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ТА ТЕХНОЛОГІЙ**

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PREFACE

This issue of the journal “History of Science and Technology” has been prepared in difficult conditions.

In difficult conditions for authors...

In difficult conditions for reviewers ...

In difficult conditions for the editorial board...

In difficult conditions for the whole world in general!!!

This issue contains ten articles. The first of these articles came in late 2019, when the world did not know yet these terrible words: Corona virus disease 2019 (COVID-19); severe acute respiratory syndrome Corona virus 2 (SARS-CoV-2)... COVID-19 was first identified in December 2019 in Wuhan, China, and has since spread worldwide, resulting in an ongoing pandemic.

As on May 29, 2020, when these lines were written, more than 5 800 000 cases were recorded in 188 countries, killing more than 359 000 people.

We hope that humanity will invent a vaccine as soon as possible, and these horrific death statistics will first stop growing and then stop altogether. For this, many events and activities are important, as history shows. Including the history of the development of science and technology, that is the subject area of our publication.

In many sources on the history of electric power production the evolution of electric power production was studied both in developed and developing countries and its impact on economy.

The growing demand for electric power became the most problem that stood before the power sector of Ghana. This issue begins with an article examining activities that in many ways helped to create a sustainable electricity supply for households and industries in Ghana, especially in the cities of Accra and Kumasi, between 1900 and 1960.

Scientific-technical borrowings are one of those types of scientific support for the work of industrial sectors, whose role in the conditions of exiting the crisis to acquiring the particular importance.

Since the mid-1920s, they have become the main way of scientific support for the organization of the development of Ukrainian electric machine-building industry in the context of large-scale electrification of the country. That was due to the need for a quick withdrawal of this industry from the previous crisis in the absence in the Ukrainian SSR of its own scientific support system for the electric machine engineering. An example of this measure, which was considered in the study, was an attempt to achieve the fastest possible increase in productivity of the Kharkiv Electromechanical Plant at minimal financial cost.

The next article analyzes the activities of the mining industry in the south of the

Russian Empire, of which Ukraine was a part of that time. An analysis of the so-called “coal crisis” and the role of large miners in collusion has been made. Market monopolization has been considered. Emphasis is made on the customs policy of the tsarist government, speculation on temporary fuel difficulties. The study shows that in the last quarter of the nineteenth century there was a consolidation and monopolization of the mining industry in the south of the Russian Empire.

In the 21st century, every reputable journal also has an online version, which makes the dissemination of scientific information almost instantaneous. We are so accustomed to the conveniences of the information age that it is difficult for us to imagine the difficulties that scientists faced a little over 150 years ago. The genesis of science launched the process of forming branch of scientific communities and demanded stable ways of communication for productive and effective development of the branch. Scientific journals have become an ideal means of disseminating information, and a scientific article has been transformed from an ordinary letter into a modern form and has taken on an ideal form. The importance of international communication between scientists, on the example of consideration of the activities of Valerian Mykolaiovych Lihin, is discussed in the following study. He became the first Russian-speaking member of one of the oldest Mathematical Societies in Europe - the French. V. Lihin broke the tradition of “isolated” science when discoveries in the Russian Empire (and later in the USSR) were made separately from the rest of the world.

In the next article an attempt to investigate in a chronological order the historical circumstances on the formation and development of the mainline electric locomotives engineering at the Luhansk diesel locomotives engineering plant (1957–2014) has been made.

Historical and biographical research is continued by the article, which considers the factors shaping the scientific worldview of Mykola Pavlovych Petrov - an outstanding scientist and engineer against the background of his initiative and organizational efforts to develop the domestic scientific and technical space of the late nineteenth - early twentieth

The article devoted to highlighting the contribution of academician Mariia Vasylivna Pavlova (Gortynska) in the development of palaeozoology science at the end of the XIX – the first third of the XX centuries continues the cycle of historical and biographical researches.

We hope that our readers will be interested in scientific work, examining the research of Russian women in the field of human genetics in 1920-1930. The main task of the article was to determine the contribution of women scientists to the development of different fields of human genetics. Particular attention was given to reconstructing women’s geneticists’ research work, reviewing the content of their publications, and analyzing the theoretical and methodological approaches they employed in solving various scientific problems.

In the history of Ukrainian archeology, there are many names of outstanding researchers who have devoted their lives to the study of our antiquity. Among them is

Yulian Kulakovskiy, a well-known domestic historian and archeologist. In 1883 Yu. A. Kulakovskiy joined the Nestor Chronicler Historical Society. Since that time, his life and career have been closely linked to this scientific union.

The analysis of the results of researches in the field of late antique archeology of the Crimea, published on the pages of “Readings of the Historical Society of Nestor the Chronicler”, is discussed in the next article.

The development of the spread of COVID-19 shows that in the fight against it in the first place are such measures and actions as unrestricted access to information on methods of combating the spread of the virus; exchange of data at the international level on treatment methods of the disease; communication between scientists from different countries; timely quarantine measures, etc. In this sense, it is important to study the historical experience of mankind in the fight against pandemics. This issue of the journal *History of Science and Technology* concludes with an article on a critical analysis of nineteenth-century military interventions as the main cause of the spread of infectious diseases internationally. Emerging problems and solutions obtained as a result of a critical analysis of the materials of the International Sanitary Conferences reveal the history of the spread of infectious diseases and the methods of early statistics used for epidemiological purposes.

Concluding this Preface, we emphasize once again the importance of a comprehensive study of international historical experience in the development of science and technology. Not limited to any one field or field of science, we are ready to provide the pages of our journal for the opportunity to exchange views with the international scientific community.

Let peace and health be with everyone in these hard times!

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An evolutionary study of production of electricity in Ghana (1900 – 1960)

***Abstract.** The literature on the history of electricity production have studied the evolution of electricity in both developed and developing countries and its impact on their economies. Some have laid foundations upon which other works are carried out.*



A close examination of historiography and multidisciplinary research on electricity production in Ghana shows that more efforts are required to improve the electric power landscape in Ghana. From the colonial era, the increasing demand for electricity has been the biggest challenge plaguing the energy sector. Respective governments have made significant strides in ensuring reliable and universal access to electricity throughout Ghana, yet such efforts have been accompanied by different levels of challenges. The study uses a qualitative and exploratory research approach to trace the activities that helped, in many other ways to the creation of a sustainable electric power provision to household and industry in Ghana, particularly in two of Ghana's cities; Accra and Kumasi, within the period 1900 to the 1960s. The work focused mainly on archival sources in its quest to arrive at how indigenous Ghanaians provided power for industrial activities and for household purposes. Results from the study show that local and cottage industries relied predominantly on wood, fuel, and biomass for their operations even before the introduction of the more sophisticated means of power generation. Also, the study revealed that in finding solutions to the challenges of electricity production, policymakers have focused more on current issues with little or no effort to trace the historical foundation of electricity production. This notwithstanding, the little efforts that have been made examined the history of energy production, with a limited focus on the immediate post-independence era.

Keywords: *electric power; economic impact; social impact; Ghana; Kumasi; Accra*

Introduction

Electricity is essential for the creation of wealth and improvement of social welfare; this means an adequate and reliable supply of electricity is required to ensure sustainable development (Apeaning, & Thollander, 2013). From a socio-economic point of view, electricity plays a multifaceted role in ensuring the improvement of quality of life, an increase in productivity, and the advancement of entrepreneurial activities. Almost all developmental activities from the production of goods and services to the advancement of economic infrastructure all depend on a reliable and sustainable supply of electrical energy (Eshun & Amoako-Tuffour, 2016). The implication is that uninterrupted access to electricity is central to achieving sound economic development in every country. As part of its policy plan, the United Nations' Sustainable Development Goal 7 has emphasized access to affordable, reliable, sustainable, and modern energy for all countries by 2030 (Report of the Secretary-General, 2019). This makes electricity a sine qua non to the development and economic growth agenda of all countries. As a developing country, Ghana has experienced severe electricity supply challenges in the past decade, which has created a wide development gap in the country's economy. Eshun & Amoako-Tuffour (2016) have argued that the real challenge to the provision of electricity in Ghana is the capacity to ensure that access to electricity is reliable and adequate (Eshun &

Amoako-Tuffour, 2016). With an estimated population of 31072940 in 2020 according to the United Nations population data, the higher demand of electricity has become a major problem to respective governments in their efforts to build a sustainable and resilient power hub to cater for the incessant power demand (Eshun & Amoako-Tuffour, 2016; United Nations, Department of Economic and Social Affairs, Population Division, 2019).

The political history of Ghana has a far-reaching impact on the country's economy. The energy sector has since the colonial era been impacted greatly by respective governments since independence. Various governments have implemented several policies to manage Ghana's Electricity Supply Industry from the colonial to the post-independence era. Botchway's (2000) briefing of the political underpinnings of Ghana's Electricity Supply shows that there has been a radical shift of policies due to how various governments assumed power (Botchway, 2000). Perhaps this may have contributed to the numerous challenges the country faces concerning supplying reliable power and also the lack of investment in the energy industry since 1966. The production of electrical energy in Ghana dates back to the Gold Coast era where diesel generators owned by factories and mining establishments served as the major source of electricity supply (Kumi, 2017). This was the colonial government's setup; to run a diesel generator power hub with no laid down policy to implement any rigorous energy program (Botchway, 2000). After independence, Kwame Nkrumah set up a seven-year policy plan for national reconstruction development (Adu-Gyamfi et al., 2019). Adu-Gyamfi (2019) have emphasized that science and technology have always been part of the revolutionized vision of Ghana's national policy since independence. In the energy sector, Nkrumah started the construction and the completion of the first hydro-electric plant in 1965 to generate electricity for all the people throughout the country (Brew-Hammond, 1996). Ghana's electricity sector since then has been heavily dependent on the Akosombo Dam for the supply of electricity throughout the country (Kumi, 2017).

The Electricity Department under the Nkrumah government was later absorbed by the newly established Electricity Corporation of Ghana under the Busia led administration in 1967 (Botchway, 2000; Brew-Hammond, 1996). Between 1972 and 1975, negotiations for the export of power to some neighboring countries including Togo and Benin was completed (Botchway, 2000). In 1983, the 'revolutionary' government led by Rawlings as part of its policies to ease the pressure on ECG, which was already undergoing restructuring due to an economic breakdown from the 1970s, introduced the Economic Recovery Programme (ERP) (Brew-Hammond, 1996). The ERP was committed to providing universal access to electricity to all areas in the country including the northern region of Ghana (Brew-Hammond, 1996). From 1990, two institutions have been tasked with the responsibility of providing electricity throughout the country; the Volta River Authority (VRA) and Electricity Corporation of Ghana (ECG) (Jacobson, & Delucchi, 2011; Alhaji, 2015). The VRA supplies electricity to all areas in the country including the then Northern and Upper

Regions while the ECG distributed power to some areas in southern Ghana which are considered outside the national grid (Botchway, 2000).

