-- BACTERIA in WATER. --

JESSE L. ROGERS.

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- BACTERIA in WATER. -

I. Title - Bacteria in Water.

II. Introduction - New Science developed. Distribution - air, water, dust, soil, ocean, high and low altitudes.

III. Discussion.

1. Economic considerations - Health of a community depends largely on its water supply.

2. Sources of contamination of water - Cultivated lands, sewage, seepage, cemeteries, roads, dust, human and animal sources.

3. Distribution by means of water - rivers, lakes, wells, springs, rain etc.

4. Bacteriological analysis of water - immediately after collection, my mode of procedure.

5. The Bacterial contents of various waters - color, odor, appearance, amount of organic matter present.

6. Multiplication of micro-organisms- temperature, nourishment, light, air.

7. The Vitality of Bacteria varies in different waters, - according to quantity of organic matter, temperature, season etc.

8. The detection of pathogenic bacteria in water.

9. The number of bacteria in water - limit of numbers as to healthful water.

10. Purification of water for drinking purposes - sand filtration, mechanical filtration, commercial filters, distillation, boiling and aeration, electricity.

IV. Conclusion.- A description with the characteristic growths of the bacteria found in the various waters in and about Manhattan, Kansas. With drawings of each. A special study of the typhoid bacillus with its cultural and differentiative characteristics.

Bacteriology is practically a new science and is one of utmost importance to each and every one of us, for our health alone. The science is only about twenty-five years old and at present is commanding the attention of the world in general. Bacteria, or worms, as they were then called were discovered several generations previous, but were not recognized then as now as forming a group by themselves. Instead, they were associated with a group of organisms including yeasts, molds, and microscopic animals.

The science of bacteriology applies itself to almost every occupation and profession and for these reasons alone we should make a diligent and careful study of bacteria. We constantly come in contact with multitudes of these minute organisms and find them everywhere in external nature; in the soil, water, air, in the dust of the air and in our foods, and in the depths of the ocean, also on the skin of our bodies, in the mouth, respiratory passages and alimentary tract. They are less abundant, however, in mid ocean and at high altitudes. Very few are found at a depth of several feet in the ground.

The economic considerations of bacteria in water is one of vital importance. The health of a community depends largely on its water supply. If the water is contaminated by pathogenic bacteria disease and death are the results. While if the water is bacteriologically pure there are fewer diseases and less deaths from fevers etc. There are on record, numerous cases of outbreaks of typhoid fever and the causes have been traced to the contaminated water supply of the community. The typhoid bacillus is very frequently found in water and in the soil and as a result it may be carried to the source of the water used.

Waters may be contaminated in various ways. The washing of

cultivated lands by heavy rains, transports many organisms to the source of water supply. River water is often contaminated by sewage and surface drainage from cities etc. In case of well water that is used for drinking purposes the water becomes contaminated by surface drainage and by seepage from cemeteries, outhouses, manure piles etc. It is a very bad practice to have the well in the immediate vicinity of the sources of contaminations. The dust of the air carries large numbers of bacteria and these are often deposited in reservoirs, tanks etc, from which the water systems of towns and cities are derived. Water containing less than two hundred non-pathogenic bacteria to the cubic centimeter is considered safe and not dangerous, but if the water contains over that number there is danger of disease. The bacteria live on the organic matter in the water and if this is eliminated they can not survive. Water usually contains a large amount of organic matter and therefore affords sufficient nourishment for the organisms to live and multiply very rapidly.

Water is one of the most common means of transporting bacteria as rivers, rain, ponds, lakes, wells, springs and also by means of ice, snow and hail. Springs are often contaminated at their source and as a result the bacteria are carried for many miles in the water. The fresh, sparkling, clear water is no sure sign that the water is bacteriologically pure; oftentimes the sparkling is produced by the gas in the water caused by the action of certain bacteria. Bacteria often gives a color and an odor to water which may be removed by filtration etc.

In collecting my samples I proceeded as follows:- First of all I collected a sufficient amount of the water in a sterile, glass-stoppered bottle, then next I made an inoculation of the water into

a tube of sterile liquefied plate agar and then made agar plates, four plates of each sample, next the plates were incubated at about 35° C and after the colonies had grown sufficiently I made an inoculation from each different colony on the plate into a tube of sterile bouillon, from this tube after a sufficient growth I inoculated a full set of media from each separate colony. After a short time had elapsed I kept notes on all the growths on the media, noting the color, appearance, rapidity etc of the growths. Then after I had run them through the cultural media and everything noted, I looked up in the various text books the organism that corresponded with the growths and found its name. A hanging drop preparation was made of each to determine the form of the organisms from these permanent mounts. I made drawings.

The bacteriological analysis of water is a very important subject th the bacteriologist; care must be exerted in the collecting and preparing of samples for the work. As soon after the collection of samples the cultures should be made and, if possible, upon the spot of collection. A great amount of time should not elapse before the analysis is made because the organisms multiply very rapidly and will have increased from a few to hundreds within a few hours.

The bacterial contents of various water cannot be determined by the color, odor or the turbidity of the water. Many people who have no knowledge of bacteriology are often deceived by the bright, sparkling appearance of the water, accompanied by its delicious and palatable taste. Many waters are bacteriologically pure and yet have a decided color and a marked degree of odor. Again many persons hold to the old home well, which is highly polluted from various sources, rather than drink the bacteriologically pure water that may be the supply of the cities, because the old well water is colder and

clearer and may taste better. The color of the water is due in a large sense to the decaying organic matter it contains and the turbidity may be the result of minerals in solution. These are removed by filtration and the addition of a small amount of a chemical to precipitate out the undesirable mineral.

Bacteria multiply very rapidly depending on the temperature, nourishment, light, air, and the amount of organic matter in the water. Some bacteria multiply most rapidly at body temperature; others at higher and lower temperatures. If the nourishment is sufficient they are the more active and reproduce faster. Low temperature as freezing and ice do not kill all bacteria but instead simply retard their growth. It has been proven that the typhoid fever germ will cause the disease after being confined in ice for some time. Sunlight is nature's greatest disinfectant and is very destructive to bacterial growths. Aerobic bacteria require the presence of air or oxygen for their development while anaerobic bacteria do not and thrive best without oxygen. The cholera bacillus has been proven to be destroyed after three days and certainly after eight days when exposed to a temperature of minus 20° C.

The number of bacteria in water also owe their vitality very largely to the season of the year, quantity of organic matter, temperature etc. They are the more numerous and the more active in the warmer seasons, while climatic conditions also effect their growth. A given amount of water with a few bacteria will increase in number at a greater rate than the same amount of water containing a great many more bacteria, the reason being the relative amount of nourishment in the water. It is an established fact that certain kinds of bacteria are capable of multiplying very rapidly in ordinary distilled

water, which would contain a very small amount of organic matter. It is also proven by investigation that there is a certain point at which the number begins to decline. The multiplication varies according to the bacterial composition of the water examined.

