

The ammoniacal decomposition of urine / by Wm. Robert Smith.

Contributors

Smith, William Robert, 1850-1932.
Royal College of Surgeons of England

Publication/Creation

[London] : [publisher not identified], [1887]

Persistent URL

<https://wellcomecollection.org/works/ey54zg9j>

Provider

Royal College of Surgeons

License and attribution

This material has been provided by This material has been provided by The Royal College of Surgeons of England. The original may be consulted at The Royal College of Surgeons of England. where the originals may be consulted. This work has been identified as being free of known restrictions under copyright law, including all related and neighbouring rights and is being made available under the Creative Commons, Public Domain Mark.

You can copy, modify, distribute and perform the work, even for commercial purposes, without asking permission.



Wellcome Collection
183 Euston Road
London NW1 2BE UK
T +44 (0)20 7611 8722
E library@wellcomecollection.org
<https://wellcomecollection.org>

13



The Ammoniacal ~~Decomposition~~ of Urine.

By

Wm. Robert Smith, M.D., D.Sc., F.R.S.Ed.,
Examiner in Chemistry and Forensic Medicine, University of Aberdeen.

With Plate XXX, figs. 1 and 2.

WHEN freshly voided, healthy urine, as is well known, is a clear, transparent, amber-coloured fluid, with a distinct acid reaction, and a peculiar aromatic odour. If left to itself in an open vessel slight clouds of mucus soon appear which gradually sink to the bottom. After a time the acid reaction is noticed to be slightly increased, and crystals of uric acid and oxalate of lime are deposited. After a longer or shorter interval, dependent on the temperature of the surrounding media, this marked acidity begins to diminish and finally disappears, the urine becomes lighter in colour, a whitish scum forms on the surface, and the well-known ammoniacal odour indicates that it has become alkaline; the uric acid crystals disappear, and whitish granules of urate of ammonia and prismatic crystals of urate of soda take their place, beautiful crystals of phosphate of magnesia and ammonia being subsequently thrown down.

The increase of acidity is called by Scherer the acid fermentation, and is considered by him to be owing to the presence of the vesical mucus. The alkaline change is spoken of as the alkaline or ammoniacal fermentation, and is owing to the decomposition of the urea into carbonate of ammonia.

These so-called fermentative changes are well known, and have long been recognised. So far back as 1682 Van Helmont spoke of the odour of urine as the effect of a putrefactive

ferment, and later on Boerhaave, in a work published in London in 1732, makes direct mention of the presence of ammonia in urine as the result of decomposition.

The source of the ammonia was, however, first clearly understood in 1799, when Cruickshank, Fourcroy, and Vauquelin discovered urea, the two latter observers showing that carbonate of ammonia was the principal product of its distillation, and they further pointed out the relationship between the conversion of urea in solution in water into carbonate of ammonia by heat, and the spontaneous "fermentative" decomposition of urine. With a more accurate knowledge of the composition of urea the reason of its conversion into carbonate of ammonia became clearer, but the discovery of Proust that freshly voided urine could be kept for years in a well-stoppered flask without undergoing any change first led him to conclude that the action of air, especially of its oxygen, was necessary for its decomposition. Later authorities attributed the decomposition to the presence of a ferment, taking its origin in the putrid destruction of the mucus.

Our ideas on the subject were, however, thoroughly changed by the work of Pasteur in 1860. He introduced fresh urine into a glass flask, boiled it for a few minutes, and then effectually closed the flask by fusing its neck. He then found that urine thus treated remained fresh for an indefinite period. If, after the lapse of five or six weeks, he introduced into such urine pieces of asbestos which had been freely exposed to the air, decomposition speedily occurred, giving rise to the ammoniacal smell and the development of numerous organisms, monads, vibriones, bacteria, &c. If, however, the asbestos, previous to its introduction, had been well heated in a blow-pipe flame, no change whatever took place in the urine. It was thus clearly shown that the ammoniacal change in urine was directly owing to the introduction of germs from the air, and subsequently Pasteur and Van Tieghem¹ showed that in every fermenting ammoniacal urine the presence of micro-organisms

¹ "Recherches sur la fermentation de l'urée, etc.," 'Comptes rendus,' T. lviii, p. 210—264, 1864.

could be abundantly demonstrated, and to the presence of these the destruction of the urea was to be traced.