A close examination of the historiography and a broad spectrum of existing literature shows that there is a growth of scholarship surrounding energy production in Ghana, however, a detailed analysis of those data shows that there is much left to be discussed. One of the areas that need further exploration due to its dearth of knowledge is the means through which electricity was generated and used in Ghana, particularly in the two former industrializing cities, Accra and Kumasi from 1900 to the 1960s. In his work, “The State, Governance, and the Energy Industry in Ghana” Botchway (2000), examined the extent to which the state and its principles of good governance have contributed to the efficiency or otherwise of the energy industry. This article pays attention to the political underpinnings of energy production with less focus on how social activities impact the generation of electricity in Ghana. Hagan’s (2015) work “Renewable energy policy review, identification of gaps and solutions in Ghana” identifies the challenges that plague the energy sector and recommends privatization and consideration of a more enhanced mechanism in adopting renewable energy technologies to solve the woes of energy production in Ghana. Similarly, Kumi (2017) in his study “The electricity situation in Ghana: challenges and opportunities” posited that the government of Ghana should prioritize the use of renewable energy resources to compliment the smaller hydropower plant to ease the heavy dependence on the Akosombo dam and the major thermal generation facilities. The role of science and technology including the use of renewable energy technologies in helping achieve economic advances, education, infrastructure, and improvements in all sectors including electricity self-sufficiency has been emphasized by Adu-Gyamfi (2019) in their seminal work “Science, technology and healthcare delivery in Ghana: A historical perspective”. However, in considering such a model, the analysis in this study shows that more efforts will be needed at the grass-root level to ensure reliable and universal access to electricity (Adu-Gyamfi et al., 2019). Apeaning & Thollander (2013), also aiming at enhancing the knowledge of industrial energy efficiency and management strategies in Ghana, have investigated the present level of energy (and efficiency) management practices in Ghana’s largest industrial park, the Tema industrial area. In this study, Apeaning and his contemporaries, gave a fair idea of the production and usage of energy in Ghana, focusing on a latter period. Several of these studies as already stated in the foregoing review among others have paid little attention to the historical foundation of the generation and management of electric power in the colonial Gold Coast, particularly in Accra and Kumasi. This is the gap this study seeks to fill.

The paper explores the various means in which energy was maximized from 1900 to the 1960s. It highlights the pertinent issues and processes that culminated into the building of the first hydroelectric dam to produce electricity in Ghana. The study is further guided by some objectives including the need to ascertain the difference in the implementation of policies on energy production in Accra and

Kumasi, to highlight the means through which the people in these areas generated and used electricity and examine the discourse on the various sectors that are involved or concerned about the use of power in Ghana.

Methodology

The study reviewed the energy culture in late colonial Ghana by extensively exploring various means in which selected big towns and cities implemented energy policies, and the various means they provided energy for themselves up until the era of independence. This study was purely based on qualitative research. Qualitative research is discovery or exploratory research, which is used to gain an understanding of thoughts, opinions, and sometimes, motivations. It delves deeper into the problem or helps develop ideas or hypotheses for potential quantitative research (Wyse, 2011). The nature of the study demanded the use of archival materials. These essential materials were obtained from the national archives of Ghana, known as Public Records and Archives Administration Department (PRAAD) which is located in Accra and also the Manhyia Archives located in Kumasi. The type of archival materials obtained were in the form of minutes, correspondences, reports, public annual electricity reports by government and colonial officials, and unpublished records. Since the period under study covers 1900–1960, there was the need to use correspondences between colonial officers and administrators as well as documents on the post-independent government of Ghana.

Apart from the archival materials which provided some data, information was obtained from libraries and internet sources to augment and corroborate the primary material retrieved from the archives and vice versa. Figures on production and use of electricity were accessed from various sources – secondary and primary – an example is the use of archival sources to generate tables and figures to ascertain the pattern of electricity production. The information gathered was analyzed using a narrative approach.

Discussion

The paper has been structured into four sections. The first section focuses on the introduction which has already been discussed; it includes the method of the study. The second section focuses on a critical appraisal of related and existing scholarship. The third section covers data analysis and discussion. The fourth section focuses on the history of electricity generation in Ghana focusing on two cities; Accra and Kumasi.

Energy, Energy Production and Usefulness

Referring to Herbert (1956), Adu-Gyamfi et al. (2017) argued that nuclear energy is produced when nuclear fissions react against each other. It is from this reaction that energy is produced (Adu-Gyamfi et al, 2017). According to the study, a mix of energy production and distribution in Ghana will be a probable way to curb the energy crisis that continues to plague the country. They argue that nuclear

energy should be added to Ghana's energy mix (Adu-Gyamfi et al., 2017). They argued further that nuclear energy is cheaper, reliable, and durable than energy produced from gas and coal. "Comparing nuclear energy to natural gas has shown that one kilogram of uranium can illuminate fourteen 100-watt light bulbs for ten years. With the same amount, natural gas and coal can light the equal number of bulbs for only ten and six hours respectively" (Adu-Gyamfi et al., 2017). The issue at stake would succinctly include why Ghana has hesitated to implement her Nuclear Energy policy which was signed in 1961? According to Adu-Gyamfi et al. (2017), the Kwabenya Nuclear Reactor Project (KNRP) aimed at achieving some key targets including the introduction of nuclear science and technology, the development of the infrastructure for nuclear power programme and the need to acquire nuclear technology to provide sufficient electricity for industrialization (Adu-Gyamfi et al., 2017).

Jäger et al. (2016) have argued that electricity can be produced from the energy from sunlight, called solar energy. Direct conversion of this type of energy to electricity is based on semiconductor materials called photovoltaics (PV) (Jäger et al., 2016). Hagan (2015) argues that solar energy's might and capacity in Ghana ranges from "4.5 to 6.0 kWh/m²/day with the highest irradiation levels occurring in the northern half of the country" (Hagan, 2015). The solar potential is highest in the Northern Region but the electrification rate is low (Solar Energy, 2018). However, Hagan expounds that, the government is piloting several initiatives on the deployment of solar energy systems. Significantly, solar energy is the technology used to harness the sun's energy and make it useable (Solar Energy, 2018).

According to Ahiataku-Togobo (2014), Ghana has high Wind Power potential along the coast. Data collection for 60 m & 80 m height has been underway in 13 sites (Ahiataku-Togobo, 2014). Some of the sites for high voltage wind energy include Kue with a height of 2.9 m/s, Lolonya with 5.4 m/s, Tema with 5.0 m/s, Aplaku with 5.2 m/s, Kpone with 4.9 m/s, Oshiyie with 3.9 m/s, Angloga with 5.4 m/s among others (Ahiataku-Togobo, 2014). As asserted by Aurela (2012), "...strongest wind regime occurs along the Ghana/Togo border (9-9.9 m/s). Along the coast, high winds are also present (6.2-7.1 m/s)" (Aurela, 2012).

Hagan (2015) has argued that Ghana's primary energy is made up of 50% biomass. He further explained that the household sector consumes the highest biomass energy in the form of charcoal and firewood (Hagan, 2015). Aurela (2012) again expounds that Ghana has a suitable climate for plantation growth of *Jatropha Curcas*, which can be used for producing biodiesel, and the government of Ghana has developed a plan for such production (Aurela, 2012). Examples of biomass include supply from agricultural residues from maize, sorghum, rice, and from agro-based produce such as shea butter, cocoa, rubber and palm oil as well as saw mills (Hagan, 2015).

Spratt (2017) argues that electricity is a tool to help poverty reduction. He reports that, it is more reasonable and attainable when electricity is produced from renewable sources. Renewable energy can support low-carbon development strategies

(Spratt, 2017). Therefore, “electricity supply, access, and reliability should be prioritized if it is a key binding constraint on growth” (Spratt, 2017). Wolde-Rufael (2006) elaborates that, the supply of electricity is believed to be a requirement for Africa’s economic and social development. In his work “Electricity consumption-economic growth nexus: the Ghanaian case: Introduction”, Adom (2011) affirms that electricity is a basic infrastructural element for economic advancement. It is a multitasking ‘energy currency’ that underpins a wide range of products and services that improve the quality of life, increase worker productivity, and encourage entrepreneurial activity (Adom, 2011).

Apeaning and Thollander (2013) have also reported that majority of the funds that help finance energy in Ghana comes from indigenous businesses, a situation which will not be able to meet the increasing demand for capital which will finance energy sector development in developing countries (Apeaning, & Thollander, 2013). They postulate that there is the need to invite foreign and external capital for the growing energy demands since it will be dangerous for private capital to run out in developing countries. Given this, there is growing external fund into the energy and power sector of Ghana as could be seen from the United States Millennium Challenge Corporation (MCC), which proposed a five-year Ghana Power Compact which comes with the vision of creating a financially stable power sector which will stand the pressures at hand and also deal with future needs of households and businesses. This required the investment of an amount up to \$498 million over five years to help transform the power sector in Ghana (Investments to transform Ghana’s power sector, 2014).

The Evolution of Power Generation and Distribution in Ghana (1900-1960)

Before the advent of diesel generators owned by industrial establishments including factories and mines as well as other institutions such as hospitals and schools, there were various indigenous means of power generation (Kumi, 2017). It should be noted that this power was consumed domestically and to a lesser extent on industrial/factory bases. On the industrial sense, power was needed for cottage factories such as soap and oil palm production, fish mongering as well as smoking of game. Though the former were of high demand, the latter were demanded on small scale bases. The nature of activities in the Gold Coast in periods before colonization depicted the greater need for heat energy. Given this, firewood was of high demand among the indigenous people of the Gold Coast. Evidence of this has to do with the various firewood concessions supervised by the chiefs in the case of Asante (Manhyia Archives, 1946). By the dawn of independence, the industrial sector, modeled along that of the colonial economic system, was small (Ackah, Adjasi & Turkson, 2014). There was little or less use of power plants during this period. This is closely related to Ghana’s indigenous economy comprising of four main activities: agriculture; hunting and fishing; cottage industries and trade (Buah, 1980). The latter included weaving and cloth-making, soap-making and salt-making, small scale

mining, subsistent farming which was targeted for local trade among others. Elsewhere in Europe, industrialization started in Great Britain during the earlier periods of the mid-17th and 18th centuries (Martin, Starace, & Tricoire, 2017). This called for the need for a more sophisticated means of power generation to boost and support the industrialized economy.