The detection of pathogenic bacteria in water is accomplished by the injection of a sufficient quantity of impure water into the skin or organs of the animal. If they die with a disease caused by this inoculation we know the water contained pathogenic organisms. The disease is then ascertained by isolating the particular organism from the blood and diseased organs of the dead animal. The length of time that the animal will live after the inoculation depends upon the virulence of the organism. Many pathogenic bacteria are isolated from the mud, slime and filter beds that supply cities with water, some of the most common of these bacteria are the tetanus bacillus, bacillus Coli Communis, typhoid bacillus, tubercle bacillus, anthrax, cholera etc. Many cases of tuberculosis are contracted through drinking such impure water, containing the bacillus of tuberculosis. Many organisms that are pathogenic to animals are not at all pathogenic to man. The two common pathogenic organisms to man that are propagated by water are Asiatic cholera and typhoid fever. The outbreaks of typhoid fever in different parts of the country are found to have their source in water, supplying the community.

The waters in and about Manhattan contain large numbers of bacteria. The tap water that comes from the city reservoir contains fewer bacteria than most of the wells in the town. The cistern water is exceedingly highly polluted which is probably due to ~~to~~ improper filters and the many organisms that are carried by the dust and air and deposited on the roofs of the houses. In all of these waters the

number passes beyond the safty mark but none of the common pathogenic bacteria have been found as yet. I found a large majority of the common bacteria in this vicinity to be also found in the sewage and drainage from the city.

It is very important to each of us that we make sure the water we drink is bacteriologically pure from the standpoint of hygiene and economy. Our health depends greatly on the water we drink and the location of the city is so, that water serves a very common medium for the transportation of multitudes of organisms from the surrounding country.

In regard to the purification of water for drinking purposes we may divide the subject into three separate heads, first filtration, and distillation and third boiling. Waters of rivers which have the drainage of sewers from a large number of towns and cities frequently have various colors as bluish, greenish, yellowish, and others; these colors are also very often accompanied with a more or less degree of turbidity of the waters. The colors may be due to peaty matters in solution and other organic matters. Also from the decomposition of vegetable and organic matter an odor is noticeable varying from very light to strong and offensive ordors. This turbidity may be removed by filtering the water through sand or some other similar substance and with it the color and odor.

The purification of waters by filtration is a very important topic. For it is only by filtering that we are able to render waters organically pure. This is accomplished best by the American System of Mechanical filtration and purification.

We have made many improvements in the methods of filtration for the past twenty-five years until we now have as the standard the previous named method. Eighteen years ago only one city in the U. S.

filtered its water and at the present day there are a large number that filter their water and the practice is rapidly increasing. In Europe the practice of filtration is nearly universal. For an example London is a good one. With a population of 6,000,000 people, its water supply taken from the River Thames, which river receives drainage of a very great population. In this city more than 100 acres is devoted to filter basins. Their method is to run the water into large reservoirs containing sand two feet in depth and supported on a sub-stratum of coarse stone. As the filth is removed it accumulates in a thin layer upon the top of the sand and when this layer bedomes so thick that the water does not filter fast enough the top layer of sand is removed, washed and replaced. The filth and gravel were removed as is easily seen and also the bacteria. The bacteria of the water feed upon the filth and also upon each other therefore aiding in their destruction. The oxygen of the air is also another helper. The bacteria that are not disease producing form a bacteria jelly and by the means of this jelly the bacteria in the unfiltered water are removed. If the water passes through slowly enough bacteria can be reduced from millions to five or ten per cubic centimeter. The economic use of these filters beds depends on the rate that the water is filtered. This method of filtration is not used in America because the beds would freeze up in winter and the growth of algae in the waters.

In the American system the filter is simply a case made of boiler iron from five to twenty feet in diameter. It cotains a bed of sand three and one-half to four feet in depth. The water is passed through the filter under pressure and out at the bottom by a series of valves that permit the water to pass but retains the sand. To clean the filter a current of filtered water under pressure is sent up from below, the sand is washed and the impurities pass out from a

waste pipe and then filtration is resumed. The bacteria are removed by a substitute for the bacteria jelly made of hydrate of Alumina. The Aluminum compounds of the soil give to the springs their bright sparkling color and in driven wells the water is usually filtered by the alumina in the soil. This method is used throughout the U. S., and is put up at a moderate cost, which amounts to a very small amount to large cities that use a large quantity of water.

Commericial filters such as we find upon the market in our towns and cities are very useful in removing minerals and filth from the water but at first do not remove many bacteria. Through constant use for some time they become more effective for then a bacterial jelly collects in them, which eliminates many of the organisms. Distillation is a sure method of securing bacteriologically pure water for in this process the water is heated to the boiling point and the vapor collected, this gives us water free from bacteria and is to a large extent chemically pure. Distilled water has a flat taste as though it was scorched but it soon becomes very palatable and is healthful. Water that has been boiled for an hour or so is practically bacteriologically pure, all the organisms being killed or destroyed by the heat then upon filtering the sediments and filth are removed. This last named method can be used by almost everyone and may prove healthful as well as economic.

Plate I, Fig.,1. - BACTERIUM TRAMBUSTI. This organism is a diplo-bacillus surrounded by a capsule, stains with a weak solution of Carbol fuchsin. Occurs singly, in pairs, threes and short chains, capsule not stained by carbol fuchsin.

Morphology:- Bacilli 3 - 5μ, size variable. Grows at 37° C.

Gelatin Colonies:- Border irregular, surrounded by a zone of liquefied gelatin.

Agar Colonies:- Star shaped, with broad, radiating outgrowths.

Bouillon:- not turbid, with a membrane.

Agar slant:- Growth grayish.

Potato:- Raised dry colonies, crumpled extending over entire surface and down the sides, irregular borders, fringed.

Gelatin:- Liquefied in a few days.

Litmus Milk:- Reddened, not coagulated.

Milk:- Changed, watery on top with a peculiar clabber sediment.

Habitat:- Water.

Plate I, Fig.,2. - B. PROTEUS VULGARIS.

Morphology:- Bacilli 6:1.2-4μ - threads to chains, in floccose arrangement, rounded ends, frequently appearing as short ovals, motile.

Gelatin Colonies:- Small depression, containing liquefied gelatin and grayish white masses of bacteria from the edge, ameboid processes.

Gelatin Stab:- Liquefaction saccate.

Agar slant:- Growth slimy, moist, glistening, translucent.

Milk:- Coagulated, acid, becoming yellowish.

Litmus Milk:- Coagulated, reddened.

Potato:- Growth yellowish white, raised, strong oppressive odor.

Bouillon:- Foul odor, uniformly clouded.

Habitat:- Commonly found in putrefying fluids, water, sewage etc.

Plate II, Fig.,3. - B. COLI COMMUNIS.

Morphology:- Bacilli 4-7:1.3μ; Facultative anaerobic, ends rounded.

Gelatin Colonies:- In depth round to lenticular, yellowish brown on surface, flat, erose to lobate, marmorated.

Gelatin Stab:- A good growth in depth, surface growth flat, spreading.

Agar slant:- Growth gray, white, moist, glistening, translucent.

Potato:- Growth yellowish to yellowish brown.

Bouillon:- A dense turbidity, with a heavy sediment.

