Ontology-Based Systemizing of the Science Information Devoted to Waste Utilizing by Methanogenesis

Ye. Shapovalov, V. Shapovalov, O. Stryzhak, A. Salyuk

***Abstract*—**Over the past decades, amount of scientific information has been growing exponentially. It became more complicated to process and systemize this amount of data. The approach to systematization of scientific information on the production of biogas based on the ontological IT platform "T.O.D.O.S." has been developed. It has been proposed to select semantic characteristics of each work for their further introduction into the IT platform "T.O.D.O.S.". An ontological graph with a ranking function for previous scientific research and for a system of selection of microorganisms has been worked out. These systems provide high performance of information management of scientific information.

***Keywords*—**Ontology-based analysis, analysis of scientific data, methanogenesys, microorganism hierarchy, T.O.D.O.S.

I. Introduction

THE amount of scientific information in the field of biotechnology has been growing and its processing and systematization has become more complicated over the past decades. The number of science articles and patents has grown exponentially since 2000. The number of patents in 2000 was about 70 and then grew to 2235 in 2017 (Fig. 1). The similar situation is observed with science articles. Their number was about 50 and it grew to 3959 in 2017 (Fig. 2) [4]. In addition, there is a fairly large amount of unsystematic data that has to be used in biotechnology research. As far as more and information is being accumulated, its scientific and analytical processing will become increasingly difficult with every year. Therefore, there is a problem with information management of the scientific branch, in particular, with regard to the production of biogas.

The aim of the work is to propose an approach to systematization of information on biogas production for further scientific work.

II. Literature Review

At the moment, the tools that are used do not allow to provide semantic analysis, but just provide user-based relevant information sorting. For example - Google-search, Google scholar, Microsoft Academy, etc. [3], [5], [7].

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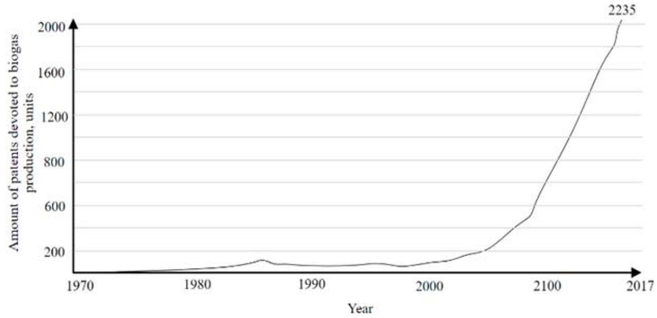

Fig. 1 The number of patents devoted to biogas production [4]

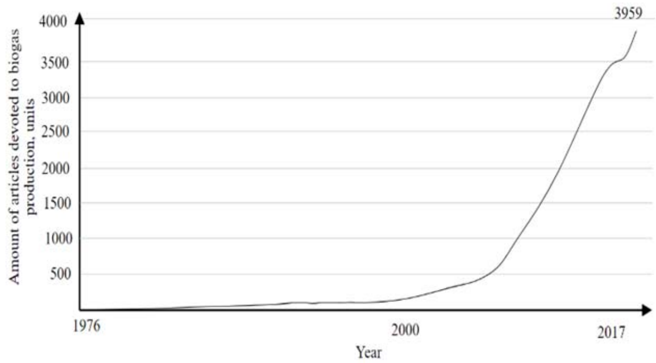

Fig. 2 The number of articles devoted to biogas production [4]

Lack of information management is the main disadvantage of these systems, so development of systems that allows to provide a quick and relevant search of scientific works is actual. One of the ways of solving this problem is the creation of ranging-based databases.

This aim may be solved using "T.O.D.O.S." (Transdisciplinary Ontology Dialog Object-oriented Systems) services. They allow to highlight semantic and numeric characteristics of each scientific work, which can be used as criteria to range scientific works [10], [11]. An example of ranking systems is presented in Figs. 3 and 4.

Still, the problem of information systematization of scientific data in the biotechnology field, using semantic characteristics, has not been realized yet. Thus, there is a scientific task to adapt a ranging platform to systematization of previous research results. It is possible in the case where scientific results may be interpreted using numeric data. However, it is often necessary to use in scientific work theoretic and not numeric information, which can be interpreted using semantic data. An example of theoretic information used in the field of biotechnology is hierarchy of microorganisms. Nowadays, this information is presented in the text type or in the structure type (Fig. 5). Thus, it takes a lot of time to process it. Operationality of this information can be significantly improved by transforming it to taxonomy [9].