Kelly (2017) argued that the Industrial Revolution in Britain introduced varying ways from which power could be generated. These included water, steam, and coal; these were believed to be abundant sources of power. He related British advancement in the textile industry during the era to her ability to explore various means of power supply. Here, Britain had considered the case of sophisticated power over manpower which dominated most means of production of European States by the dawn of industrialization. Again, electrical energy transformed the United State of America rapidly than the railway did. The gradual introduction of machines contributed to the birth of electrification and power production. The success of Ghana can also be explored from this angle, in the sense that the period preceding colonialism saw Gold Coast with a graciously weak industrial base. Even after that, Ghana took sometime before making efforts to move toward the path of industrializing states but this was truncated by political instability, intra-party and interparty conflict, poor governance and leadership, corruption as well as military coups among others. The need to industrialize requires some sophisticated power system.

Demand for Electricity in the Gold Coast

Attempts for Rural or Provincial Electrification

On 7th May 1956, The Development Committee of the Gold Coast in a meeting came out with a memorandum, which aimed at the provision of electricity for selected towns. After this decision was taken, a comprehensive scheme was drawn. Significantly, the financing of the scheme was to be done by the Local Authorities with a total cost which was not to exceed £120000. The scheme aimed at establishing eight rural electrification stations in all the regions of Ghana (PRAAD, Accra; RG. 7/1/1627). However, the initial work did not start with all the regions but there was the selection of a few. These can be viewed in table 1 below. In Ashanti Region, more than eight towns were selected, but the cabinet at the time deleted one of the towns from the list since the scheme had to cover only forty stations (Baffour, 2013). Greater Accra, which happens to be one of the regions selected to form part of the pilot study was not included in this scheme. The viable reason was that, the Greater Accra Region had its own isolated scheme designed to provide electricity.

On May 12th, 1954, the Development Committee made plans to extend the existing diesel station in Accra to 9000 kW capacity. The expansion of the diesel generating plants was not able to meet the demands of Accra and Tema which needed between 16500 and 20000 kW of power.

Table 1. Towns Selected for the Operation of the Rural Electrification Scheme on 7th May 1957 (Public Records and Archives Administration Department, file number RG.7/1/1628)

REGIONS	TOWNS SELECTED
Eastern Region	1. Akim Mansu 2. Akropong 3. Apedwa 4. Kwabeng 5. Mpraeso 6. Nkawkaw 7. Somanya 8. Suhum
Western Region	1. Abakrampa 2. Agona Junction 3. Apam 4. Asankragua 5. Awutu 6. Axim 7. Esiama 8. Half Assini
Trans-Volta/Togoland Region	1. Afloa/Denu 2. Anfoega 3. Jasikan 4. Kadjebi 5. Kpandu (sic) 6. Kpedze 7. Kpetoe 8. Worawora
Ashanti Region	1. Akrokerri 2. Bechem 3. Berekum 4. Dormaa-Ahenkro 5. Effiduase 6. Kukuom 7. Manso-Nkwanta 8. Sunyani 9. Techiman
Northern Region	1. Bawku 2. Bimbila 3. Bole 4. Damongo 5. Navrongo 6. Sambu 7. Wa 8. Yendi

Based on this, some consultation was done to investigate and design a new steam station to serve Accra and Tema (PRAAD, Accra; RG. 7/1/1627). In 1956, the scheme was suspended but the question was revisited in 1958 by the Standing Development Memorandum. The project was capable of adding additional generators up to 80 megawatts total capacity (PRAAD, Accra; RG. 7/1/1628).

Hydropower Potency of Some Rivers in the Gold Coast

The Gold Coast lies amid numerous rivers, great and small which she could tap from to meet her power/electricity needs. Therefore, in April 1957, the Chief Engineer studied some small hydroelectric schemes. There were some rivers he took into account for their suitability, and these are enumerated in table 2 indicating their hydropower strength or potential.

Table 2. Hydropower Potency of Some Rivers in the Gold Coast (Hydro-Power Schemes, Development Commission, (PRAAD) RG. 7/1/2150)

River	Location	Hydropower Score	Estimates in Kilowatt
River Pawn Pawn	Approximately 8 miles away from Koforidua	71	53.0
River Akrum	Near Begoro, 11 miles from Koforidua	41 (seasonal)	30.7
River Densu – Waterfalls	4.5 miles from Koforidua	1470	1095.0
Waterfalls	west of Mount Ejuanema and East of Nkawkaw	655 (seasonal)	493.0
Waterfalls	Near Amama, 5 miles from Mpraeso	13	9.7
River Apatosu	7 miles NorthEast of Mpraeso	22	16.2
The Birrutu Falls	9 miles from Mpraeso	136	10.5

Furthermore, under the rural electrification, which aimed at preparing several towns to access electricity based on the utilization of thermal generation; it was noted that it will be more economical and less time and resource consuming. Extending some of the electricity supply to some of the towns that were situated near or within a

reasonable distance of rivers with hydro-electric generation was less time and resource consuming. This view was supported by a parliamentary survey (PRAAD, Accra; RG. 7/1/2150). The towns which were selected along water or within river areas are listed in table 3. Also, table 4 shows an estimated power demand for selected cities in the Gold Coast from 1954 to 1968.

Table 3. Potential power estimate (PRAAD, 7/1/2150)

River	Potential Power Estimate (Megawatts)
Bui	65
Ajena	810
Kosombo (sic)	810
Tano	9.7
Offin	1.9
Pom Pom	3.6
Asuboni	3.4

Table 4. Estimated Demand (Public Records and Archives Administration Department, file number RG. 7/1/1627)

Area	1954	1956	1958	1963	1968
Accra	4.500	—	9.000	13.500	18.000
Tema	—	—	2.000	3.000	4.500
Kpong	—	—	—	?	?
Sekondi/Takoradi	2.500		4.000	6.000	9.000
Kumasi	1.300		4.000	5.000	7.500

Power Production Before the Akosombo Dam

The fact that no extensive electricity was produced in the Gold Coast before the construction of the Akosombo dam meant that there were hindrances. One of the greatest hindrances to the issue of energy production and management in the Gold Coast centred land. As it has been stated elsewhere in this paper, local land is held for the people by the chiefs or king. Therefore, issues arose with the procurement of sites for firewood plantations for the people of the Gold Coast. In one instance, on 23rd November 1945, the office of the *Asantehene* (King of Asante) wrote to the District Commissioner for their regret for giving the government a wrong site. The site which was approved for the firewood plantation was the property of the people of Bremang and that land was reserved for the people of Bremang and for posterity. It necessitated the need to select a new station for the plantation. This issue came into being when the *Bremanghene* (the chief of Bremang) and his councilors forwarded a petition to the office of the *Asantehene* on this matter (Manhyia Archives, MAG 1/6/4/4; No. 0013/10).

On 7th May 1956, in an attempt to electrify the region of the Gold Coast, the Development Committee of the Gold Coast argued that the cost of production should be borne by the Local Authorities. However, some native authorities could not afford their financial obligations; the committee set out a new agenda that will allow indigenes to bear the cost of wiring their homes. After the commencement of the experiment, there was a memorandum by the minister of works, which suggested among other things that it did not envisage that the consumers were prepared to pay the full fee for internal wiring of their houses. The supply was experimental and was intended to provide for the cost of running small supplies in towns and rural areas. The expected revenue from the internal wiring had to be shouldered by the Electricity Department (Manhyia Archives, MAG 1/6/4/4; No. 0013/10).

In the year 1956, the development estimates for the reconstruction of the various sectors in the Gold Coast required correction on the basis that electricity was added to the estimate. While all other issues had allocated funds, electricity/power generation had limited funding. Instead of pumping funds into electric power generation, they rather excluded it from the total estimates. This shows in many ways the lack of importance placed on energy and electricity within the period under review (PRAAD, Accra; RG.7/1/1627). Also in 1957/58, no funds were made available in the Development estimates. It is noted that the funds estimated for electricity development were limited, however, these funds were needed to increase the generating capacity and distribution systems in the principal urban centers (PRAAD, Accra; RG.7/1/1627).

Construction of The Akosombo Dam For National Electrification

Every developing country aims to reach a level of higher living standards and this dream can in many ways be achieved through sustained and cheap electricity/power. The spirit of a young Gold Coast in the early years of its birth was very high as its leaders vied to provide electricity to ensure their industrial breakthrough. According to the National Energy Education Development Project (NEED), (2016), there had been numerous attempts by the British government to build a dam for the Gold Coast. Their gaze was on the the Volta River. During the early years, the British authorities had made a lot of effort to find a bauxite reserve in their colony (NEED, 2016). Also, Kwesi Lampitey, opposition member of parliament (MP) from 1951 to 1957, asserted that the Volta River scheme was an old British government scheme. In an initial report and research by Sir Albert Kitson, head of the Geological Survey Department of the Gold Coast in 1913, he identified the hydro potency of the Volta River and came out with a way to harness and utilize the water-power and mineral resources (NEED, 2016). According the University of Ghana Resource Center for Energy Economics (2005), an amalgamation of all attempts to build the hydroelectric dam got to its peak when in the 1950s Sir William Halcrow and Partners pioneered the implementation of engineering studies and studied the construction of the Volta River by constructing a dam at Ajena in the

Eastern Region of Ghana. The tenets of the Halcrow report captured the “climate and hydrology of the Volta Basin, evaporative studies, flood control, geology, power plant design, and project cost estimates in detail” (The University of Ghana. Resource Center for Energy Economics, 2005). The Akosombo River and its surroundings provided the site for this project. However, the project was not successful.

The preparatory ground for the construction of the dam was part of the colonial masters’ attempt to keep on with their exploitative scheme. According to Kojo Botsio (Minister of Education for the Gold Coast, 1951-1957), the power was initially conceived just for the manufacture of aluminium in this country. However, when Kwame Nkrumah came, he gave a new accent and new importance to that power project. Essentially, the power was to be used for the comprehensive economic development of the country. Notwithstanding this fact, there were diesel generators available in the Gold Coast. The power from the Volta River, once generated meant all diesel equipment not required could be removed and used elsewhere as standby or to meet peak demand. It was argued among other things that, it was unproductive and uneconomical to supply smaller towns with the power from the Volta since these towns did not have strong industrial and economic demand (Development Plan General Electricity, 1954). During the process of constructing the dam and in the name of education, Kwame Nkrumah and the British Government took the Ghanaian population through a series of a traveling exhibition of the power scheme. Prototypes and models of the dam were built and taken to public places where the local Ghanaian population witnessed what the dam would look like (NEED, 2016). Due to the exhibition the project underwent, a large number of Ghanaians were very much interested in looking for ways in which they could provide support. This is affirmed by SQN. LDR Clem Sowu, assistant exhibition officer 1956 that, a farmer came to him asking which way he could be of help to speed up the construction of the dam (NEED, 2016).

