

Andrzej NOWAK¹

WHAT THE OLD MICROBIOLOGISTS KNEW...²

CO WIEDZIELI DAWNI MIKROBIOLODZY...

Abstract: Amazing is the fact that although the organisms have been known since the end of the seventeenth century, effective study of this group of organisms started after about 160 years, in the last two decades of the nineteenth century. The origins of science about bacteria were very difficult, there were many unknowns and conflict information. The research results provided by various scientists created complete chaos. From today's perspective, it is difficult to imagine how it was possible, do research in such conditions, and obtain reliable results? Yet despite these difficulties, knowledge of our predecessors was neither so small nor so doubtful as might be supposed. On the contrary, it was surprisingly big and wide. What our predecessors knew about bacteria and especially their importance in nature? They knew that bacteria live everywhere, knew about their unlimited spread in the biosphere. The role of microorganisms in the mineralization of organic matter was known, as well as the circulation of matter in nature and role of bacteria in cycles of nutrient elements, and the solar energy as the driving force behind these changes. Today - although we understand these mechanisms much more accurately, we know a lot details and individual changes - but the basic outline of the functioning of the biosphere, valid until today created our predecessors. A look back at the beginning of the microbiology teaches us, how much can be achieved with seemingly primitive methods, if accompanied by a passion for research and imagination.

Keywords: history of microbiology, biosphere, cycles of elements

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² Lecture was presented during ECOpole'18 Conference, Polanica-Zdrój, 10-13.10.2018

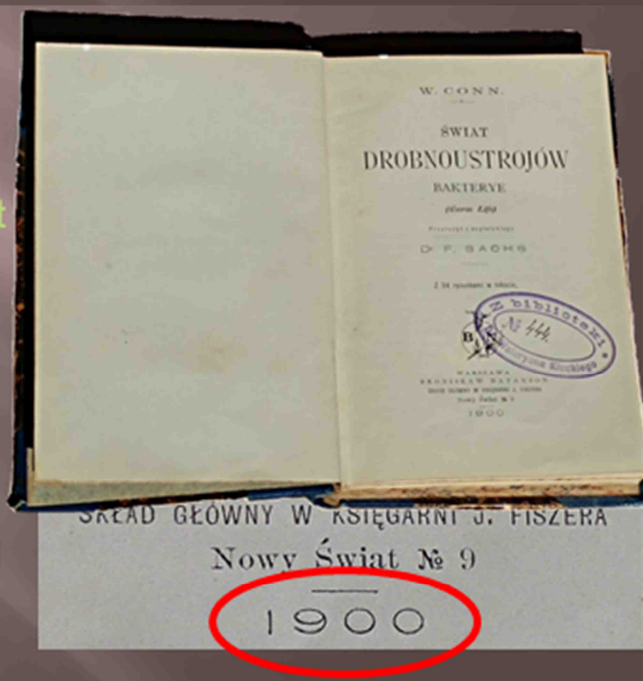
Preface...

Recently, among various antiques, I found a small book in my old family home. It was old microbiology handbook used in the past by my father, when he had studied agriculture in Dublany, near Lwów. The book was published in 1900, almost 120 years ago.



Preface...

I was very interested in: what was known about microorganisms so long ago? How changed microbiology over last century? So - what the old microbiologists knew ...





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WHAT THE OLD MICROBIOLOGISTS KNEW...

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The emergence of microbiology...

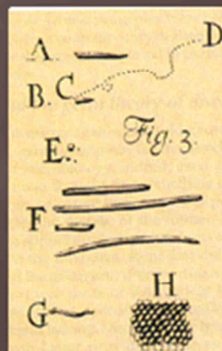
It is amazing, that although microorganisms have been known since the end of the 17-th century, effective studies on it began in the last twenty years of the nineteenth century (after 160 years).



Leeuwenhoek microscope



Antoni van Leeuwenhoek (1632 - 1723)



Leeuwenhoek drawings

The emergence of microbiology...

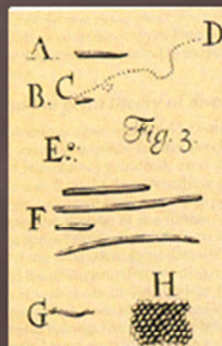
Difficulties in methodology meant that for a long period of time it was impossible to find specific and reliable information about this group of organisms.