The importance of these experiments was at once manifest, not only as giving a clearer explanation of the changes in urine, but also as indicative of the cause in fermentation generally, and in the present day we all recognise the importance of Pasteur's work as being the foundation of our methods of inquiry into the causes of infectious diseases.

Two questions now naturally present themselves for consideration :

1. Whether these organisms, which cause the alkaline fermentation, always gain admission from without, or whether freshly voided urine contains such germs, so that unboiled urine, carefully protected from contact with the air, may still decompose; which would admit of the conclusion that the elements of fermentation do not always arise from without?

2. What particular organism causes the alkaline fermentation, or are several kinds involved?

(1) As regards the entrance of the organism. It has been shown by Cazeneuve¹ and Livon, and Meissner² that perfectly fresh urine may be preserved free from any fermentative change by eliminating the possibility of the entrance of air and germs, and Professor Leube, by a series of ingenious experiments, has shown that normal urine, on its exit from the bladder, contains neither fungi nor germs, the development of which would cause decomposition of the urea. Further, by the exposure for a few minutes of nutrient gelatine in shallow glass vessels such as those used in plate cultivations, micro-organisms may be cultivated from the air, which, when isolated, are found to be capable of giving rise to the decomposition of sterilised urine, and which, in form and general characters, are found to be identical with the organisms present in decomposed urine.

(2) Is the ammoniacal change in urine due to the presence of one or more organisms? It is with the object particularly of dealing with this question that I have lately carried on an in-

¹ 'Comptes rendus,' T. lxxxiv, p. 571, 1877.

² 'Deutsche Zeitschrift für Chirurgie,' Bd. xiii, p. 344, 1880.

vestigation under the direction of Dr. Klein at the Brown Institution.

I would, however, in the first place call attention to a valuable paper published last year by Professor W. Leube, to which I am indebted for much information, in which he describes at some length a series of experiments undertaken by Dr. E. Graser and himself with the view of determining the particular organisms which produce the alkaline urinary fermentation. He mentions that, as the result of their experiments, they were able to isolate "four well-described varieties" which possessed this property, two of them to a very great extent, and the remaining two only in a feebler sense.

The strongest influence he found to be exerted by small bacilli which he designated the *Bacterium ureæ*. These bacilli are described as being of a uniform size, .001 mm. in thickness, of an average length of .002 mm., with rounded ends.

The second growth of most frequent occurrence is a micrococcus of a globular form, and all of equal size, about .8 m. (.008 mm.) in diameter. They are occasionally united to form diplococci, or two diplococci may join to form a square. They do not liquefy gelatine.

The two remaining organisms which are said to possess a weaker and less constant action are :

1. Small and thick bacilli of an oval shape with a varying length of 1.2 m. to 1.5 m., their greatest width being always .7 or .8 m.

2. Very minute bacilli with a length of from 1.2 to 1.4 m., and a thickness of .6 m.

With the view of further investigating the life-history of the organisms producing this fermentation, I took a quantity of ordinary normal urine which had been recently voided and divided it into two parts; one part I placed aside in a sterilised beaker to allow of decomposition taking place in the ordinary way; the other part I boiled in a sterilised flask for half an hour. I then filtered it into another sterilised flask, taking the ordinary precautions, and finally decanted it into a number of sterilised test-tubes which were subsequently steamed for

twenty minutes on two successive days in the steam of boiling water; the tubes were then placed in an incubator, and after an interval of three weeks were still found to be sterile without the slightest trace of ammonia being present.

Sterile neutral urine was prepared in the same way.

In starting the cultivation of the organisms I adopted the plan described by Dr. Klein at a recent meeting of the Chemical Society. The fine end of a freshly made capillary pipette was placed in the ammoniacal urine, and a little allowed to ascend in the tube by capillarity; a number of tubes containing nutrient gelatine were then inoculated by passing the pipette through the cotton-wool plug and allowing a droplet of the urine to pass out; the tubes were then placed in water having a temperature of about 40° for the purpose of melting the gelatine; they were then gently shaken so that the droplet which had been introduced should be uniformly distributed, the gelatine being subsequently poured out, with the usual precautions, into the lower of the two dishes used in plate cultivations and allowed to reset. After this had occurred, the glasses were placed on a glass plate, covered with a Bell jar containing a piece of moist blotting paper and maintained at a temperature of 20° C. in an incubator.