Milk:- Coagulated.

Litmus Milk:- Acid, cultures have an odor of H_2S.

Bouillon becomes clouded with a sediment ammonia produced, and an alkaline reaction.

Habitat:- Water from sewers.

Plate II, Fig.,4. - B. SUBTILIS.

Morphology:- Bacilli 1.2:3-4μ, filaments, chains, ends rounded, stained with carbol fuchsin, motile, aerobic, non-pathogenic.

Agar Plate Colonies:- Anthrax-like.

Gelatin Stab:- Liquefaction craterform - saccate-stratiform.

Bouillon:- Turbid, a membrane on the surface adhering to the walls of the tube.

Potato:- Growth white, thick mealy, grows best at 30°C.

Agar slant:- Growth thick, crumpled.

Milk:- Coagulated, peptonized.

Litmus Milk:- Coagulated, color not changed.

Habitat:- Found in water.

Plate III, Fig.,5. - BACT. AMABILIS.

Morphology:- Bacilli.5:1.μ. Occur singly, short chains of three or four bacilli and longer, and in masses. Ends rounded. Stains easily with carbol fuchsin.

Gelatin Colonies:- Large, translucent, yellowish.

Agar Slant:- Growth white, limited, with a yellowish tint.

Potato:- Growth thin, bright yellow.

Milk:- Coagulated.

Litmus Milk:- Coagulated and reddened.

Bouillon:- Turbid with a sediment.

Gelatin Stab:- A growth in depth of a yellowish gray color.

Habitat:- Sewer water, air.

Plate III, Fig.,6. - BACT. MIGUELII.

Morphology:- Bacilli 1μ thick, and of variable length, to filaments. Optimum temperature 50°C, non-motile.

Agar Slant:- 43°. a white raised colony, elevated disks.

Bouillon:- At 50° turbid with a fragile membrane, later liquid becomes clear with a heavy sediment.

Gelatin:- No growth as gelatin melts at a high temperature.

Habitat:- River water below the sewer outlet on the Kaw.

Plate IV, Fig.,7. - M. SIMPLEX.

Morphology:- Cocci medium sized, in pairs, tetrads, and clumps.

Agar plate Colonies:- Irregular margins, stains with carbol fuchsin.

Gelatin Stab:- Liquefaction, strati-form, gelatine rendered alkaline, liquefied rapidly giving a green cast tothe liquefied gelatin.

Agar Slant:- Growth milk white, glistening.

Bouillon:- Turbid, alkaline and a flaky sediment.

Potato:- Growth feeble, composed of whitish, discrete colonies.

Milk:- Coagulated.

Litmus Milk:- Viscid, pink above, decolorized blow, becoming coagulated and acid.

Habitat:- Water.

Plate IV, Fig.,8. - M. EPIDERMIS.

Morphology:- Cocci smal, occur in two and tetrads, slightly flattened at point of contact.

Agar plate Colonies:- Glistening, light yellow.

Gelatin Colonies:- Small, round, opaque spots containing liquefied gelatin.

Gelatin Stab:- Growth in depth, thin yellowish, or surface thin yellowish white, slimy, liquefaction with a yellowish sediment.

Agar Slant:- Growth a greenish yellow, penetrating into depth of agar.

Potato:- Growth deep orange yellow.

Milk:- Not coagulated.

Litmus Milk:- Not coagulated but color changed.

Bouillon:- A cloudy turbidity, white sediment.

Habitat:- Sewer water.

Plate V, Fig.,9. - M. FLAVUS.

Morphology:- Cocci rather large, in twos, threes and in groups.

Gelatin Colonies:- In depth, round, oval, often lobular, on surface yellowish brown, finely serrate, becoming surrounded by a zone of liquefied gelatin.

Gelatin Stab:- Growth in depth beaded, yellowish, gelatin rapidly liquefied with a yellowish flocculent sediment; later becomes clear and sediment settles.

Potato:- Growth irregular, intense yellow.

Slant agar:- A yellowish-white layer is formed.

Bouillon:- Turbidity with a yellowish white sediment.

Habitat:- Water from theKansas River.

Plate V, Fig., 10. - SAR. ALBA.

Small cocci. They form small white colonies on the nutrient gelatin. Inoculated in the depth of gelatin they grow slightly along the needle track, but are heaped up on the surface with out liquefying the gelatine.

On Slant agar; a whiteish gray growth.

On potato; a white growth, thin.

Bouillon; A whiteish gray sediment.

Habitat; air and water.

Plate VI, Fig., 11.- SAR. LITORALIS.

Morphology, Cocci 1.2 to 2 m in diameter. Bound together in four to eight families, which in turn may unite and include as many as sixty-four tetrads.

Agar plates:- The colonies are at first white, become brick red later on.

Gelatin Stab:- A funnel shaped appearance, later the liquefaction extends to the sides of the test tube.

Bouillon:- A turbidity and a yellowish-red deposit.

Slant agar:- At first the growth is white then changes to a brick red color.

Potato:- No growth.

Milk:- Not coagulated. Litmus milk, no change.

Habitat:- In sewage water.

Plate VI, Fig.,12. - SAR. AURANTIACA.

Morphology, Cocci occur in bunches like grapes.

Agar plates:- Colonies are orange-yellow, roundish, entire, moist.

Gelatin Stab:- Liquefaction along entire needle track, slowly, and form on the surface an orange yellow growth within a funnel of liquefied gelatin.

Agar Slant:- Slightly raised, orange yellow, buttery consistency.

Bouillon:- A flocculent turbidity with much sediment.

Milk:- Coagulated and peptonized.

Potato:- Growth yellow orange, glistening, becoming raised, dull.

Habitat:- Found in well water.

PLATE VII, Fig.,13. - STREP. "(NEW ORGANISM)".

Morphology:- Small round organisms, in chains usually.

Gelatin Stab:- A pinkish growth on surface, and in stab not liquefied.

Bouillon:- A pinkish heavy sediment and a turbidity.

Milk:- A pinkish sediment with a film adhering to the walls of test tube at surface of milk. Not coagulated.

Litmus Milk:- A pinkish ring adhering to sides of tube at surface of milk. Not coagulated.

Agar slant:- A brilliant pinkish red color all over the entire surface.

Potato:- Growth elevated, moist, pint. The color is very characteristic throughout all of the growths on media.

Habitat:- Filtered tap water.

Plate VII, Fig., 14. - STREP.MIRABILIS.

Morphology:- Cocci forming very long curved chains; elements .4m, sometimes they occur singly.

Agar Plates:- Colonies scant, masses of fine long threads, filamentous.

Gelatin Stab:- On surface a thin transparent film, 3-5 m.m.

Agar Slant:- Like growth on gelatin.

Potato:- Growth inappreciable.

Bouillon:- A fine sediment like masses of threads of cotton wool.

Habitat:- Isolated from sewage.

Plate VIII, Fig., 15. - STAPH. PYOGENES AUREUS.

Morphology:- Cocci singly, in pairs, very short chains, and irregular masses.

Agar Plates:- Colonies orange yellow.

Potato:- Orange yellow growth, luxuriantly.