Leeuwenhoek microscope



Antoni van Leeuwenhoek (1632 - 1723)



Leeuwenhoek drawings

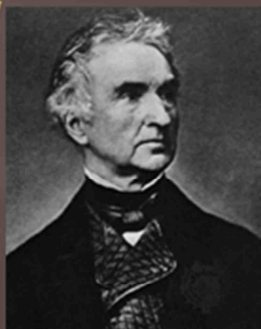
The emergence of microbiology...

There were other, side reasons, for example, despite Schwann's information about the possible connection of bacteria with fermentation processes, this issue was not considered scientifically true for a long time due to the enormous scientific authority



Theodor Ambrose Hubert Schwann
1810-1882

of Liebig, who believed that the fermentation processes were purely chemical. This opinion affected for decades on the development of microbiological research.



Justus baron von Liebig
1803-1873

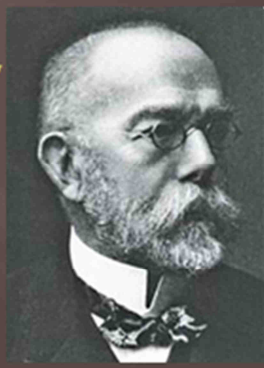
The emergence of microbiology...

Only the appearance of another great scientist - the father of microbiology - Louis Pasteur, caused a breakthrough. The second breakthrough element



Louis Pasteur
1822-1895

was the work of Robert Koch, especially on methodology. Some of his methods (the dilution method, staining procedures, grow media) are used until today.



Heinrich Hermann Robert Koch
1843-1910

The emergence of microbiology...

Since then, progress was rapid and knowledge accumulated in an avalanche, and in the book "The world of microorganisms" published in 1900 William Conn writes about bacteria:

„Although their size is negligible, their significance can not be highly appreciated because the continuity of life in the animal and plant kingdom is based on their activities. Both in good and in evil they are the factors of unending and almost unlimited powers... ”



Herbert William Conn
1859-1917

Today, we understand this statement even better and more fully, but it has lost nothing of its relevance.

What was known about bacteria...

Shape...

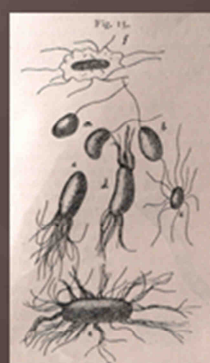
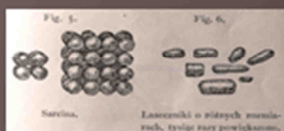
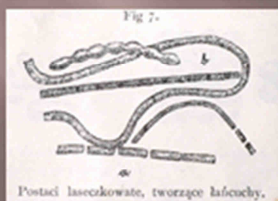
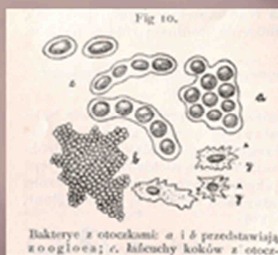
Not much was known about their construction. The shapes were mainly known, which today we define similarly.

„In terms of shape, the bacteria have the simplest one we know. Although there are hundreds of different species, they have only three main forms which can be compared with billiard balls, pencils and corkscrews.”



What was known about bacteria...

Structure...



And here some pictures of microorganisms from the book

What was known about bacteria...

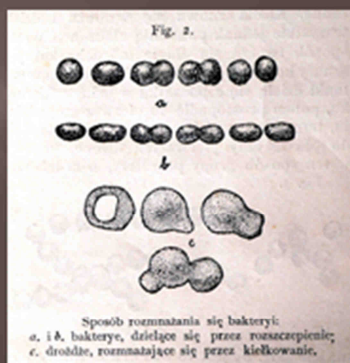
Reproduction... It is known that it is...

Very little was known about reproduction:

„They have the ability to multiply by simply dividing or splitting.”

„The method of reproduction by a simple division is a feature that differentiates bacteria from yeast, as these, as plants, reproduce in a way called germination”

(It must be said, that today we know: yeasts are not plants, they are fungi)



What was known about bacteria...

Inner construction... A great mystery...

And even less about inner construction:

„In fact, they have a certain internal structure, but we know very little about it.”

„Bacteria seem to have a membrane...”

„Some microscopists supposedly found the nucleus... Others considered the whole bacterium as a nucleus without protoplasm, when others came to the conclusion that the visible internal structure is not anything other than a phenomenon, depending on the physical configuration of the protoplasm.”



What was known about bacteria...

Taxonomy... Plants or animals?

Very important was to find the answer to the question: are the bacteria plants or animals?

„They undoubtedly have many features in common with both. The very prevalent among them ability to actively move, and the fact that they usually live on complex bodies, serving them for food, are the characteristics of animals, and it was based on the supposition that bakteryja are real animals. But their general form, the way they grow, form threads and spores, are purely plant features.”