Fig. 3 The general view of a classical ranging system

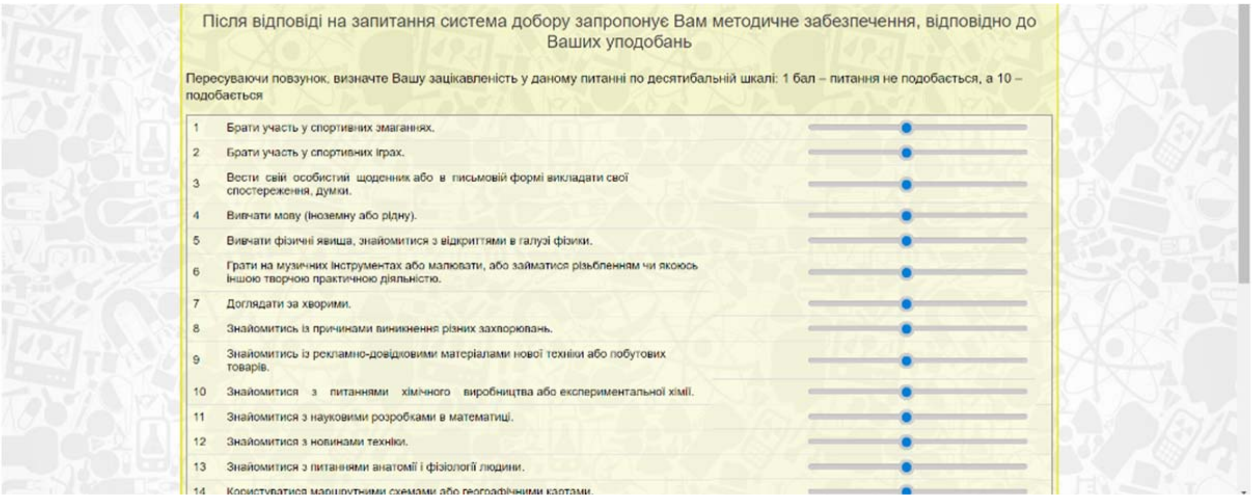

Fig. 4 The general view of a renewed ranging system

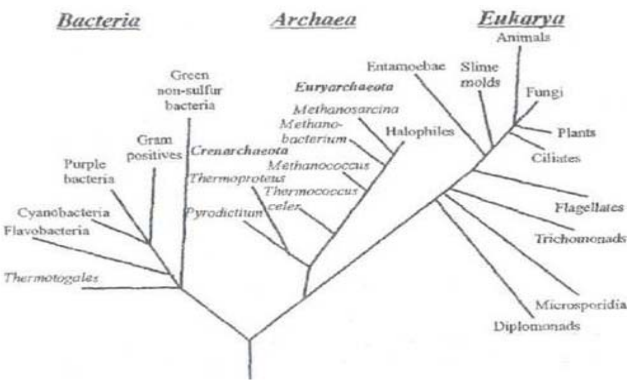

Fig. 5 An example of interpretation of hierarchy of microorganisms

We propose to use filtration instrument of the IT-plafrom "T.O.D.O.S." to improve information management of hierarchy of microorganisms. We have previously realized this idea to systemize the instruments of scientific work [1], [2], [8]. The filtration-based ontology of wastewater clearing technologies is presented in Fig. 6.

The detailed features of instruments of ranging and filtration of the ontology-based data are presented in our previous works [1], [2], [8].

II. Materials and Methods

To store information and provide its sharing, google sheets were used, with their further conversion into the .xls and .csv Excel sheets. The obtained documents were used to create the ontology structure (xml) and to fill the ontology graphs with semantic and numeric information for ranking and filtering.

To do this, the sheets were loaded to the part of "T.O.D.O.S." IT-platform editor4. After that, generation of the graph edges with its characteristics was carried out. The obtained ontological graphs were open in the appropriate form of ranking or filtering.

III. Results

To construct a system of ranking of previous studies, we have identified semantic characteristics of the scientific research devoted to biogas production from chicken manure. These semantic characteristics include temperature (° C), volume of reactor (l), chicken manure content (%), moisture content (%), active sludge content (%), final solids content (%), biogas and methane production (ml/g VS), methane content (%), year of the research, ammonium nitrogen content (mg / l), final pH, initial pH, minimal and maximum pH of substrate [6].

The characteristics were selected from the studies on dry fermentation of chicken manure and were input to the google sheets (Fig. 7).

