid themselves of the refuse and other slops by throwing them, usually from the kitchen door, upon the ground in the vicinity of the supply of their drinking water. It is easy to understand that contamination of this well-water was a matter of no great difficulty, since the soil covering the well is only about two feet in depth and mostly made up of coarse sand through which penetration is not difficult. For none of the wells used for the supply of drinking water at the time of the epidemic could any other possible source of contamination be made out. At the C. house there exist two other wells located in a more favorable situation, but nevertheless readily liable to outside contamination by reason of their open character. Neither of these wells were used for the supply of drinking water at the time of the epidemic or previous to its occurrence.

The investigation was necessarily restricted in its extent owing to the distance of, and difficult accessibility to, the seat of the epidemic; for these and other reasons many points of importance and interest were unfortunately not determined.

Bacteriological Examination.—The microscopic and bacteriological investigation was limited to the examination of six specimens of intestinal discharges, four from the S. family and two from the C. cases. Three of these six specimens were from fatal cases, two from the S. cases and one from the fatal case in the C. family. The investigation also extended to the examination of five specimens of the drinking water, one specimen from each of the three wells at the C. habitation and two from the only well at the S. house.

A careful search for amœbæ was made in the specimens of intestinal discharges, with negative results in every instance. Amœbic dysentery is practically unknown in this section of the country.

Intestinal Discharges.—Cover-slip preparations stained by aniline gentian violet proved the predominating organism to be a bacillus of moderate length and thickness, showing little disposition toward any definite arrangement. A few other forms of bacteria were also present and resembled such micro-organisms as are usually observed in fæcal material. Epithelial cells, and in some cases some blood and granular debris, were likewise observed.

Gelatin and agar plates were made from all these specimens. Both sets showed an abundant growth of variously sized colonies which in the case of the gelatin plates always consisted almost exclusively of liquefiers. In three or four days the plates showed a greenish color throughout the medium. Further investigation demonstrated that the liquefying colonies consisted of a bacillus usually of the same morphological appearance when taken from different colonies in the same plate, but differing frequently in its morphology in different plates. Occasionally a discrete colony of a dirty white, brown or orange color was detected in the plates. A number of separate varieties of organisms was isolated: (1) a bacillus producing a green-colored pigment and in all the plates the most abundant organism; (2) another bacillus, a liquefier, but apparently producing no pigment, and (3) a non-liquefying and non-pigment-producing bacillus. Both of these latter varieties morphologically resembled, more or less, the predominating bacillus in the plates. A few saprophytic bacteria were also isolated.

The green pigment produced behaves in the following manner: In cover-slip preparations the organism proved to be a bacillus quite variable in its morphology when obtained from different media, and sometimes upon the same kind of media. The active motility of this organism was usually well observed in 20 to 30-hour bouillon cultures.

Agar-agar. Profuse, moist, greenish white growth along inoculation tract. After the second day the medium is diffusely colored with a more or less vivid green fluorescence.—*Potato.* Rust-brown, usually profuse growth. The chameleon phenomenon of P. Ernst was obtained.—*Bouillon.* Uniform turbidity with production of a slightly green film as culture becomes older.—*Dunham peptone solution.* Turbidity. Test for indol positive.—*Litmus-milk.* Acidification with precipitation of casein.—*Gelatin stab.* Liquefaction of gelatin with development of greenish color in gelatin.

Pyocyanine crystals were successfully isolated from various cultures by the method recommended by Charrin.

Animal experiments were made with this organism. 0.5 cc. of a 26-hour bouillon culture injected subcutaneously into a rabbit resulted in the production of a large inflammatory infiltration about the seat of

inoculation, with subsequent extensive sloughing of the superficial tissue. The animal survived. A similar dose was injected intravenously into a rabbit, and produced stupor and later death in about 30 hours. The autopsy showed congestion of lungs, kidneys, ecchymoses in liver and punctiform hæmorrhages in intestinal mucosa with congestion. The bacillus originally inoculated was isolated from the blood and viscera. The cultures used in the above inoculations were both derived from specimens of the intestinal dejecta. A guinea-pig received 1 cc. of a 20-hour bouillon culture (obtained from specimen of water) intraperitoneally. Stupor and slight diarrhœa and death on second day. Post-mortem examinations showed small hæmorrhages into peritoneum, pericardium and intestinal walls; congestion of latter as well as of kidneys; spleen swollen. The bacillus originally inoculated was cultivated from the abdominal viscera, but not from the blood.