What was known about bacteria...

Taxonomy... Plants or animals?

Today we know, that all organisms can be divided in two groups: *Procaryota* and *Eucaryota*.

Eucaryota contents *Fungi*, *Plant* and *Animal*.

Bacteria and *Cyanobacteria* belongs to *Procaryota*.

So, the *Bacteria* are neither *Plants* nor *Animals*.

What was known about bacteria...

Difficult beginnings...

The beginnings of knowledge about bacteria were difficult.

There were many unknowns, contradictions, and chaos prevailed in the information provided by various researchers.

From today's perspective, it is difficult to imagine how research could be carried out in such conditions, and come to the truth, reliable, indisputable findings?

Amazing effects...

Despite the difficulties...

And yet... in spite of these sky-high difficulties, the knowledge of our predecessors was neither as small nor as uncertain as one might suppose.

On the contrary, it was amazing big and wide...

The role in the biosphere...

Prevalence...

We will look what was known about the role of bacteria in the biosphere:

„There are no plants or animals that are so commonly found in nature as bacteria. Their ubiquity, together with the great ability to reproduce, gives them such importance in nature. They exist almost everywhere on the Earth's surface.”

We can say exactly the same today...

The role in the biosphere...

Prevalence...

„They are in the ground, especially on its surface...”

„They are in all waters, both on their surface and in the depths ...”

„...There are further bacteria in the air, especially in populated areas ...”

„...found in immense abundance in every molecule of decaying matter.”

We can say exactly the same today...

The role in the biosphere...

Circulation of matter...

Former microbiologists considered the basic principles of the functioning of the biosphere:

„...what is it that the Earth has not been exhausted from nutrients for centuries?”

„In what way the Earth can produce plants annually over millions of years, without losing its original fertility anyway?”

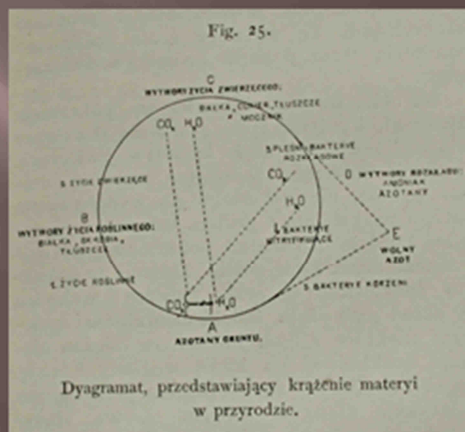
The role in the biosphere...

Circulation of matter...

And they knew how it works:

It is a original picture from book, showing the circulation of matter in the biosphere and the role of bacteria in this cycling.

The picture shows the connected cycles of carbon and nitrogen.

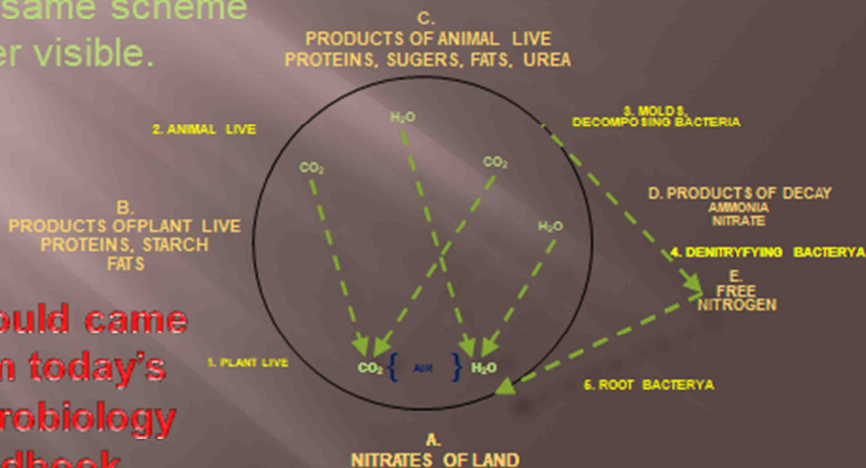


The role in the biosphere...

Circulation of matter...

The same scheme
better visible.

It could come
from today's
microbiology
handbook...



The role in the biosphere...

Circulation of matter...

In such way was described circulation of matter:

"Thus, the material of animals and plants does not stop in their eternal circulation. The light of the Sun provides energy for movement. The light of the Sun also forces the nutrient material to move in a circle and sustains these infinite changes; and as long as the Sun shines above the Earth, it seems, there is no reason for the matter to rest. This constant circulation has made possible an uninterrupted life over millions of years."