Agar Slant:- Growth orange yellow, looking like a streak made with oil paint.

Gelatin Stab:- Liquefaction, orange yellow sediment.

Milk:- Coagulated.

Litmus Milk:- Changed and coagulated.

Bouillon:- An orange sediment, liquid clear.

Habitat:- Well water.

Plate VIII, Fig.,16 - STAPH. CEREUS ALBUS.

Morphology:- Cocci single, pairs and in chains, irregular masses.

Gelatin Stab:- A white, slightly shining layer, like drops of wax, with somewhat thickened, irregular edges. In depth they form a greyish white, granular thread.

Agar Plates:- On first day white points are observed, which spread themselves out later on the surface.

Potato:- A greyish white, shinging streak develops.

Blood Serum:- A similar growth.

Agar Slant:- A sulphur or lemon color, growth changes.

Habitat:- Sewage water.

Plate IX, Fig., 17. - B. TYPHOSUS.

Morphology:- A bacillus with rounded ends, length varies, as short rods, to long threads, very actively motile, possess flagella, stains with difficulty with ordinary dyes, does not form spores. It is a facultative anaerobe, grows at body temperature.

Gelatin is not liquefied, growth in depth filiform, beaded on the surface, growth thin, whitish, irregular.

Bouillon:- Slightly turbid, uniformly clouded, faint film.

Milk:- Slightly acid but not coagulated.

Agar Slant:- Growth thin, translucent, slimy, spreading, moist, white growth.

Litmus Milk:- Color slightly changed to red, but not coagulated.

Potato:- Growth a pure white glistening streak, or a moist invisible layer, thin or scarcely visible.

Habitat:- K. S. A. C. Laboratory.

I used the following method for separating the typhoid bacillus from B. Coli and other similar organisms. It depends upon the difference in rapidity with which the organisms will grow through a porcelain filter. A solution is prepared as follows. 1000 c.c. 3 per cent solution of peptone, 80-100 c.c., 1 per cent N A O H, 88-1200 c.c. saturated salt solution. The suspected material is placed in the candle of a chamberlain's filter and the lower part of the candle placed in the solution above described. The whole apparatus is incubated at 37° and if typhoid bacilli are present the bouillon becomes cloudy in a few hours and is found to contain nearly pure cultures of typhoid bacillus. For testing water many liters are filtered in a similar manner and the filter placed in the solution in the same manner. The method worked fine.

Plate X, Fig., 18. - BACT. "(NEW ORGANISM)".

Characteristics of growths of a new organism isolated from the K.S.A.C. well.

Morphology:- Rods very small, short, single, not in chains, non-motile, grows at body temperature, obligative anaerobe.

Gelatin Stab:- Stratiform , liquefies rapidly with a dense heavy yellow growth at bottom of liquefied gelatin and through the entire gelatin.

Potato:- A shiny brownish yellow growth rather thin.

Bouillon:- A ring adhering to walls of test tube with a slight sediment.

Milk:- A kind of peculiar coagulation clabber-like.

Litmus Milk:- Changed from blue to faintly red, not coagulated.

Agar:- A yellowish pigment.

Habitat:- K.S.A.C. well water.

Plate X, Fig.,19. - M. "(NEW ORGANISM)".

Morphology:- Cocci round, possessing browning movement, occur single, twos, tetrads, and in groups, aerobic bacteria, small cocci.

Gelatin Stab:- Not liquefied, split, a greyish growth along stab.

Potato:- Whitesih yellow, creamy.

Bouillon:- Very slightly turbid, with a whiteish yellow, stringy sediment, no scum.

Milk:- Coagulated,acid.

Litmus Milk:- Coagulated and changed to strongly acid.

Agar Slant:- A whitesih yellow growth on surface, smooth, glistening.

Habitat:- K.S.A.C., well water.

Plate XI, Fig., 20. - STREP. (NEW ORGANISM).

Morphology:- Bacilli rod shaped, some bent, large rods, possess flagella, very motile, found single, in chains, groups etc. Stains with carbol fuchsin.

Gelatin Stab:- Growth slow, in depth, liquefies slowly.

Milk:- Not coagulated. Strongly acid.

Litmus Milk:- Changed, upper half reddish color, lower part whitish, reduced and not coagulated.

Bouillon:- Slightly turbid and a whitish sediment.

Potato:- A rich, thick yellowish growth, elevated, spreading over entire surface.

Agar Slant:- A yellowish white growth, glistening and smooth, covering the whole surface of the agar.

Habitat:- Water.

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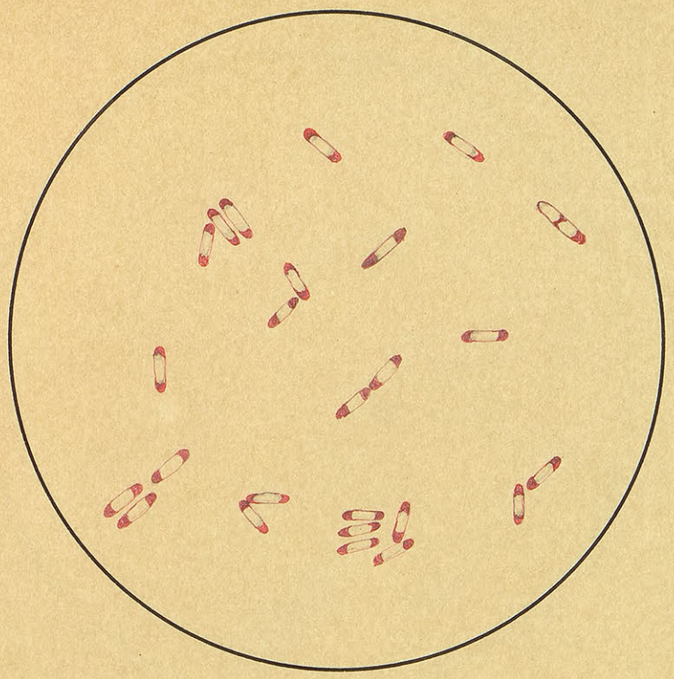
PLATE I.

BACT. TRAMBUSTI.

FIG. 1.



B. PROTEUS VULGARIS.

FIG. 2.