By these means after the introduction of the smallest droplet a large number of organisms was obtained, and by the subsequent processes of "fractional cultivation" and "dilution" these were isolated, and the tubes containing the acid and neutral sterile urine inoculated with them with the view of determining the particular organisms producing the ammoniacal change.

By these methods I was able to isolate about twenty different organisms, both bacilli and micrococci, but after repeated experiments I only found one organism—a micrococcus—able to decompose the urea into carbonate of ammonia. It would be tedious and serve no useful purpose to describe each of these organisms, and so I shall confine my remarks to a description of that one which induces the desired change.

If a plate cultivation be made of this micrococcus, and kept

at a temperature of 20° C., in twenty-four hours a number of small points are visible which by an ordinary magnifying glass are seen to have a faint outline, and to be scattered uniformly over the surface; in two days they are very distinct and are seen as circular whitish spots of the size of a fine point. These spots do not increase much in size, and in a few days liquefaction of the gelatine commences.

In tube cultivations, in which the solid gelatine is inoculated by means of a platinum wire inserted for some distance in the depth, the tubes being subsequently placed in an incubator at 20° C., in twenty-four hours the channel of inoculation is visible as a pale whitish streak made up of closely placed minute dots; these in a few days so enlarge that an appearance is presented of more or less parallel lines of small dots, at the same time that the growth spreads over the surface as a whitish film. In about three or four days the first trace of liquefaction is seen with slight depression of the surface; this liquefaction gradually extends downwards from the surface, the liquefied part being thick and uniformly turbid.

The accompanying drawings (Pl. XXX, figs. 1 and 2) show these characteristics, and fig. 2 the amount of liquefaction which had taken place in eighteen days, the tube having been inoculated on the 12th July, and the sketch made on the 30th July.

Microscopically, the micrococci are seen to be mostly single, or diplococci; there are, however, a few short chains and a few small groups of four, five, to eight.

With this organism I inoculated both acid and neutral sterile urine, and in twenty-four to thirty-six hours the ammoniacal change took place. I also inoculated the fluid recommended by von Taksch, consisting of one litre of water, one eighth gramme of acid phosphate of potash, one sixteenth gramme of sulphate of magnesia, and three grammes of urea with a like result.

Therefore, so far as my observations go, the ammoniacal decomposition of urine is brought about by the presence of a micrococcus which differs from that described by Professor W. Leube, inasmuch as it liquefies gelatine. Whether this organism

is identical with the organism known since Pasteur and Cohn ('Zeitsch. f. Biol.,' A. Pfl. ii) as the *Micrococcus ureæ* I cannot say, because the characters of this latter had—at the time when Pasteur and Cohn investigated them—not been so studied by plate cultivation, &c., as they now are.

I have not been able to detect any other organism having a like effect, although it is possible that there are such possessing this quality in an inferior degree.

DESCRIPTION OF PLATE XXX, figs. 1 and 2,

Illustrating Dr. Wm. Robert Smith's Paper on "The Ammoniacal Decomposition of Urine."

FIG. 1.—Showing dotted appearance of the organism in the depth of gelatine, with surface film, and commencing liquefaction at surface.

FIG. 2.—Showing the amount of liquefaction which had taken place in eighteen days from the date of inoculation of a gelatine tube with the *Micrococcus ureæ*.

THE HISTORY OF THE UNITED STATES

OF AMERICA
FROM THE FIRST DISCOVERY OF THE CONTINENT
TO THE PRESENT TIME
BY
JOHN F. JOHNSON
OF NEW YORK

NEW YORK: PUBLISHED BY J. JOHNSON, 14 NASSAU ST. 1847.

THE HISTORY OF THE UNITED STATES

OF AMERICA

FROM THE FIRST DISCOVERY OF THE CONTINENT

TO THE PRESENT TIME

BY

JOHN F. JOHNSON

OF NEW YORK

NEW YORK: PUBLISHED BY J. JOHNSON, 14 NASSAU ST. 1847.

Fig. 1.



Fig. 2.