It was not until after Ghana gained independence from the British in 1957, that the first black prime minister, Dr. Kwame Nkrumah launched the plan to build a hydropower plant in Ghana. In the process, he asserted that ‘I have always been convinced that an abundance of cheap electrical power is the soundest base for the expansion of industry in a country such as ours’ (NEED, 2016). From this point of view, it can be deduced that the building of the dam was geared towards the betterment of the social, economic, and political life of Ghana. Kwame Nkrumah realized this importance.

The construction of the dam took a political turn in the sense that Ghana was caught-up in the hegemonic power struggle between the Soviet Union and the United State of America. George Ball, who worked under the secretary of state during the Kennedy administration of the United State, recognized the progress the Soviet Union was making with their communist ideologies, particularly in Africa and to some other parts of Europe. Therefore, the United States countered with foreign aid

as a defense mechanism against communism, and Ghana was one of the countries to benefit from this (NEED, 2016). Ghana struck a deal with the United States of America when Dr. Kwame Nkrumah visited the country and told their leadership about the importance of the dam, its aluminum reserve, and the fact that, the best way for the construction of the dam to be a success was to bring in an American Aluminum Company. In the process of agreeing to Nkrumah's request, in 1958, a team of engineers from Kaiser Aluminum landed in Accra to take a look at the plan for the scheme (NEED, 2016). Initially, the dam was to provide huge electricity for Kaiser, in paying for the construction of the dam and the rest of this power will go into servicing the need of the people of Ghana. Another means of obtaining funds for the dam came from the World Bank when Kwame Nkrumah requested of them to offer Ghana a loan of 30 million pounds . This amount was the biggest ever asked from the World Bank at that time. Thus in 1961, "the Volta River Authority (VRA) was established by an Act of Parliament and placed directly under the Office of the Prime Minister. The Act gave VRA responsibility for generation and high-voltage transmission of electricity throughout Ghana" (Brew-Hammond, 1996). On 22nd of January 1962, Kwame Nkrumah signed the master agreement and was then completed in 1965 which came at a cost of \$200 million. The Volta Aluminum Company (VALCO) was set up to control electricity production. The Kaiser Cooperation Company run the VALCO. It employed over 1500 Ghanaians and brought precious foreign exchange into Ghana. The Kaiser cooperation used the dam's electricity and so allowed the World Bank loan to be paid off without interruption (Brew-Hammond, 1996).

The construction of the dam came with increasing industrialization in the country's economy. In 1968, Ghana's electricity demand shore up to a peak of 540 GWh (Eshun & Amoako-Tuffour, 2016). With industrialization rapidly growing in the country, more houses being erected, and the pressure on the dam at Akosombo, there were increases in generation by 1972, the generation capacity of the Akosombo dam reached 3321.23 GWh with the installation of two additional generating units (Brew-Hammond, 1996).

Power Production and Management

Electricity in Greater Accra and Ashanti

Duku et al. (2011) as well as Gyamfi et al. (2018), indicate that Ghana's primary energy sector is predominantly biomass. 64% of energy production in the country comes from biomass (Duku, Gu & Hagan, 2011). Traditional biomass comes in the form of plant/crop and dung and other wood residues (Gifty, Kemausuor & Brew-Hammond, 2013). Ghana, like any other country, started with the use of traditional energy specifically firewood. According to Evald (2013), firewood is produced from branches, smaller whole trees, etc. from the forest. It could be from whole trees and wood waste from gardens, parks, and other recreational areas, areas along railways among other places as well as from industrial surplus products and other numerous

sources. The people of the Gold Coast realised the importance of firewood, which is classified as a renewable source of energy (McKendry, 2002). The land which hosted the firewood belonged to the people communally and the chiefs held them in trust for the community” (PRAAD, Accra; Ghana 1945, ADM 5/4/18). With the advent of colonialism, the colonial administration combined efforts with the native authorities to ensure that, wood fuel was readily available to the people of the Gold Coast. The indent below draws insights on the matter:

I shall be glad to know as soon as possible whether you have agreed to the area which the Adumhene inspected, being used as a Firewood Plantation for Kumasi. If this is agreed, it will be desirable to pass Native Authority Rules, declaring it a Forest Reserve so that it can be properly managed. It is important that an agreement is reached as soon as possible so that the nursery for the trees can be started at once for planting out next year (Manhyia Archives, Kumasi, Ghana, MAG. 1/6/4/4; No 0013/10).

The period under review witnessed the passage of ordinances that demarcated areas that formally became known as firewood concessions. This was administered directly under the Native Jurisdiction Ordinance; empowering chiefs and for that matter the *Asantehene* to demarcate portions appropriately. The above correspondence gives an account of traditional and indigenous means of power generation in the Gold Coast. Vineyards and homesteads were built to store firewood for various purposes. Per the content of the correspondence, large acres of profitable lands were left for traditional energy production, especially in Asante. There was great importance placed on the energy derived from wood. Kitson (1945) argued that wood fuel has been for transportation (especially water launches), in industry, mining, and domestic purposes (Kitson, 1945). Kitson again saw the importance of wood fuel in the life of the people of the colony and mentioned that the continuous deforestation and cutting down of trees for fuel without replanting had the propensity to distract the daily lives of the people of the Gold Coast. He suggested that efficient and effective measures should be put in place to conserve and reserve the forests since there will come a time when wood fuel would be too expensive or non-existent (Kitson, 1945).

From the use of wood fuel to the introduction of stand-alone generators, the management and distribution of energy and power were done collaboratively for the local and colonial administration. The local Ghanaian population during the early parts of the 1900s used wood fuel in large quantities. Since the administration of the Gold Coast was still in the collective hands of the colonial administration and the native authorities, energy for both domestic and industrial purposes was managed by both administrations as seen in the following correspondence:

I have to inquire whether you agree with the recommendation of the Finance Board that the cost of the firewood reserve should be borne equally by Government and the Native Administration and that the profits should be shared equally (Manhyia Archives Kumasi, 1945, MAG 1/6/4/4, No.0013/12).

In 1945, the office of the District Commissioner of Kumasi reported that the headache for the cost of planting a tree and reserving them for fuel has to be shared whether equally or otherwise, by both authorities. The idea behind this phenomenon was that the Native Authority had to bear the cost for the natives who used firewood for domestic activities and to a lesser extent, to support local industry. Again, the fact that most earlier industrial activities such as mining and lumbering were in the hands of the colonial administration, they the local people could not bear the cost of maintaining the plantation reserves alone. The Kumasi Forestry Department in response demanded that the government was to accept and pay all debts. Thus, at the end of the financial year, a statement of expenditure was submitted to the Finance Board of the Kumasi Divisional Council, who was required to pay 50% of the total expenditure (Manhyia Archives, Kumasi, 1945, MAG 1/6/4/4; No 0013/27). This made sense since both the natives and the colonial administration had a stake in the usage of the firewood. Tariffs and taxes were collected from the local people for using the wood fuel from the plantation.

The introduction of the electronic means of power production came into the Gold Coast during the early period of 1900. Factories and companies who operated high-speed machinery imported lightning systems to propel their operations. The organization further stated that the Gold Coast Railway administration in 1914 operated public electricity systems which was used to supported the railway systems in Sekondi as well as the management of their supplementary facilities like offices and workshops (The University of Ghana Resource Center for Energy Economics, 2005). Aside from the railways administration, another section of government that operated public lightning was the Public Works Department (PWD). In 1922, they started the operation of public electricity and provided Accra with a small scale direct current public supply of electricity. Two years later, in 1924, the PWD supplied alternating currents to Accra (The University of Ghana Resource Center for Energy Economics, 2005). On 12th May 1954, the Standing Development Committee for Electricity Development considered a memorandum on electricity for Accra and Tema. They concluded that the already installed diesel station at Accra should have an extension to about 9000 kW capacity, that steam power should be built, and that an expert should be invited to design a steam power station to serve Accra and Tema (PRAAD, Accra; RG. 7/1/1627).

The Electricity Department believed that Accra and Tema would need an estimated amount of between 16500 kW and 20000 kW before the installation of any power from the Volta. Furthermore, the department saw that a steam generating plant could be in operation in 1957–1958 and this could be more economical to operate than a diesel station (PRAAD, Accra; RG. 7/1/1627).

In earlier demands, the supply of electricity to Kumasi and the mining areas required power from the Volta leaving Accra and Tema to be served by a steam generating station (PRAAD, Accra; RG. 7/1/1627). In 1925, the installation of a small power plant made up of “three horizontal single-cylinder oil-powered engines”

was completed in Koforidua. It continued the next year in Kumasi, where in May 1927, a restricted evening supply was commenced and a power station finally started operation in October 1927 (Electricity company of Ghana. Our History, 2019). The people of Winneba received their share of the grass-root national electrification when in the same year, in 1927, a Direct Current (DC) supply was extended to them but was later replaced with Alternating Current (AC) and extended supply from Swedru which was already in operation (ISSER 2005). Efforts to supply the nation with electrical energy went further and took a different dimension when from 1929 to 1930, Tamale received a limited supply until the installation of a new AC plant was completed in 1938. According to ISSER (2005) and ECG, the works of the Public Works and Railways were handed over to the Electricity Department on 1st April 1947.

Purchase of the University College's Power System by Government of Ghana

The minister responsible for communications and Works in 1957 prepared a memorandum on Electricity Development which captured the purchase of a power station developed by the University College of the Gold Coast now referred to as the University of Ghana, Legon. According to records, the generating station at Legon had a capacity of 4000 kW and had the tendency of expanding to 9700 kW capacity and that the school was willing to sell out the station to the Government for an amount, not more than £310000 on the basis that the station was too large for the College's immediate requirements (PRAAD, Accra; RG. 7/1/1627). During the process that laid the foundation for the purchase of the station, the authorities of the University College stated terms, which were to be studied and accepted by the government. The terms stated that:

- (a) The government should take control of all installations, however, the distribution system including substations should remain the sole property of the College,
- (b) That government should not pay less than £305000 nor more than £310000 for the station subject to certification by the College's architects and quantity surveyors,
- (c) That at a fixed price, the college should be provided with bulk supply of electricity,
- (d) That the college should be prioritized ahead of other consumers and should have the first claim on all electricity generated at the station, and
- (e) That Government should provide facilities for training of the University College students in Electrical Engineering at the power station (PRAAD, Accra; RG. 7/1/1627).