Diagnosis.—*Bacillus pyocyaneus* (Gessard).

The extreme degree of variation noted in the morphology of the bacillus *pyocyaneus* has frequently been observed. This polymorphism was carefully studied by Charrin and Guignard* with particular reference to the conditions favoring its production.

The non-pigment-producing liquefier in cover-slips is seen to consist of a bacillus of variable size. This is also an organism of considerable motility.

Agar-agar. Moist, gray-white growth. Offensive odor.—*Gelatin stab.* Liquefaction usually well marked in 48 hours.—*Bouillon.* Uniform cloudiness of medium in 20 hours.—*Litmus-milk.* Rapid acidification and precipitation of casein.—*Glucose agar.* Abundant gas production.—*Saccharose agar.* Slight gas production.—*Potato.* Thick dirty-brown growth with strong trimethylamine odor.—*Dunham solution.* Turbid. Test for indol positive.

Diagnosis.—*Proteus vulgaris* (Hauser).

The third variety isolated was a short, thick bacillus, taking aniline-gentian violet stain well. Motility of the bacillus moderately active in 24-hour old cultures.

Agar-agar. Dirty white, sometimes brownish growth along tract of the needle.—*Bouillon.* Marked turbidity.—*Potato.* Abundant yellowish brown growth which later changes to darker color.—*Dunham solution.*

* *Académie des Sciences*, 12 Decembre, 1887.

Cloudiness. Indol reaction.—*Litmus-milk*. Acid reaction, precipitation of casein.—*Glucose agar*. Slight gas production.—*Saccharose agar*. Slight gas production.—*Gelatin stab*. No liquefaction.

Diagnosis.—*Bacillus coli communis*.

The bacillus pyocyaneus was present in almost pure culture in every specimen of the intestinal discharges examined, the bacillus coli communis in two specimens in very small numbers, and proteus vulgaris in three specimens, once in association with pyocyaneus and colon bacillus and twice with pyocyaneus alone. Associated with these three varieties was an exceedingly small number of colonies of common intestinal saprophytes.

The same methods of investigation were extended to the examination of the five samples of well water. The plates contained abundant numbers of liquefying colonies elaborating a green pigment, and further study demonstrated the colonies to be those of the bacillus pyocyaneus. In a specimen from one of the wells not used for drinking purposes by the C. family, a few colonies of the proteus vulgaris were isolated. All of these specimens in addition contained some common saprophytic water micro-organisms.

The probability of the causative relation of the bacillus pyocyaneus to the epidemic of dysentery is further strengthened by the fact that it is not a normal intestinal saprophyte. This has been well demonstrated by several investigators, and, indeed, its presence in the intestinal canal is not only very uncommon, but should be regarded with extreme suspicion, as was pointed out by Kossel.

Calmette, as a preliminary study to his investigations upon enterocolitis prevalent in Cochin-China, examined the stools of a large number of normal individuals in order to ascertain the exact nature of the normal microbial intestinal flora. In none of these bacteriological researches did he isolate the bacillus pyocyaneus, and therefore concluded that its presence in the intestinal tract cannot be regarded as normal. Kossel, from the results of numerous examinations of normal and pathological stools, confirmed the conclusions of Calmette. The presence of the organism in pathological conditions of the intestinal canal is by no means common. W. D. Booker,* in his work

* *Johns Hopkins Hospital Reports*. Vol. vi.

upon the summer diarrhœas of infants, found it only in occasional instances. Such an opinion receives additional confirmation from Krannhals,* who, in a bacteriological investigation of some 60 various intestinal disorders, only succeeded in isolating it once from an intestinal abscess.

The literature of dysentery referable to the bacillus pyocyaneus is extremely scanty. Outside of the researches of Calmette and Maggiora nothing can be found except isolated instances either of general or localized infection in which the intestinal symptoms were prominent, but generally associated with others of various kinds.