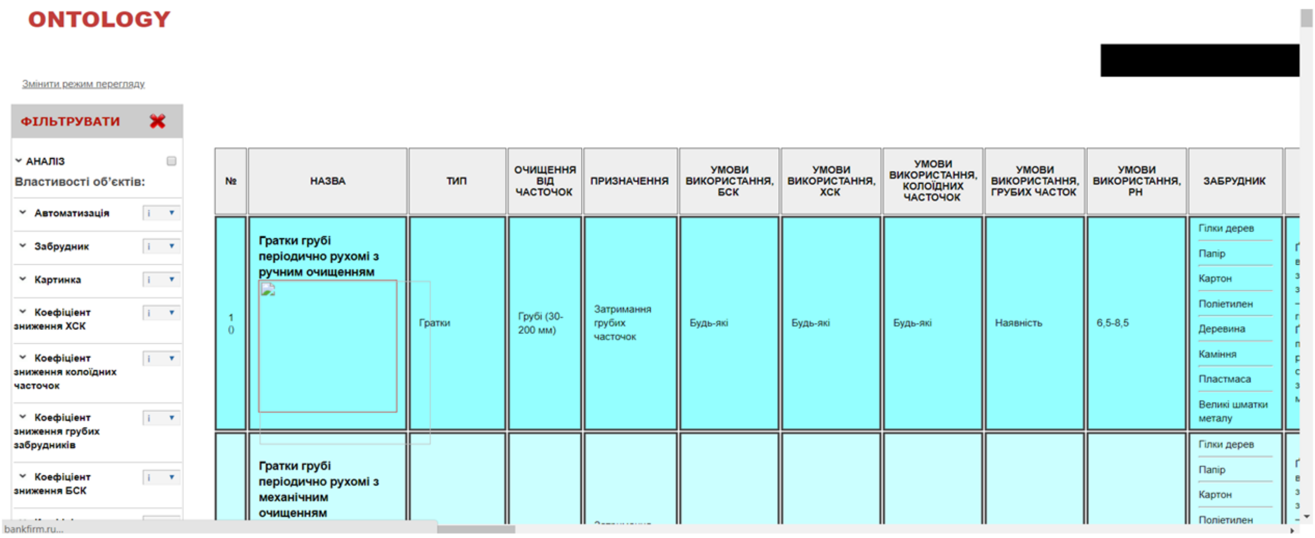

Fig. 6 The filtration-based ontology of wastewater clearing technologies

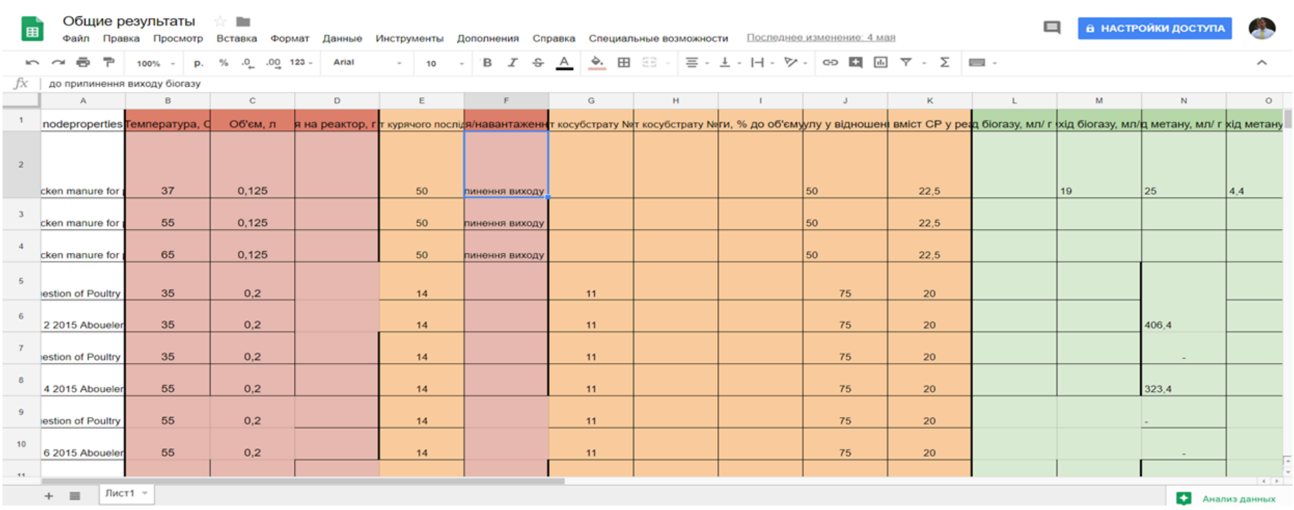

Fig. 7 General view of the google sheet with data on chicken manure dry fermentation

The data were processed by the methods described in detail in our previous works [1], [2], [8]. As a result, it was possible to use ranging of previous research results. The general view of the taxonomy is presented in Fig. 8. The interface for selecting the importance of indicators is presented in Fig. 9, and the interface for ranking the results is presented in Fig. 10.