It should be noted, however, that, the prices set up for the station was the actual cost of production, and also kilowatts of power generated cost of £77. The normal Gold Coast price ranged from £45-£55 per kilowatt and £60-£70 per kilowatt in the United Kingdom. However, the Legon station was constructed and equipped to be far more sophisticated than normal trends in the country. It was considered that the cost of constructing and equipping this station was a better idea (PRAAD, Accra; RG.

7/1/1627). The government of Ghana equally believed that it would be useful for the economy.

Conclusion

Electricity production in Ghana has taken many turns, starting from the era when the indigenous Ghanaian communities relied mainly and predominantly on traditional ways of energy production in the form of biomass – firewood and plant residues. This system was very instrumental in the development of indigenous industries as well as for household consumption. Cottage industries like bead-making factories, blacksmithing, pottery making, salt, and soap-making among others were reliant on such mode of energy production. It was not until colonization when glimpses of more sophisticated means for the generation of electric power was started in the country. Since it was expensive to maintain and run, it was predominantly bigger industries like the railway departments of government as well as schools that could use stand-alone power plants for their operations. By studying the evolution of power production in Ghana from the 1900 to 1960, the study reports among other things that the management and distribution of energy/power was done by a collaboration between the colonial authorities and native authorities on one hand, native authorities alone, as well as industrial establishments.

Attempts for the provision of electricity to the natives came in later when Rural Electrification Schemes were drawn up to provide power for selected rural areas in Ghana. Before the construction of the Akosombo Hydroelectric Dam for the provision of electric energy, other rivers and lakes were considered for their hydroelectric potential. The study finally highlights that the exigencies of the time, especially during the construction of the Akosombo Dam, saw Ghana's increasing tilt towards the Soviet Union and the United States of America. It can also be argued that this was possible because of Ghana's non-aligned posture.

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Дослідження еволюції виробництва електроенергії в Гані (1900–1960 рр.)

***Анотація.** У літературі з історії виробництва електроенергії вивчалася її еволюція як в розвинених, так і в країнах, що розвиваються і її вплив на економіку. Деякі автори заклали основи, на яких ґрунтуються інші роботи. Уважне вивчення історіографії виробництва електроенергії в Гані показує, що для поліпшення ситуації з електроенергією в Гані потрібні додаткові зусилля. Зростаючий попит на електроенергію став найбільшою проблемою стоїть перед енергетичним сектором, з часів колоніальної епохи. Відповідні уряду домоглися значних успіхів в забезпеченні надійного і універсального доступу до електрики на всій території Гани, однак такі зусилля супроводжувалися різними рівнями проблем. У дослідженні використовується якісний дослідницький підхід, що дозволяє простежити діяльність, яка у багатьох відношеннях допомогла створити стійке забезпечення електроенергією для домашніх господарств і промисловості в Гані, особливо в містах Аккра і Кумасі, в період з 1900 по 1960 роки. Дослідження було зосереджено, головним чином, на архівних джерелах, з метою з'ясувати яким чином корінні жителі Гани яка забезпечує електроенергією свою промислову діяльність і побутові цілі. Результати цього дослідження показують, що в своїй діяльності місцеві та кустарні підприємства в основному поклалися на деревину, паливо і біомасу ще до введення більш досконалих засобів виробництва електроенергії. Крім того, дослідження показало, що при знаходити власні шляхи розв'язання проблем виробництва електроенергії, розробники більше уваги приділяють поточних питань, практично не докладаючи зусиль для відстеження історичної основи виробництва електроенергії. Незважаючи на це, важливими є невеликі зусилля, які були зроблені для вивчення історії виробництва енергії, з обмеженим акцентом на епоху, що настала відразу після здобуття незалежності.*

Ключові слова: електроенергія; економічний вплив; соціальний вплив; Гана; Кумасі; Аккра

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Исследование эволюции производства электроэнергии в Гане (1900 – 1960 гг.)

Аннотация. В литературе по истории производства электроэнергии изучалась ее эволюция как в развитых, так и в развивающихся странах и ее влияние на экономику. Некоторые авторы заложили основы, на которых основываются другие работы. Внимательное изучение историографии и междисциплинарных исследований производства электроэнергии в Гане показывает, что для улучшения ситуации с электроэнергией в Гане требуются дополнительные усилия. Растущий спрос на электроэнергию стал самой большой проблемой стоящей перед энергетическим сектором, со времен колониальной эпохи. Соответствующие правительства добились значительных успехов в обеспечении надежного и универсального доступа к электричеству на всей территории Ганы, однако такие усилия сопровождалась различными уровнями проблем. В исследовании используется качественный исследовательский подход, позволяющий проследить деятельность, которая во многих отношениях помогла создать устойчивое обеспечение электроэнергией для домашних хозяйств и промышленности в Гане, особенно в городах Аккра и Кумаси, в период с 1900 по 1960 года. Исследование было сосредоточено, главным образом, на архивных источниках, с целью выяснить каким образом коренные жители Ганы обеспечивали электроэнергией свою промышленную деятельность и бытовые цели. Результаты этого исследования показывают, что в своей деятельности местные и кустарные предприятия в основном полагались на древесину,

топливо и биомассу еще до введения более совершенных средств производства электроэнергии. Кроме того, исследование показало, что при поиске решений проблем производства электроэнергии, разработчики больше внимания уделяют текущим вопросам, практически не прилагая усилий для отслеживания исторической основы производства электроэнергии. Несмотря на это, важными являются небольшие усилия, которые были предприняты для изучения истории производства энергии, с ограниченным акцентом на эпоху, наступившую сразу после обретения независимости.

Ключевые слова: электроэнергия; экономическое влияние; социальное влияние; Гана; Кумаси; Акра

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Cooperation with AEG in 1925–1928 as the first form of scientific-technical borrowings in the electric machine-building industry of the Ukrainian SSR

Abstract. *Scientific-technical borrowings are one of those types of scientific support for the work of industrial sectors, whose role in the conditions of exiting the crisis to acquiring the particular importance. Since the mid-1920s, they have become the main how of scientific support for the organization of the development of Ukrainian electric machine-building industry in the context of large-scale electrification of the country. That was due to the need for a quick withdrawal of this industry from the previous crisis in the absence in the Ukrainian SSR of its own scientific support system for the electric machine engineering. The first form of scientific-technical borrowings for the republican segment of the Soviet Union profile industry was the agreement between the State Electrotechnical Trust and the German electrotechnical company Allgemeine Elektrizitäts Gesellschaft on scientific-technical cooperation. The main objective of this act was to achieve at the lowest possible financial cost the fastest possible increase in productivity of the Kharkiv Electromechanical Plant. To do this, it was supposed using the American technologies for the production of electrical machines but implemented them on German technological equipment. Allgemeine Elektrizitäts Gesellschaft was the company that already made such it at the beginning of the twentieth century using the technologies of the General Electric Company. Moreover, in the pre-Soviet period, it made an attempt to hold a similar act at the Kharkiv Electromechanical Plant, which it owned in this time; however it ended in failure due to the revolutionary upheavals that began in Ukraine. Thus, the agreement concluded with the German company was a continuation of the same actions, what itself had begun, but, already in new historical realities. That is, the Allgemeine Elektrizitäts Gesellschaft actions were copied by the Soviet government, however, adapted to the Soviet way of organizing industrial production. Despite the fundamental difference between the latter and the working conditions of the Allgemeine Elektrizitäts Gesellschaft in Germany, the concentration of the parties precisely on the scientific and technical component of the*



project made it possible to achieve the expected result in full. However, at the same time, Ukrainian electric machine builders focused specifically on the speed of duplication of scientific-technical knowledge missed the opportunity to study the methodology for obtaining them. This became the reason that these scientific-technical borrowings did not become the proper basis for the formation of the scientific component of the scientific-technical potential of the domestic electric machine-building industry.

Keywords: *scientific support; construction; technologies; scientific and technical potential; electrical engineering*

Introduction

Scientific and technical borrowings in the industry is a fairly common way to improve the technical level of products and the productivity of enterprises, since they do not require significant time for the necessary preliminary research and development work (R&D). Scientific and technical borrowings have different forms of implementation and their role becomes very important in conditions when progress in the product range and production technologies must be achieved very quickly. The conditions of the large-scale electrification that has been carried out in the Ukrainian Soviet Socialist Republic (UkSSR) since the mid-1920s were just these for domestic electric machine-building, which at that time take the scientific-technical assistance from the German Allgemeine Elektrizitäts Gesellschaft (AEG). This assistance can be considered as a form of scientific and technical borrowings implementation by the Ukrainian segment of the Soviet specialized industry, the reasons, essence and results of which require special study in the context of summarizing the historical experience of using scientific and technical borrowings.

Despite the indicated importance of scientific and technical borrowings, in Soviet historical studies, which in one way or another cover the development of Ukrainian electric machine engineering during the selected period, the question of their implementation is either ignored altogether or considered superficially. So, in the multivolume monograph “History of the Energy Technology of the USSR”, the talk is about updating the product range in the electric machine engineering of the Ukrainian SSR while simultaneously mentioning the receipt of scientific and technical assistance by the Soviet industry from the German AEG and the American General Electric Company (GEC) (Aleksandrov et al., 1957). However, the relationship between these two phenomena is not made by the authors, which makes it impossible to conclude on the degree of influence of the received foreign scientific and technical assistance on the development of Ukrainian electric machine building, especially - the determination of the types of scientific-technical borrowings, which was implementation. In the collective scientific work “An outline of the history of the Kharkiv Electromechanical Plant”, cooperation with foreign electrical engineering companies is not mentioned at all, although it is indicated that in 1926/1927 (the time when such full-scale cooperation began) the enterprise experienced sudden

significant qualitative and quantitative changes in the range of products (Suzdal'cev et al., 1965a). In foreign studies of the period of the existence of the USSR, the scientific-technical borrowings issue in Ukrainian electric machine-building is also mostly considered superficially, although the scientific-technical cooperation with foreign companies is – more complete than in the works of Soviet historians. So, the fundamental role of Western electrical engineering firms in the development of republican electric machine engineering is noted in the monographs “Foundations of a Planned Economy 1926–1929” (Carr & Davies, 1978) and “The Structural Origins of Soviet Industrial Expansion” (Hutchings, 1984). However, these studies are filled only with a statement of the facts of scientific and technical cooperation, as well as a listing (often incomplete) of the types of electric machines with production which this cooperation was related. Only in the first volume of the monograph “Western Technology and Soviet Economic Development” (Sutton, 1968) is the question of the scientific-technical borrowings by Soviet electric machine engineering considered in more detail. At the same time, detailing the scientific-technical borrowings issue in this work relates mainly to the political-economic part, which, together with the limited information on the Ukrainian segment of this industry, does not make it possible to consider it quite informative on the topic of this publication. In addition, A. C. Sutton does not adequately cover the background to the conclusion of an agreement on scientific-technical assistance with AEG, which makes it impossible to objectively establish the reasons for this event.