Calmette in the dysentery of Cochin-China found the bacillus pyocyaneus to be present in 15 cases out of 16 investigated, in the intestinal contents and ulcers in such abundance that it was practically the only bacterium which grew in the plates. From some of these cases it was also obtained from the blood in pure culture. The frequent association of the streptococcus with the bacillus pyocyaneus in the intestinal contents caused Calmette to attribute to the coccus the role of a predisposing factor in the production of the pyocyanic infection. Recently E. Phisalix† has published the results of experimental work which apparently demonstrates the increased susceptibility to pyocyaneus infection when associated with the staphylococcus pyogenes aureus. This is, however, true of many infections with other organisms.

Clinical evidence certainly shows that such infection is relatively more common as a secondary complication, and furthermore that age is a predominating factor. Young children in whom infection by pyogenic or other organisms is common, and where resistance is low, are those in whom pyocyaneus infection is most apt to occur. Infections with this micro-organism are not, however, confined to children, as many authors are inclined to believe, but are also relatively frequent in adults.

Patients suffering from the Cochin-China dysentery are affected with gastric disturbances, abdominal pains and frequent alvine evacuations, while not uncommonly a green discoloration of the intestinal

* Loc. cit.

† *Compt. rend. Soc. de biol.*, Feb. 27, 1897.

discharges is seen. The symptoms presented by the cases reported in this paper were in many respects not unlike those studied by Calmette.

In 1891 Maggiora,* in the dejections from 20 cases of epidemic dysentery which existed in the north of Italy, found colon bacilli and extremely virulent cultures of the bacillus pyocyaneus. Thiercelin,† and Williams and Cameron‡ found them in the pyretic and other forms of the gastro-enteritis of infants, as did also Lange.§

Of the small number of isolated cases of pyocyaneus infection which have been published from time to time, the following presented symptoms which were chiefly referable to the intestinal tract. Oettinger's¶ case was a young man who on the twentieth day of his convalescence from typhoid fever had what was apparently a relapse, but skin vesicles soon appeared and diarrhoea became very marked. Previous to the appearance of the vesicles constipation had existed. The pyocyaneus was obtained in pure culture from the vesicles and urine. Kossel observed in a four weeks old infant vomiting, diarrhoea and green stools. The patient died and cultures contained the bacillus in practically pure growth in the blood and intestinal discharges. Krannhals,|| Finkelstein** and Triboulet†† have reported similar cases in which diarrhoeal symptoms were prominent and the color of the stools was more or less markedly green.

The etiological relations of the bacillus pyocyaneus to epidemic dysentery is probably very infrequent, for Krannhals in the examination of 40 cases failed to find the bacillus in a single instance. A number of other investigators who have examined cases of dysentery have likewise failed to find it.

The bacteriological findings in the epidemic which occurred at Hartwick and which was studied by us, demonstrated the pres-

* *Centralb. f. Bact.*, 1891.

† Thèse de Paris. 1895.

‡ *Journal of Pathology and Bact.*, 1896.

§ See Heubner in Pentzold-Stintzing's *Handbuch der Therap.*, vol. iv, p. 169.

¶ *Loc. cit.*

|| *Loc. cit.*

** *Loc. cit.*

†† *Loc. cit.*

ence of the bacillus pyocyaneus constantly and in abundant numbers in every specimen of water and intestinal discharges. Furthermore, animal experiments showed this organism to be possessed of a considerable degree of virulence. Attention must also be called to the fact that the bacillus was not only the sole micro-organism present in great numbers in every case, but also that it was the only organism invariably found in the water.

The proteus vulgaris was isolated from two specimens of the intestinal discharges and once from a sample of water from a well not utilized for drinking purposes at the time of or previous to the outbreak of the epidemic. The bacillus coli communis was in no instance isolated from the water and only twice from the intestinal specimens.

The constancy of the presence of the bacillus pyocyaneus in both the discharges and drinking water, the numbers in which it was found and the virulence of the cultures furnish evidence of such a nature as to leave little doubt in the author's mind as to the etiological relation of the bacillus pyocyaneus in the production of this epidemic of dysentery. This view, it seems to me, is strengthened by the similar observations of Calmette and Maggiora, and the not infrequent production of diarrhoeas in children by this organism.