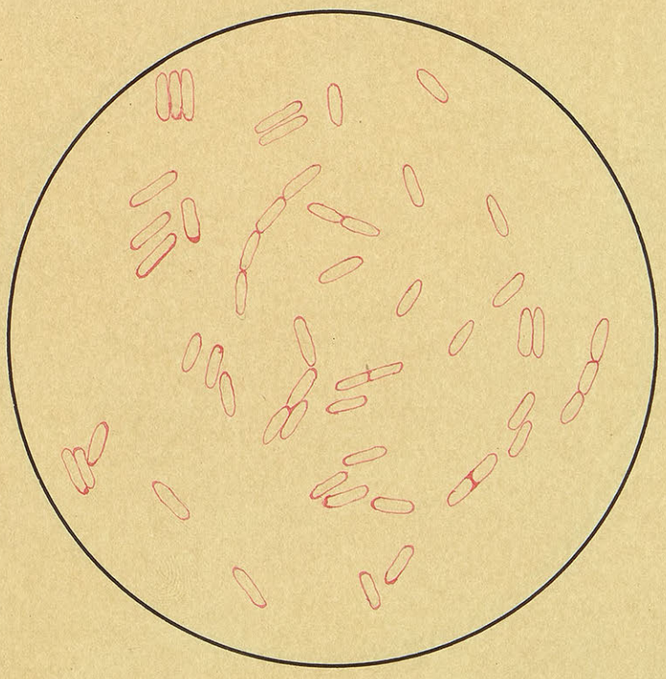
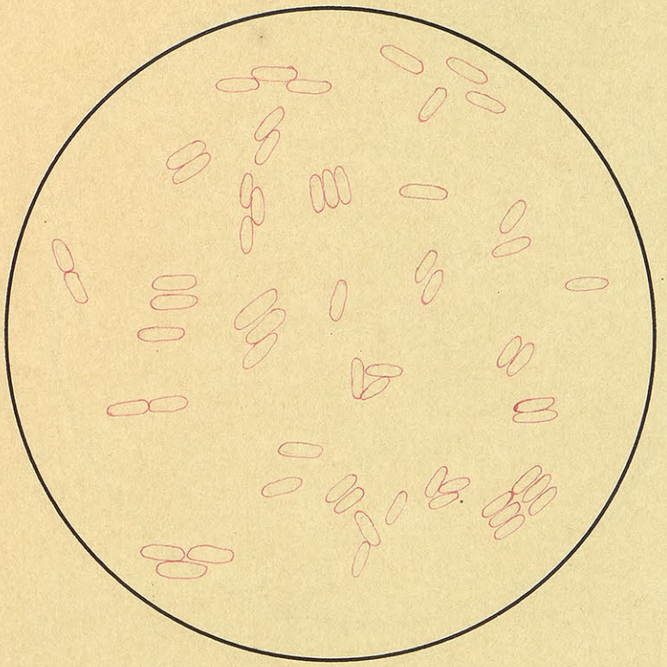


PLATE. II.

B. COLI COMMUNIS

FIG. 3.



B. SUBTILIS.

FIG. 4.

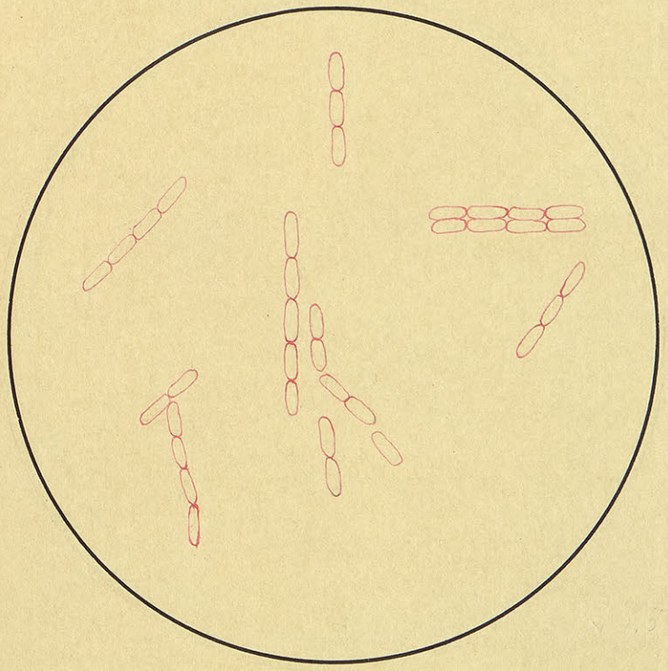
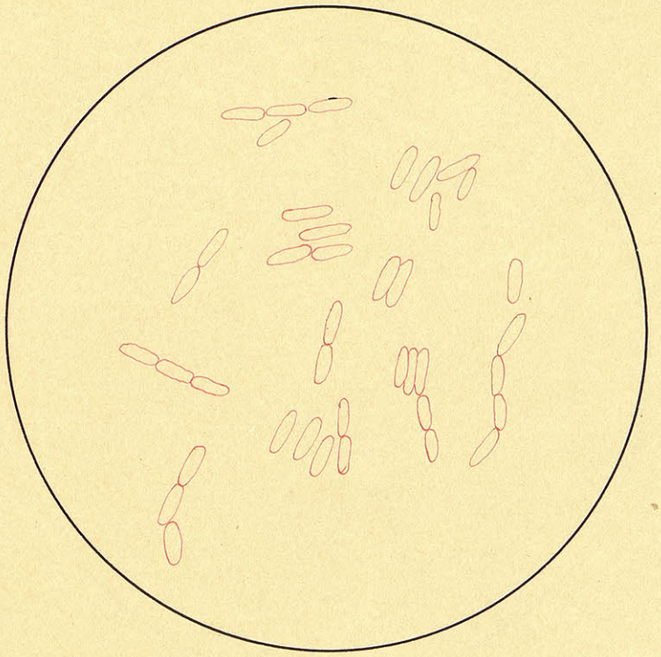


PLATE. III.

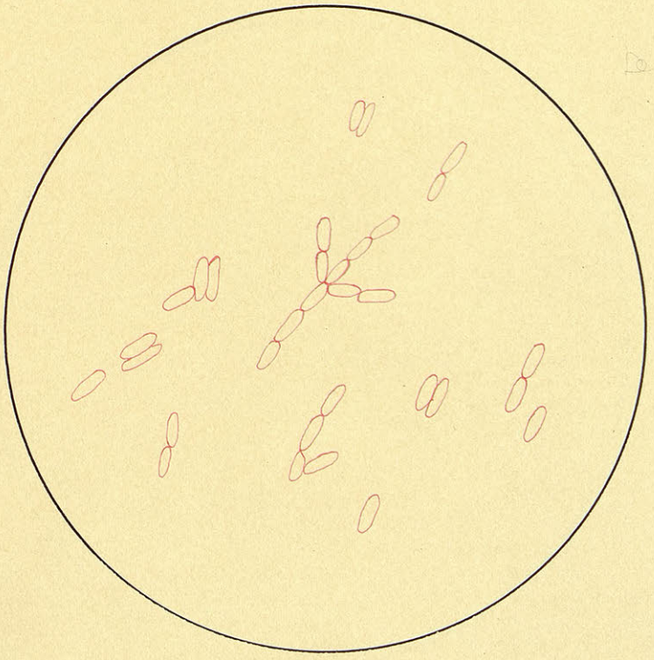
BACT. AMABILIS.