In post-Soviet Ukrainian studies of the development of domestic electrical engineering, the only work that mentions the dependence of Ukrainian electric machine engineering in the 1920s and 1930s on foreign aid is the PhD dissertation “Contribution of scientists from Kharkiv Technological and Electrotechnical Institutes to the development of the electrotechnical industry in Ukraine (1885–1950 years)” (Tverytnykova, 2009). However, what exactly was this dependence, the author of this thesis does not specify, nor does he focus on its influence on the development of Ukrainian electric machine-building. In the post-Soviet Russian historiography of Soviet electric machine engineering, the Ukrainian segment of this industry is considered rather fluently. In the study “The History of Electrical Engineering” (Glebov ed., 1999), Ukrainian electric machine engineering of the 1920s is mentioned fragmentarily and scientific-technical borrowings produced by it during this period are not mentioned at all. At the same time, it should be noted that for other regional sectors of Soviet electric machine engineering, the issue of scientific-technical borrowings in this work is also rarely raised – the facts of scientific-technical cooperation with leading foreign electrical companies only fixed. The PhD dissertation “Foreign Capital in the Soviet Electrotechnical Industry of Strong Currents: Forms of Attraction and Use Results” (Novikov, 2006), in contrast to the previous work, discusses scientific-technical borrowings in Soviet electrical engineering more deeply, although mainly in the organizational-financial context. Despite this, some aspects of this dissertation can serve as a basis for determining the

objective reasons for using certain types of scientific-technical borrowings in the Soviet specialized industry, and indirectly in its Ukrainian sector. Direct projection of the corresponding material of this dissertation on Ukrainian electric machine engineering is rather difficult due to its infrequent mention by the author in the context of the topic being studied.

Thus, the results of the historiography analysis of scientific-technical borrowings problem in Ukrainian electric machine-building show that its scientific and technical cooperation with AEG in this context has not yet been investigated and the topic of this article is relevant in terms of restoring the historical picture of this industry. However, in addition to historical science, studying the topic of the article is important for the economy, since it is part of the process of awareness the previous experience of urgent and large-scale quantitative and qualitative improvement of the scientific support of those high-tech industries, the current level of development of which determines the prospects for the scientific-technical development of a country generally. Therefore, the purpose of this scientific work is to analyze the scientific-technical assistance of AEG to Ukrainian electric machine engineering in the mid-1920s as one of the types of industry-specific scientific support. To achieve this goal, objective and subjective reasons, the essence and general results of the scientific-technical cooperation for the domestic profile industry are determined.

Research methods

The study is based on the principles of historicism, objectivity and systemicity, that allowed to consider the electric machine building of the Ukrainian SSR as a structural element of the all-Union profile industry, which is in the conditions of the need for a rapid transition from a crisis to that phase of its development, which would determine its further self-sufficient functioning with the necessary productivity of techniques of the scientific-technical level which be corresponding of world. At the same time, problem-chronological and comparative-historical methods were widely used, as well as the method of periodization, as a result of that was identify the stages of the formation of the way of scientific-technical cooperation between AEG and Ukrainian electric machine building, the causes of their occurrence and subsequent transformations, objective results of scientific-technical borrowings carried out in whole.

Results and discussion

The absence in the Ukrainian SSR at the beginning of the 1920s of specialists in the field of designing electric machines, as well as those competent in the technologies for their production, as well as the shortage of specialized R&D centers, were caused by the fact that in the pre-Soviet period of development of the industry, due to the industrial policy pursued by the tsarist government, electric machine engineering was concentrated in the Russian branches of foreign firms. As a result of the fact that domestic specialized enterprises were, in fact, only the production

capacities of foreign concerns, the scientific support of the industrial production of electric machines throughout the Russian Empire was almost completely carried out from its borders (Annienkov, 2014). For this reason, and also because of the low level of electrification of the country, which did not require significant efforts of the electric machine-building industry, the issue of preparing specialized qualified designers and technologists in the pre-Soviet period did not arise on the territory of the future USSR. These factors also influenced that the need for R&D in the field of electrical engineering in the empire was not properly recognized, and they did not have significant support either from domestic business or from the state. Theoretical studies conducted at Ukrainian technical institutes under the guidance of G. E. Evreinova at the Ekaterinoslav Jewish Polytechnic and Ekaterinoslav Mining Institute (Savchuck & Siukh, 2012); A. A. Skomorokhov at the Kyiv Polytechnic (Vydolob & Sen'ko, 1998); P. P. Kopnyaev at Kharkiv Technological Institute (Tkachenko, 2006), were not supported by proper funding. This moment did not allow reaching the volume and depth of fundamental research work that would allow, based on its results, to develop broad R&D of a practical nature, ending with specific design and technological solutions.

The establishment of Soviet power with its program of electrification of the country gave reasonable hope for the imminent increase in the demand for specialists in the field of electrical engineering, which prompted all higher education institutions of the Ukrainian SSR without exception to introduce into their programs disciplines on the basics of designing electric machines (Savchuck & Siukh, 2012; The State Archive of Odesa Region, File (F.) r-126. Description (D.) 1. Case (C.) 147. 93 sheets (s); The State Archive of Kyiv City (SAKC), F. r-308. D. 1. C. 48. 129 s.; The State Archive of Kharkiv Region (SAKR), F. r-1682. D. 1. C. 83. 23 s.). The validity of this hope was ensured by the presence in the republic of 38 electrotechnical enterprises, of which 10 were factories with an electromechanical profile of production (Vasil'ev, Potresov & Tejtell, 1922). True, among them were: the Yekaterinoslavsky Vickers plant, which only was started by construction, and the Temvod plant in Mykolaiv, which was built but not yet fully equipped, and four factories, in the product range of which, along with electric machines, were present means of communications (Annienkov, 2015). Besides also small (about 40 people) was the production enterprise of the Kharkiv Installation and Construction Bureau (MSB) of the former Vseobshchaja Elektricheskaya Kompaniya (VEK) [*until summer 1917, the VEK was called the Vseobshchaja Kompaniya Elektrichestva (VKE) and was a subsidiary of AEG*] (SAKR, F. 349. D. 1. C. 196. 50 s.). Thus, only three enterprises – Kharkiv Siemens-Schuckert Electric Plant and the production unit of the Mykolaiv MSB of the former WEC, which together was the medium-sized, as well as the country's largest Kharkiv electromechanical plant (KhEMZ) VEK represented the main production potential of Ukrainian electric machine-building industry (SAKR, F. 349. D. 1. C. 184. 583 s.). However, the development of a large-scale plan for the electrification of the country left no doubt that all the available electric machine-

building capacities in the Ukrainian SSR would be used with the prospect of their expansion.

Meanwhile, the industrial crisis in Ukraine caused by the revolutionary events and the ensuing civil war did not favor the growth of demand for electric machines in the early 1920s, as a result of which it amounted to about 4% of the pre-war [*First World War*] (Annienkov, 2014). The situation was complicated by the electrification policy pursued by the central government in Moscow, according to which the “old” industrial areas of the Center and North-West of Russia has electrified in the first place. As a result, a further drop in demand for electric machines in the UkSSR led to the closure or reprofiling of all electromechanical plants in the republic, except for the KhEMZ VEK, which had new calling Elektrosila No. 1. But the situation with the provision of orders for this plant, subordinate to the Board of the Electrotechnical Trust of the Central Region (ETCR) in Moscow was very difficult too, and therefore in 1923 the question arose of its closure (SAKR, F. p-1. In. 1. D. 896. 44 s.). However, the liquidation of such a large plant on the eve of the planned large-scale measures for the electrification of Ukraine was a rather risky step, all the more so – contrary to the government’s concept of concentration of mass production organized at giant enterprises. For these reasons, the plant was not completely stopped and continued to function partly due to state subsidies, and partly thanks to targeted government directives requiring consumers to place a certain part of their orders, from among those that can be executed at Elektrosila No. 1, at this enterprise (Suzdal'cev et al., 1965a).

It goes without saying that the state of the electric machine-building industry in Ukraine, which existed until the mid-1920s, did not favor any significant increase in R&D in the republic, despite the opening in 1921 at the Kharkiv Technological Institute (KhTI) of the Electric Machines Cathedra under the direction of P. P. Kopnyaeva (Tverytnykova, 2008). The profile material and technical and personnel bases of the KhTI were significantly inferior to the electrical research centers concentrated in Moscow and Leningrad. In addition, unlike Elektrosila No.1, the electromechanical plants of these cities were already operating at full capacity and began the process of expanding production, which significantly expanded the innovative capabilities of local researchers. Thus, in spite of the individual R&D results of the Cathedra of Electrical Machines of KhTI, which were introduced in the Soviet electric machine building, as a whole, its research work during the 1920s was more concerned with testing electric machines purchased by consumers or planned by them for purchase (Kamienieva, 1959). In other higher technical educational institutions of Ukraine, due to the concentration of the corresponding production in Kharkiv, research activities in the field of electric machine engineering were carried out on an even smaller scale. This factor of concentration of production influenced the centralization in Kharkiv training of Ukrainian specialists – designers of electric machines and technologists in the field of their production, although in view of the practical stagnation of their main consumer – Elektrosila No. 1, until the second half

of the 1920s there were isolated cases graduation of such specialists (SAKR, F. r-1682. D. 1. C. 191. 22 s.). In contrast to the KhTI at the same time, for example, in Moscow, at the Higher Technical School, the Lomonosov Institute and the Kagan-Shabshay Institute, the training of specialists in the field of electrical engineering was carried out extensively and on a system basis (SAKR, F. r-1682. D. 1. C. 191. 22 s.).