We can say exactly the same today...

The role in the biosphere...

Circulation of matter...

Already 120 years ago it was known that:

"The existence of the current state of nature and the existence of life in the previous periods of the world's history is based on the ubiquity of bacteria and on their ongoing activity, both decaying and creative."

We can say exactly the same today...

Summary from 1900...

And here the conclusion about the importance of microorganisms in the environment:

„The ability to reproduce is inconceivable, and the ability to induce deep chemical changes is unlimited.

This gigantic squad of living beings therefore presents strength, or a series of forces, of terrifying significance. We must consider most of this mass as our friends."

We can say exactly the same today...

Summary from 1900...

And their meaning for life on the Earth:

„We should look at them as workers who are never in rest, thanks to which the surface of the Earth may be fresh and green. Their strength is the basis, and activity is a necessary condition, for the continuation of life.”

We can say exactly the same today...

What can we learn...

We looked back in the years of the beginnings of microbiology and learned the difficulties and successes of former microbiologists. What does this knowledge teach us? We saw how they struggled with the dignity, working to discover the unknown. In the absence of research methods, in an imperfect and uncertain manner, they tried to steal nature from its secrets. They were gathering information scraps, trying to make a coherent whole out of them.

What can we learn...

For us - equipped with the modern methodologies, analytical equipment, genetic methods, isotopic methods, modern microscopes, computer techniques - the effort of our predecessors seems to be simply titanic, and their achievements are simply unbelievable.

What they had, instead of our modern research techniques?

What can we learn...

Scientific passion, curiosity, tireless perseverance, knowledge and intelligence, research intuition, imagination and the ability to associate facts, their synthesis and to create hypothesis.

Thanks to this, with such unusually modest means, they were able to collect knowledge, which in basic terms is no different from the one we have today.

What can we learn...

Of course, we know more details today, we have discovered mechanisms, the course of various changes, their nature and consequences. But the basic outline of the functioning of the biosphere, valid until today – created our predecessors. They should be remembered for it and respected from us - who are busy mainly with collecting points, writing applications for projects, with multiplication and duplication of papers – respected as great scientists, who thanks to their passion and imagination, entered the Pantheon of Science.

CO WIEDZIELI DAWNI MIKROBIOLODZY...

Zakład Chemii, Mikrobiologii i Biotechnologii Środowiska, Zachodniopomorski Uniwersytet Technologiczny w Szczecinie, Szczecin, Polska

Abstrakt: Zdumiewające jest, że jakkolwiek drobnoustroje znane były już od końca XVII wieku, to skuteczne badania tej grupy organizmów rozpoczęły się właściwie około 160 lat temu, w ostatnim dwudziestolecu wieku XIX. Początki nauki o bakteriach były bardzo trudne, wiele było niewiadomych, wiele sprzeczności, w informacjach podawanych przez różnych badaczy panował kompletny chaos. Patrząc z dzisiejszej perspektywy, trudno wyobrazić sobie, jak w takich warunkach można było prowadzić badania, dochodzić do pewnych ustaleń? A jednak pomimo tych trudności wiedza naszych poprzedników nie była ani tak mała, ani tak niepewna, jak można by przypuszczać. Wręcz przeciwnie, była zdumiewająco obszerna. Co wiedzieli nasi poprzednicy o bakteriach, a zwłaszcza o ich znaczeniu w przyrodzie? Wiedzieli, że bakterie żyją wszędzie, wiedzieli o wszędobylstwie bakterii, o ich nieograniczonym rozprzestrzenieniu w całej biosferze. Znana była rola mikroorganizmów w mineralizacji materii organicznej, wiedzano o krążeniu materii w przyrodzie i cyklach obiegu pierwiastków odżywczych oraz o energii słonecznej, będącej siłą napędową tych przemian. Dzisiaj, choć rozumiemy te mechanizmy znacznie dokładniej, znamy wiele szczegółów i przebieg poszczególnych przemian, widzimy, że podstawową koncepcję funkcjonowania biosfery, ważną do dzisiaj, stworzyli nasi poprzednicy. Spojrzenie wstecz, w lata początków mikrobiologii uczy nas, jak wiele można osiągnąć prymitywnymi wydawałoby się metodami, jeśli towarzyszy temu pasja badawcza i wyobraźnia.

Słowa kluczowe: historia mikrobiologii, biosfera, cykle krążenia pierwiastków