Fig. 5



BACT. MIQUELII

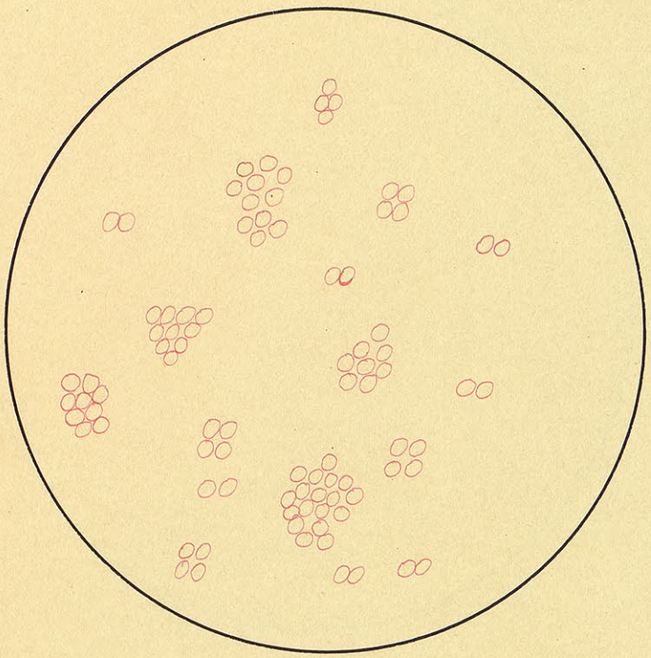
Fig. 6.



PLATE, IV.

M. SIMPLEX

Fig. 7.



M. EPIDERMIS.

FIG. 8.

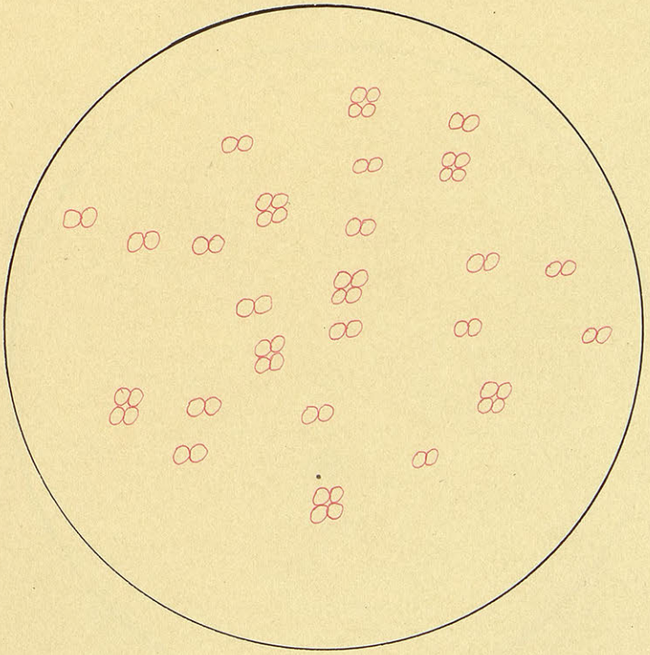
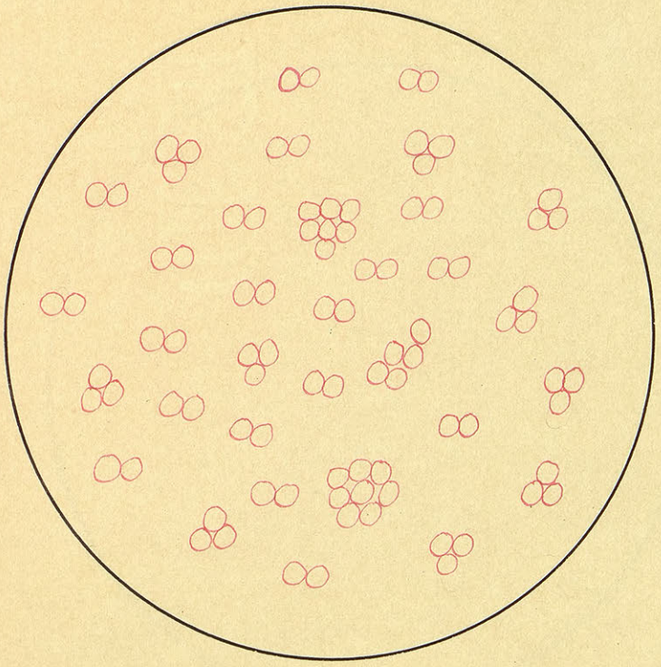


PLATE. V

M. FLAVUS

FIG. 9.



SAR. ALBA.

FIG. 10.

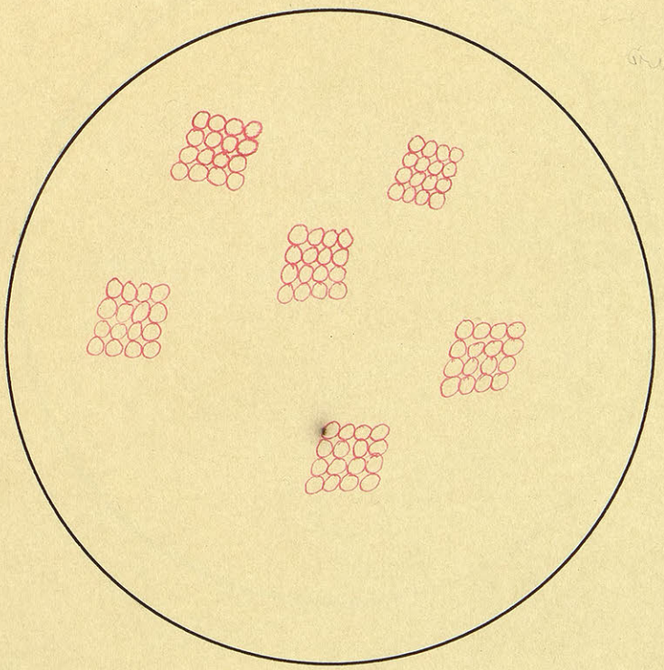
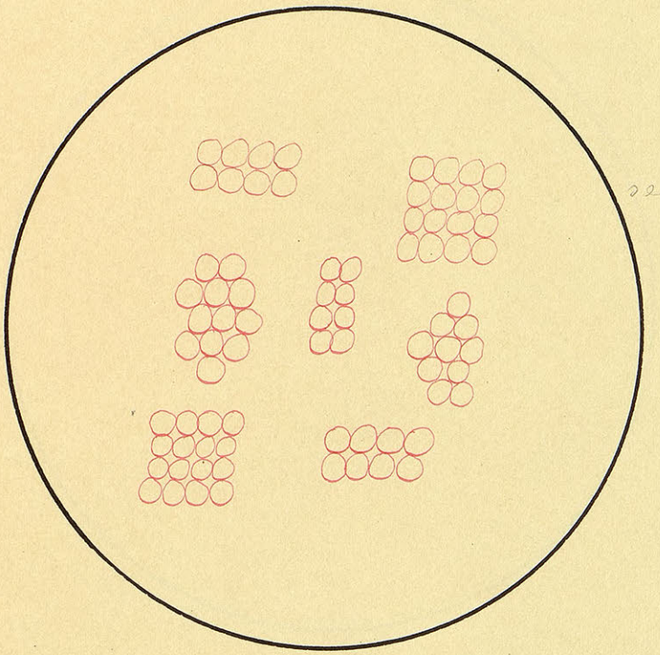


PLATE. VI.

SAR. LITORALIS.

FIG. 11.



SAR. AURANTIACA.

FIG. 12.