The interface for selecting the priorities of numerical information for ranking allows to take into account the priority of modern articles, with the correct marking of importance criteria. The considered system allows quick search of the information by necessary criterion.

Systematization of knowledge in the field of biotechnology may also be complicated by the fact that semantic characteristics cannot always be quantified, and therefore the ranking system cannot always solve the issue of information management.

For such systems, it was suggested to allocate semantic characteristics and apply a filtering function. The semantic characteristics of each microorganism was also proposed and input into the google sheets. All semantic characteristics were added in the collective access mode. The general view of the attachment file for the system for selecting microorganisms is presented in Fig. 11.

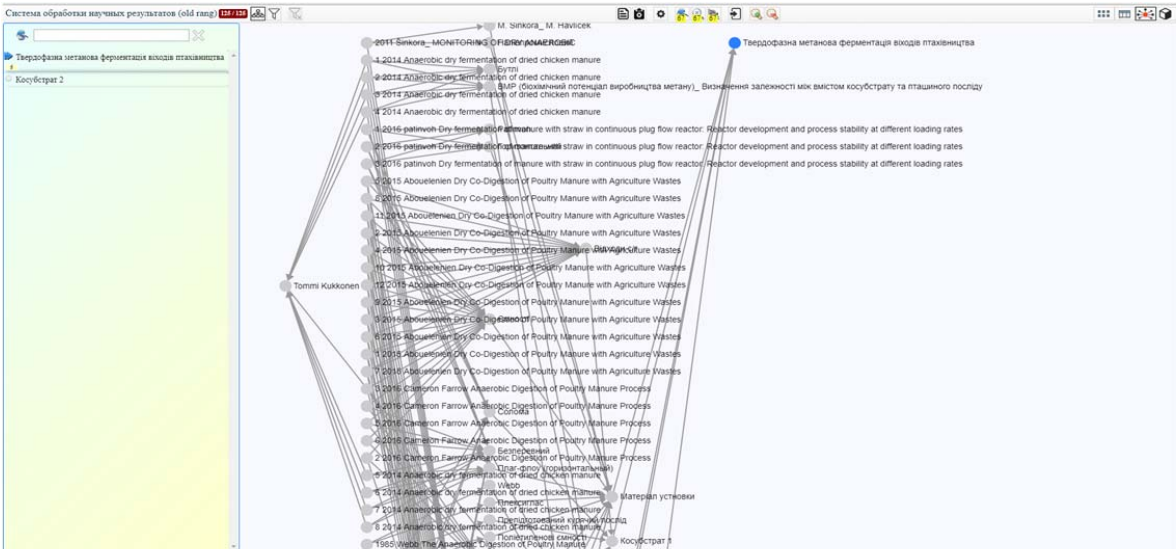