Thus, by the mid-1920s, a situation had developed where the scientific component of the scientific-technical potential of Soviet electric machine-building was mainly concentrated in Moscow and Leningrad. Its sector in Kharkiv was not sufficiently developed in order to independently carry out the necessary scientific support for the processes of creating electric machines at republican production facilities. Considering the conditions of information exchange that existed in the period under review, this moment has significantly weakened the scientific support of the Ukrainian segment of the Union branch of electric machine production. It is also necessary to take into account the fact that based on the condition of electric machine-building production in Russia in the pre-Soviet period mentioned at the beginning of this article, the formation of the scientific component of the sectoral scientific and technical potential in Moscow and Leningrad began only in the first half of the 1920s. Therefore, by the middle of this decade, neither the research centers located in them nor the scientific and technical specialists trained by the educational institutions of these cities had gained sufficient experience in creating electric machines. That is, by the mid-1920s in Moscow and Leningrad, a sectoral scientific-technical resource was already sufficient to provide effective assistance to manufacturers of electric machines in mastering new designs and technologies which was borrowed, but still not sufficient to create such designs and technologies independently, at least – in the required quality and quantity. At the same time, the volumes of specialists trained in these centers by the second half of the 1920s have not yet reached the mass that would allow creating the appropriate reserve for use him in other regions. As a result, by the mid-1920s, Ukrainian electric machine industry turned out to be almost completely devoid of not only current scientific support, but also the minimum level of scientific service necessary for it in the near future.

Meanwhile, the electrification process in the USSR became more and more intensive according to the plans of the Soviet government for industrialization of the country. According to the same plans, from the 1924/25 operational year, measures were launched to widely electrify the industrial regions of the Ukrainian SSR, which led to the intensification of the work of Elektrosila No. 1. However, despite the increase in the fixed assets of this plant by their alienation from the canned enterprises, as well as a significant increase in the main industrial-production personnel, Elektrosila No. 1, renamed the State Elektrozavod (GEZ) in 1925, was unable to satisfy the rapidly growing demand on electric machines (SAKR, F. p-1. D. 1. C. 1180. 96 s.). Resuming operation of the former Siemens-Schuckert factory in Kharkiv, known as the Kharkiv Elektrozavod (KhEZ), and restoring the production of

electric machines at the former MSB VEK in Mykolaiv, renamed the Nikolayev Naval Construction Bureau (NVMSB) for the increase capacities of Ukrainian electric machine-building in needed scale it turned out also insufficient (Annikenkov, 2015). According to the information provided to the Central Committee of the Communist Party of Ukraine by the State Electrotechnical Trust (GET), which replaced the ETCR in 1925, the total productivity of these enterprises for the 1925/26 operational year covered only 2/3 of the domestic demand on electric machines of all types manufactured by them (The Central State Archive of the Public Unions of Ukraine, F. 1. D. 20. C. 2506. 43 s.). That is, it became obvious to the GET and party-government circles that by simply increasing the number of industrial capacities it is no longer possible to achieve such an increase in the productivity of Ukrainian electromechanical plants which it would satisfy the growth rate of consuming their products, and necessary a radical change in production technologies to more productive ones is required (The Central State Archive of the Public Unions of Ukraine, F. 1. D. 20. C. 2506. 43 s.). In addition, the technical level of electric machines produced by Ukrainian GET plants according to pre-war technical documentation did not correspond to modern trends in the development of electric mechanic, which did not allow counting on their long-term operation. At the same time, the existing scientific component of the domestic sectoral scientific-technical potential, as mentioned above, did not allow making the required changes on its own, so the question of ask for help for a comprehensive focused on the Ukrainian segment of the Soviet electric machine engineering, foreign scientific-technical assistance by 1925 acquired objective inevitability.

Thus, based on the fact that the GET primarily raised the issue of increasing the productivity of Ukrainian electromechanical enterprises, we cannot agree with the position of A. Sutton, who argues that when the agreement about scientific-technical cooperation was concluded between the GET and AEG for USSR was of paramount importance access to information on modern designs of electric machines. More consistent with real historical reality are the claims of M. Novikov that USSR in 1925 it was extremely necessary to obtain highly productive technologies for the production of electric machines (Novikov, 2006). However, this author inaccurately assesses the situation in Soviet electric machine engineering in the mid-1920s, insisting too, like A. Sutton, that the entire industry was needed scientific-technical cooperation with AEG, and not just its Ukrainian segment alone. This, strictly speaking, contradicts the facts cited by themselves about the rather successful results of scientific and technical cooperation between electromechanical plants in the Central and North-Western regions of Russia with, for example, firms such as Siemens-Schuckert, Vickers, Allmänna Svenska Elektriska Aktiebolaget (ASEA), both before and after the chronological period considered here. However, when we are faced with A. Sutton arguments about why all Soviet electric machine building needed scientific and technical cooperation with AEG in the mid-1920s this contradiction becomes understandable.

So, according to A. Sutton, herself received scientific-technical assistance from GEC during the study period, AEG, working with the GET, thereby transmitted the latest achievements of American electric machine engineering to the latter. The direct non-conclusion of a similar agreement between the GET and the GEC in 1925 is explained by the author mainly with arguments based on the fact of the fierce competition between the GEC and Westinghouse at that time, although the author never indicates this directly. Indeed, if you look at the successful opposition of Westinghouse AEG in litigation regarding the priority of intellectual property for multiphase current technique, the argument about the GEC's large-scale support for the latter, including the provision of mediation rights she in cooperation with the USSR, seems entirely justified. Moreover, already in 1929, GEC became the co-owner of AEG, having acquired an appropriate stake in this German concern in 27.5%. It also seems justified, based on the meaning of the material presented, to clarification GEC's reluctance to work directly with the Soviet government at that time for anxiety of creating in the USSR an electrical giant equipped with the latest technology and projects, similar to the GEC factory in Schenectady. In the future, in the event of closer cooperation between the USSR and Westinghouse, this been could significantly weaken the position of the GEC in the world electrical market. The non-direct transfer of knowledge left the GEC an opportunity to maneuver in the issue of the degree of novelty of the designs and technologies, which be transferred. This line of thought, given the change in the direction of the USSR's vector of cooperation in the field of electrical engineering from GEC to Westinghouse in the early 1930s, may also seem correct, if one does not take into account the deeper background of the conclusion of an agreement on scientific and technical cooperation between GET and AEG.

It should be recognized that all the reasons given could take place in history and be laying the foundation of the theses of A. Sutton, emphasizing the GEC initiative in indirect participation in the development of Soviet electric machine engineering. So, the Soviet Union did want to create a plant similar in Kharkiv to the previously mentioned enterprise, what it did not hide no in the mid-1920s or later, but what, however, did not prevent the GEC from concluding a direct agreement on scientific-technical cooperation with him in 1928 (Lisin & Zuck eds., 1935). Moreover, the possibility of creating an enterprise in Kharkiv, similar to that located in Schenectady, was considered back in the summer of 1917, after the confiscation of HEMZ in AEG and the transfer of 1/6 of the shares VEK to GEC (The State Archive of Mykolaiv Region, F. 301. D. 1. C. 39. 8 s.). And direct scientific and technical assistance from GEC to KhEMZ, as well as SMB in Kharkiv and Mykolaiv, were received during the entire World War I, according to the corresponding agreement concluded between this company and AEG in 1914 (Suzdal'cev et al., 1965b). Thus, the entire background of the conclusion of an agreement on cooperation between the GET and AEG testifies to the initial desire: first, German entrepreneurs, and then the Russian and, after them, Soviet governments, to create in Kharkiv, on the basis of KHEMZ, one of the largest electromechanical enterprises in the world, in than the

GEC took the most active and direct part in the pre-Soviet period. Nevertheless, in 1925 the corresponding direct agreement between the GET and the GEC was not concluded, which, as we can be convinced, could not have significant obstacles from the GEC. Consequently, the reasons of the implementation of scientific-technical borrowings from GEC to Ukrainian electric machine engineering in 1926–1928 through the mediation of AEG, lyses in the plane of Soviet industrial policy, and not in the strategy and tactics of the American manufacturer.

Returning to the thesis about the urgent need for the Soviet government in 1925 to increase the productivity of Ukrainian electrical engineering, we note that for the successful implementation of this event, in principle, it is necessary not only to have the appropriate knowledge but also the equipment with which this knowledge gets its materialized expression. Meanwhile, during the economic downturn, the replenishment of the active part of KHEMZ's fixed assets took place due to the transfer of the morally and physically obsolete equipment from the conserved enterprises same as that was already having at this plant. In addition, it should be borne in mind that the park of metalworking machines at KHEMZ, in its predominant part, was not at all adapted to work by flow methods and to mass production. In other words, the Soviet government was faced with the task not so much of introducing large-scale scientific-technical borrowings into the range of products, as, first of all, of making quantitative and qualitative changes in the active part of the fixed assets of the enterprise, which would allow introducing large-scale scientific-technical borrowings into the technology of electric machine-building production. For these purposes, it was necessary to purchase a considerable amount of appropriate equipment, which for the most part was not produced by Soviet industry, and the best conditions for its import of the USSR in all the necessary assortment in the mid-1920s were provided by Germany (The Central State Archive of the Supreme Authority and Administration of Ukraine, F. r-143. In. 1. D. 161. 489 s.). Thus, the best option that allows the Soviet Union to create a modern, highly productive center for electrical engineering, aimed at the production of machine and apparatus designs borrowed mainly from American electrical companies, was the one according to which the corresponding specialized American knowledge would be embodied on German equipment. However, such an option for the organization of electric machine-building production has already been implemented in Germany at AEG, and with a positive result. This was the reason that the agreement on scientific and technical cooperation was concluded precisely with AEG, and cooperation, in essence, was duplication under the German and American specialists the acts that were once done by this company.

The orientation of the tasks facing Ukrainian electric machine building in the mid-1920s, namely to the transition to American production technologies, is also confirmed by the fact that out of all metalworking equipment for the production of electric machines delivered to KHEMZ from 1920 to 1939, more than 73 % accounted for the period of its direct or indirect (through AEG) cooperation with the GEC in 1926-1932.

(Annienkov & Annienkova, 2015). And according to the “HEMZ Census of Metalworking Equipment” of this amount, qualified equipment amounted to 85%, 80% of which was imported, and more than $\frac{3}{4}$ of volume in the import was German equipment (SAKR, F. r-4217. In. 2. D. 376. 66 s.). If we take into account that during the period under review, the Soviet machine-tool industry specialized mainly in the production of duplicates, and mainly of German machine tools, then the remaining 20% of the domestic qualified equipment supplied to the GEZ can also be considered, at least in design, as German ones (Annienkova, 2019). Thus, the data presented testify to the correctness of the thesis that the task set for the Ukrainian electric machine was to switch to American technology with German technological equipment.