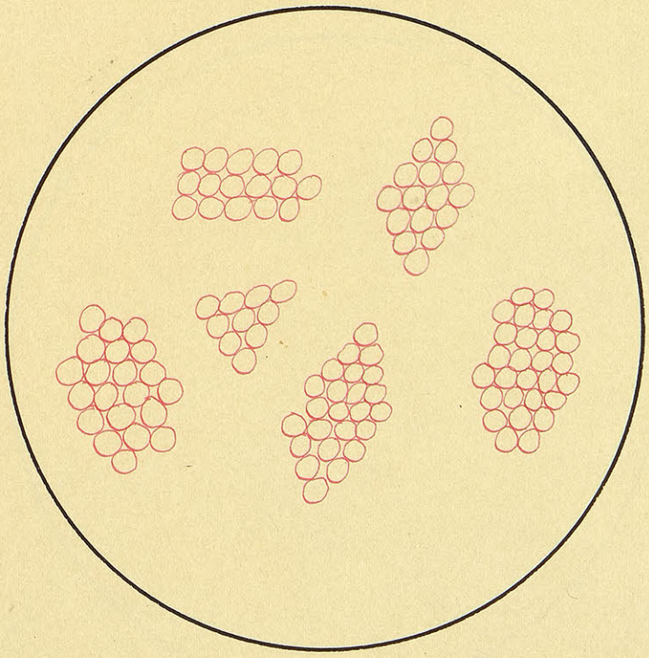
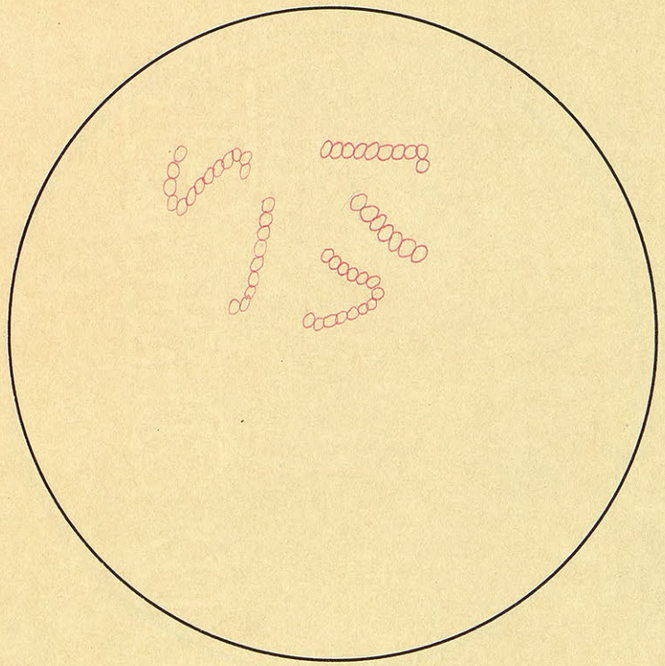


PLATE VII

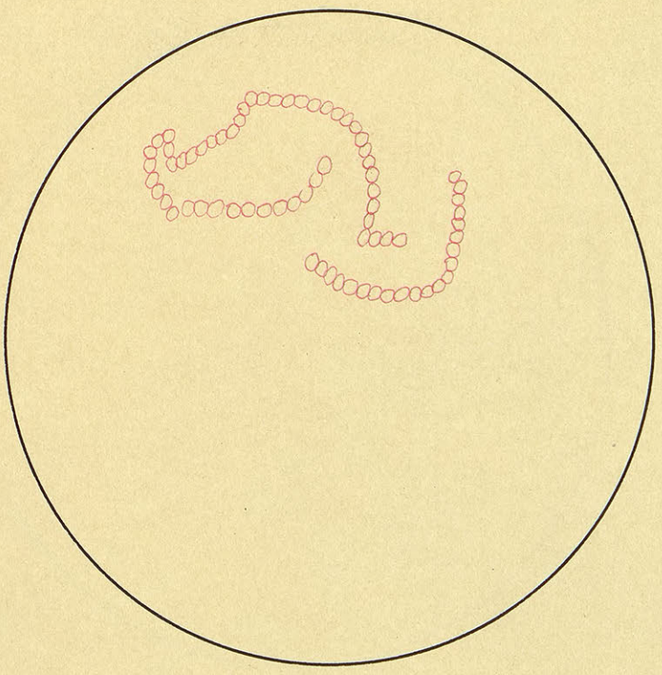
STREP. "(NEW ORGANISM)"

FIG. 13.



STREP. MIRABILIS

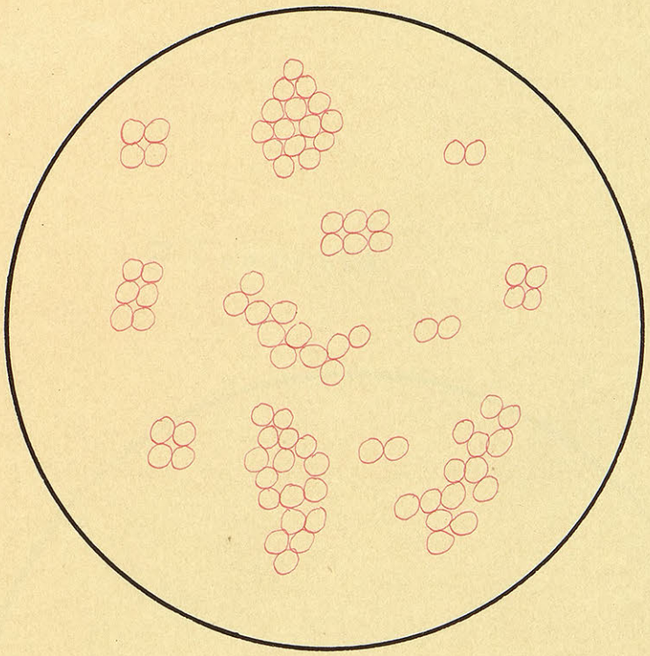
FIG. 14.



PLATE, VIII.

STAPH. PYOGENES. AUREUS.

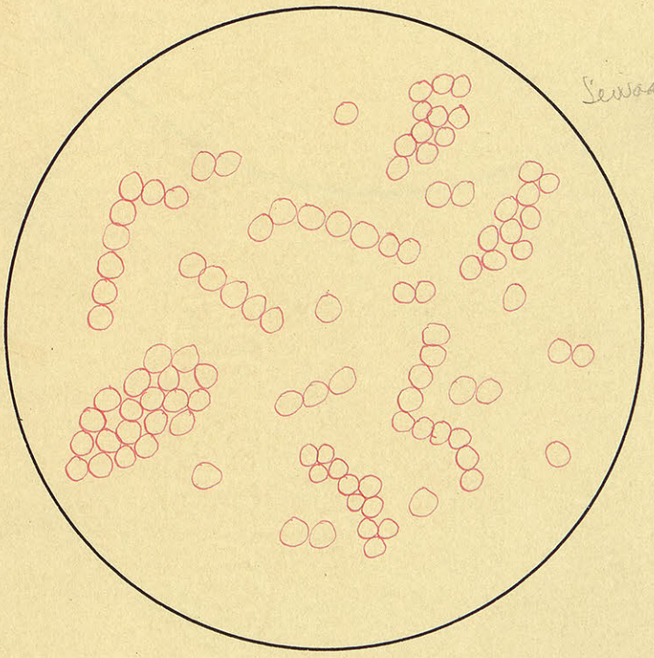
FIG. 15.



water

STAPH. CEREUS ALBUS.