Fig. 8 The general view of the taxonomy

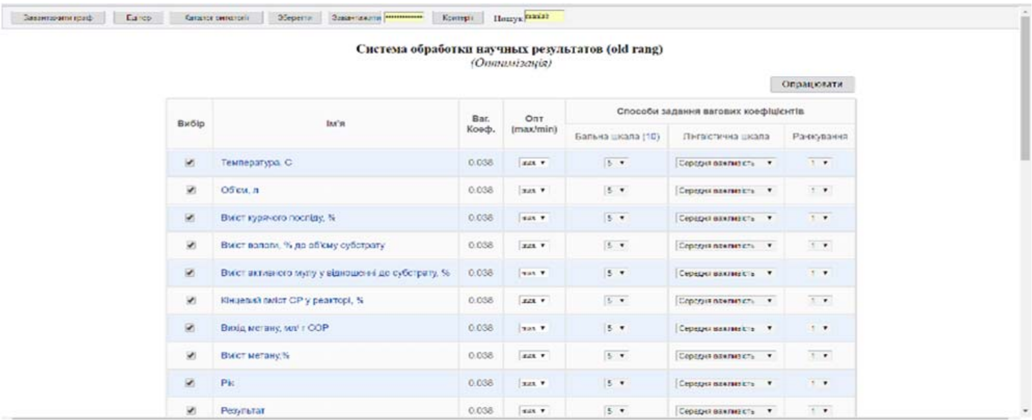

Fig. 9 The interface for selecting the importance of indicators

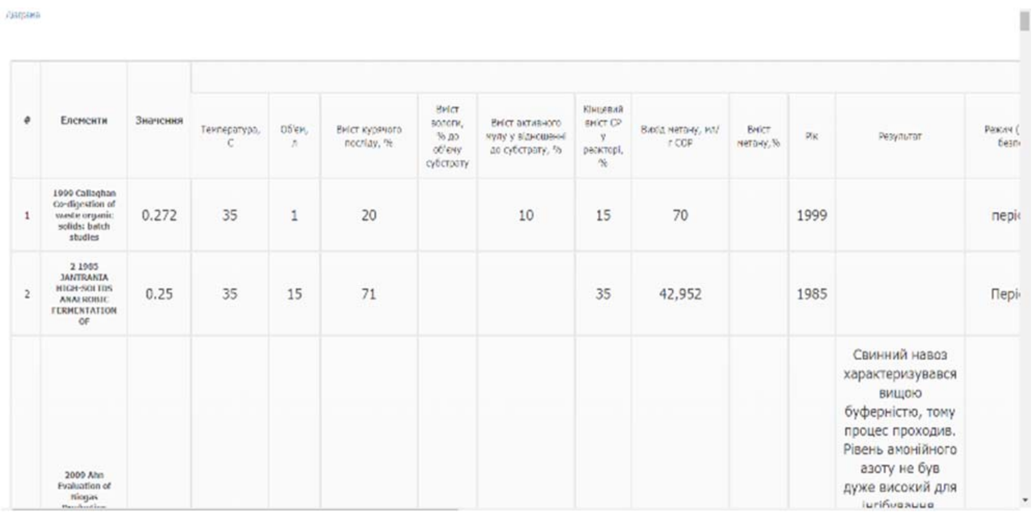

Fig. 10 The interface for ranking the results is presented

The resulting ontological graph provides the possibility to use the filtering, and it is possible to find the discovered microorganism or group of microorganisms. General view of the ontological taxonomy of microorganisms is presented in Fig. 12 and general view of the microorganisms selecting system in Fig. 13.

IV. Conclusions

Thus, the proposed systems allow to systematize previous research and theoretical information using ontological graphs and provide information management in this field of biogas production. Developed approaches allow us to analyze the results of previous research and theoretical information, as well as to simplify the work with previous information for the scientific research.