FIG. 16.



Sewage

PLATE, ~~IX~~.

B. TYPHOSUS.

FIG. 17.

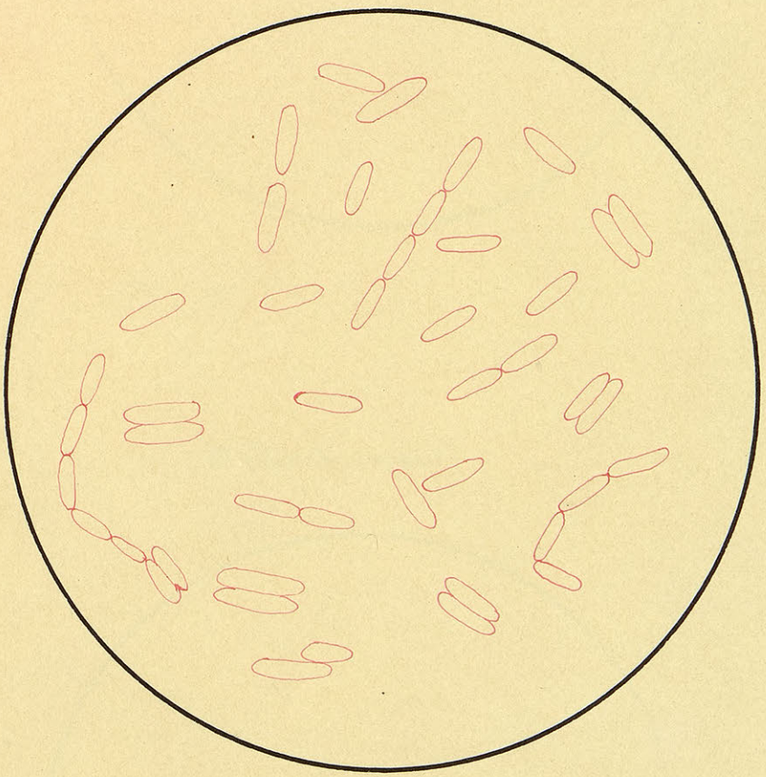
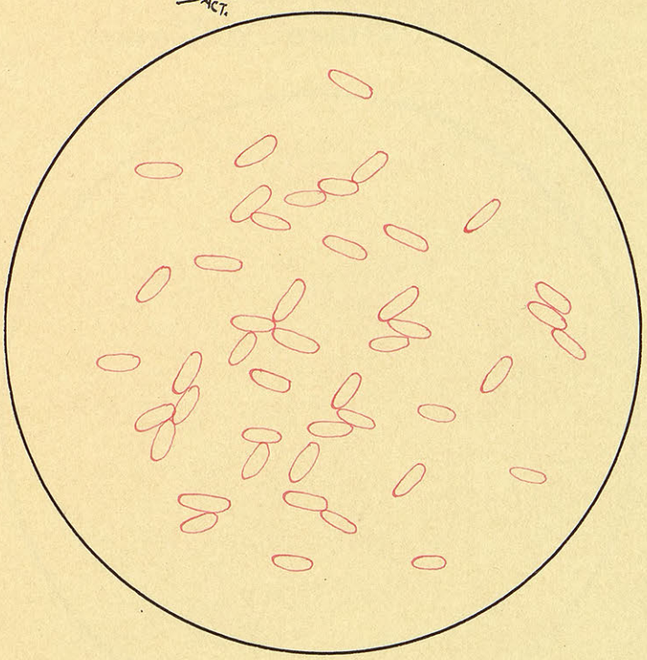


PLATE. X.

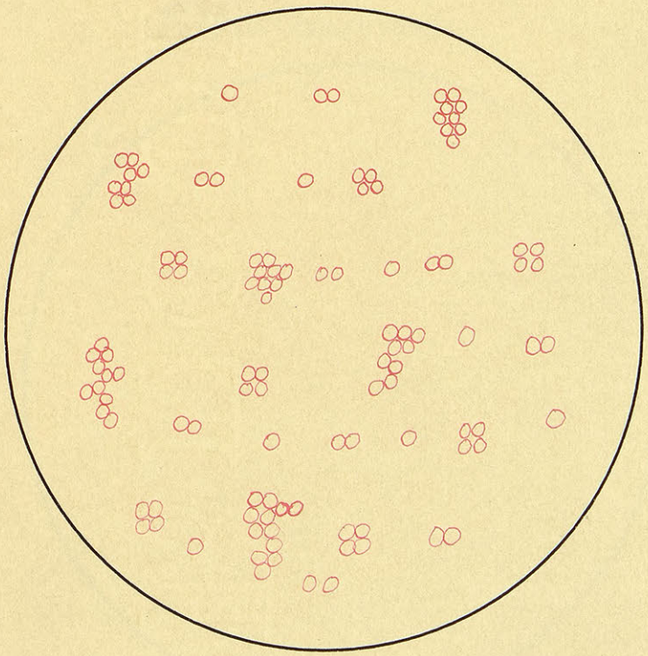
B. ACT. "(NEW ORGANISM)"

FIG. 18.



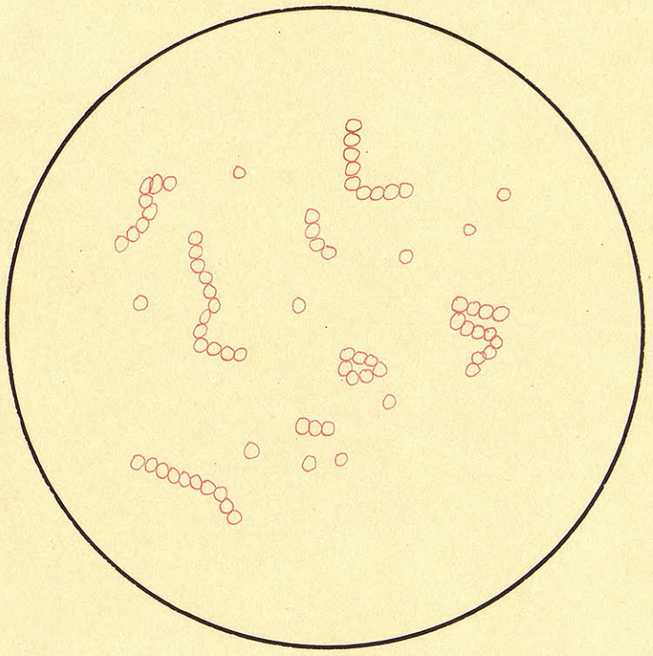
M. "(NEW ORGANISM)"

FIG. 19.



STREP. "(NEW ORGANISM)"

FIG. 20.



B. "(NEW ORGANISM)"

FIG. 21.