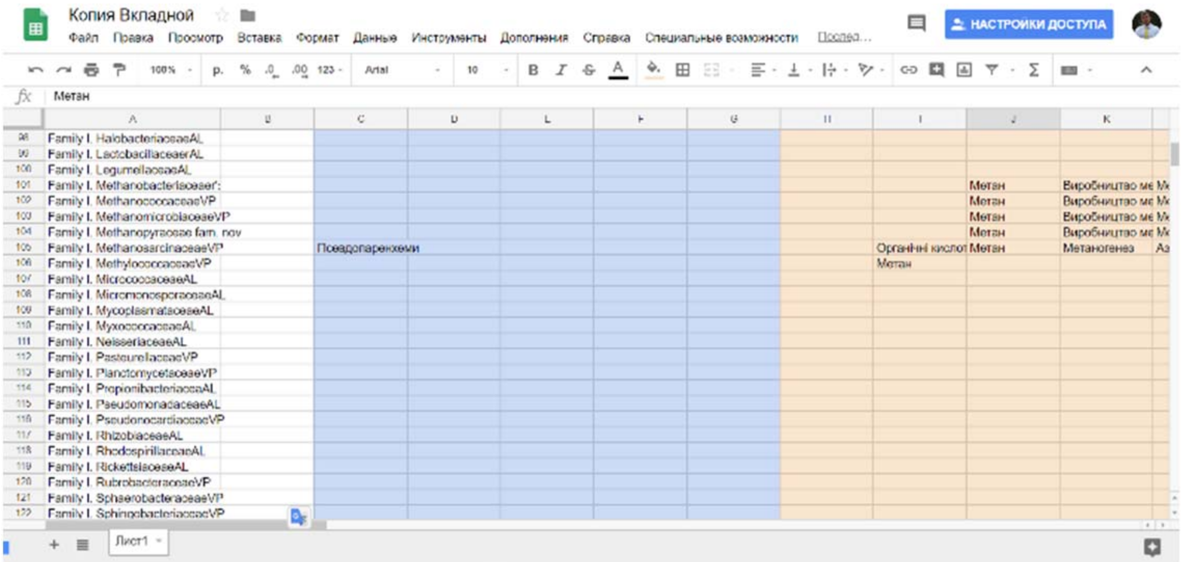

Fig. 11 The general view of the imputed sheet on hierarchy of microorganism data

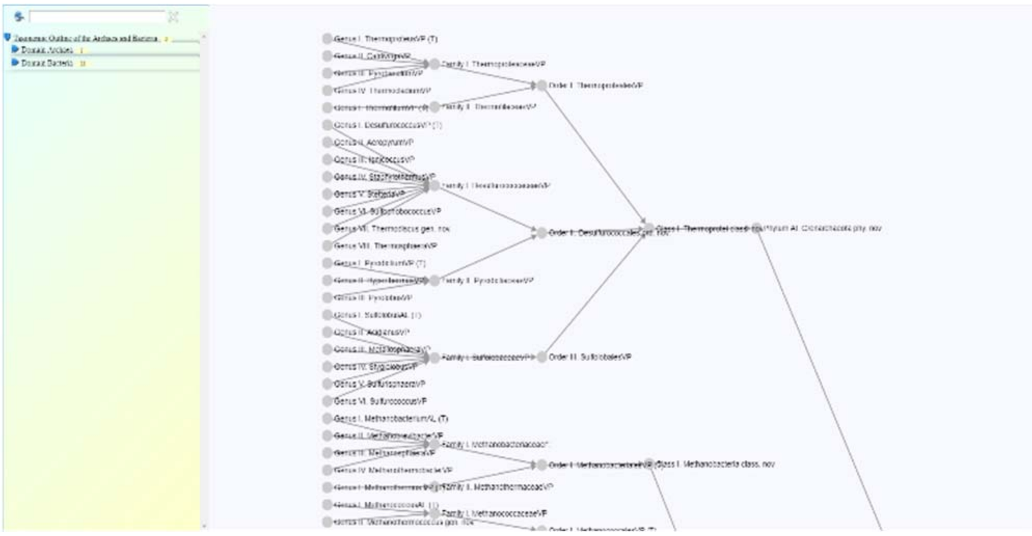

Fig. 12 General view of the ontological taxonomy of microorganisms

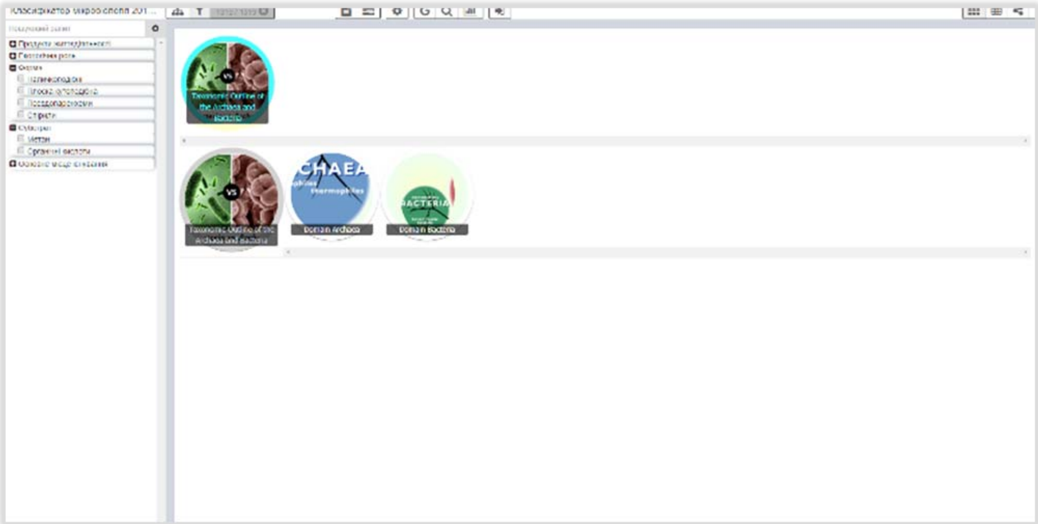

Fig. 13 General view of the microorganisms selecting system

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