It should be recognized that the results of the cooperation between the GET and AEG fully met expectations for increasing the productivity of Ukrainian electric machine-building industry. By 1929, the GEZ already produced a third of the electric machines manufactured in the USSR (Suzdal'cev et al., 1965a), which allowed the KhEZ to be transferred to the production of military radio communications, and the industrial capacities of the NVMSB organized on assembling naval electrical products based on complete electric machines. However, while in the industrial-innovative plan AEG was one of the authors of the transferred knowledge, in the scientific-innovative plan it was only an intermediary. Therefore, in the implementation of this type of scientific-technical borrowings, there was no achieved significant increase in the scientific and technical level of products manufactured by the GEZ, as a result of which until the end of the 1920s there was not a tendency to a decrease in the volume of imports of electric machines in the USSR (The Central State Archive of the Public Unions of Ukraine, F. 1. D. 20. C. 2506. 43 s.). The fast pace of electrification of the Soviet Union led to a change in consumer demand for electric machines not only quantitatively, but also qualitatively, and the domestic scientific support of the industry, as we have seen, could not provide the latter. Therefore, the need for electric machines of a higher technical level or structurally different from those that were manufactured as a result of foreign scientific and technical assistance was still covered by import at the turn of the 1920 s and 1930 s.

Conclusions

The implementation of large-scale scientific-technical borrowings from abroad in the field of electric machine engineering in the mid-1920s in Ukraine became an objective necessity, caused by the lack of domestic scientific support for the industry, sufficient to organize, first of all, its productivity at least at the minimum level required by the country's electrification process. Scientific and technical cooperation with AEG was based on the principle of introducing in Ukrainian electric machine-building American manufacturing technologies adapted to German equipment. This was the first form of scientific-technical borrowings implementation that was most acceptable for the USSR, which made it possible to increase the current productivity of Ukrainian electric machine building at minimal cost, while providing it with the

ability to maintain or even independently increase its productivity in the future, with switching to the production of a more technically advanced product range. Itself this form of scientific-technical borrowings itself was not invented by the Soviet government but was a copy of similar acts conducted by AEG in the early twentieth century, which this company tried to implement at its factory in Kharkiv in the same period too, but the copy was new conditions adapted. Despite the certainly positive overall outcome of cooperation with AEG, its significant drawback was the superficial mastering by domestic scientific, technical and industrial personnel of the methodological foundations of the design and manufacture of electrical machines used by German and American specialists. This moment was caused by the rush with which the Soviet government carried out the measures for the scientific-technical borrowings considered here, and which led to the fact that their implementation acquired the character of predominantly unthinking duplication. The consequence of this was both the continuation of the unrelenting dependence of the domestic electric machine building on foreign scientific-technical borrowings in the aspect of the product range and the high probability of making mistakes with the further independent adaptation of the technologies in worsening conditions of their application.

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Ігор Анненков

Національна сільськогосподарська бібліотека Національної академії аграрних наук України

Співробітництво з АЕГ у 1925–1928 рр. як перша форма науково-технічних запозичень в електромашинобудуванні Української РСР

Анотація. Науково-технічні запозичення є одним з тих видів наукового забезпечення роботи промислових галузей, чия роль в умовах виходу з кризи набуває особливої значущості. З середини 1920-х років вони стали основним способом наукового супроводу організації розвитку українського електромашинобудування в умовах масштабної електрифікації країни. Це обумовлювалося необхідністю швидкого виведення галузі з попереднього кризового стану за відсутності в УСРР власної системи наукового забезпечення електромашинобудівної індустрії. Першою формою здійснення науково-технічних запозичень для українського сегменту союзна галузі став договір між Державним Електротехнічним трестом та німецькою електротехнічною фірмою Allgemeine Elektrizitäts Gesellschaft про науково-технічне співробітництво. Головною метою даного заходу стояло досягнення якомога більш швидкого збільшення продуктивності Харківського електромеханічного заводу за мінімальних фінансових витрат. Для цього передбачалося використати американські технології виробництва

електричних машин, що втілювалися б на німецькому технологічному оснащенні. Allgemeine Elektrizitäts Gesellschaft була тією компанією, що вже втілила в себе такий прийом на початку ХХ ст., використовуючи технології General Electric company. Більше того, нею було здійснено спробу здійснити аналогічний захід на Харківському електромеханічному заводі, що належав їй у дорадянські часи. Однак вона завершилася невдачею через розпочаті на українських теренах революційні потрясіння. Таким чином, укладений з німецькою фірмою договір став продовженням нею ж розпочатих дій, проте в уже нових історичних реаліях. Тобто, радянським урядом було скопійовано заходи Allgemeine Elektrizitäts Gesellschaft, але адаптовані до радянського способу організації промислового виробництва. Не зважаючи на докорінну відміну останнього від умов роботи Allgemeine Elektrizitäts Gesellschaft у Німеччині, зосередження сторін саме на науково-технічній складовій проекту дозволило домогтися очікуваного результату в повному обсязі. Проте при цьому українськими електромашинобудівниками, зосередженими на швидкості дублювання науково-технічних знань, було упущено можливість вивчення методології їх отримання. Це стало причиною тому, що проведені науково-технічні запозичення не стали належним ґрунтом формування наукової складової науково-технічного потенціалу вітчизняного електромашинобудування.

Ключові слова: наукове забезпечення; конструкції; технології; науково-технічний потенціал; електротехніка.

Игорь Анненков

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Сотрудничество с АЕГ в 1925–1928 гг. как первая форма научно-технических заимствований в электромашиностроении Украинской ССР

Аннотация. Научно-технические заимствования являются одним из тех видов научного обеспечения работы промышленных отраслей, чья роль в условиях выхода из кризиса приобретает особую значимость. С середины 1920-х годов они стали основным способом научного сопровождения организации развития украинского электромашиностроения в условиях масштабной электрификации страны. Это обуславливалось необходимостью быстрого вывода отрасли из предыдущего кризисного состояния при отсутствии в УССР собственной системы научного обеспечения электромашиностроительной индустрии. Первой формой осуществления научно-технических заимствований для республиканского сегмента союзной отрасли стал договор между Государственным Электротехническим трестом и немецкой электротехнической фирмой Allgemeine Elektrizitäts

Gesellschaft о научно-техническом сотрудничестве. Главной целью данного мероприятия было достижение при минимальных финансовых затратах как можно более быстрого увеличения продуктивности Харьковского электромеханического завода. Для этого предполагалось использовать американские технологии производства электрических машин, реализуемые на немецком технологическом оборудовании. Allgemeine Elektrizitäts Gesellschaft была той компанией, которая уже осуществила у себя такой прием в начале XX века, используя технологии General Electric company. Более того, ею была сделана попытка проведения аналогичного мероприятия на принадлежавшем ей в досоветский период Харьковском электромеханическом заводе, которая закончилась неудачей из-за начавшихся на территории Украины революционных потрясений. Таким образом, заключенный с немецкой фирмой договор стал продолжением ею же начатых действий, однако уже в новых исторических реалиях. То есть, советским правительством были скопированы мероприятия Allgemeine Elektrizitäts Gesellschaft, адаптированные, однако, к советскому способу организации промышленного производства. Несмотря на коренное отличие последнего от условий работы Allgemeine Elektrizitäts Gesellschaft в Германии, сосредоточение сторон именно на научно-технической составляющей проекта позволило добиться ожидаемого результата в полном объеме. Однако при этом украинскими электромашиностроителями, сосредоточенными именно на скорости дублирования научно-технических знаний, была упущена возможность изучения методологии их получения. Это стало причиной тому, что проведенные научно-технические заимствования не стали должной основой формирования научной составляющей научно-технического потенциала отечественного электромашиностроения.

Ключевые слова: научное обеспечение; конструкции; технологии; научно-технический потенциал; электротехника

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The impact of decisions of Mining Industrialists Congresses on the Industrial Revolution increasing in Ukraine in the late XIX century

Abstract. *The activity of the mining industry in the South of the Russian Empire, of which Ukraine was part at that time, is analyzed. It is noted that the rapid development of industry in the Russian Empire after the abolition of serfdom in 1861 opened up opportunities for investors to raise capital. Information is given about why Kharkiv became the center of investment life of mine owners, namely its good geographical location. Data on the number of inhabitants of the city and the number of trading institutions are provided. The stages in the formation of the mining industry of the South of the Russian Empire as a driving force for economic development in Ukraine are highlighted. The causes of weak coal sales from the Donbas and the development of the factory industry of Ukraine in the 1860s are analyzed. It is shown how these issues were resolved. In particular, mining congresses were organized to discuss and resolve these issues. It is shown how the decisions of mining congresses influenced the development of the country's economy at the end of the nineteenth century. Examples of issues discussed at these congresses are given. In particular, the congresses discussed – workers, higher and secondary specialized education, mining credit, insurance, the ratio of the mining industry to zemstvos and land taxation of enterprises of the mining industry, taxes, land relations, postal, telegraph and telephone traffic, passenger traffic in the Southern Russia area, duties, ports, marinas, navigable rivers and canals, shipbuilding and merchant shipping, export of mineral fuel abroad, construction of new railways, etc. It should be noted that the central issue discussed at almost all mining congresses was the question of tariffs, and this was not a coincidence, since it directly concerned*



the markets for industrialists without whom production could not be developed, and with it the intensification of the industrial revolution. Therefore, this problem, in one form or another, has arisen constantly. Information is provided on the number of such congresses, as well as on the creation of a permanent body, the Council of Miners of the South of the Russian Empire. It analyzes the so-called “coal crisis” and the role of major mining companies in the collusion. The monopolization of the market is considered. Emphasis is placed on the customs policy of the tsarist government. Speculation on temporary fuel difficulties is illustrated. It is noted that at the end of the 1890s, there were especially high rates of development of the Donbas coal industry. Special tariffs for the export of Donetsk coal abroad were introduced. Thus, in the last quarter of the 19th century, the mining and monopolization of the mining industry of the south of the Russian Empire were enlarged and monopolized.

Keywords: *mining congresses; the South of the Russian Empire; coal; tariffs; exchange committees; the industrial revolution*

Introduction

The rapid development of the Russian Empire’s industry after the 1861 serfdom abolition opened up opportunities for raising investors’ capital. This had a significant impact on the Kharkiv city because of its favourable geographical location. At that time, this provincial city numbered no more than 50 thousand people. Among them were accounted for 1.4 thousand trading institutions and 4.5 thousand merchants and salesmen (Vasiljeva & Pernatjev, 2004). More important, that here intensification of research in the field of metallurgy was started. This was due to the rapid development of the coal and metallurgical complex in the Donbas and the Dnieper region.

According to research (Krutikov, 1981), there were three stages in the formation of the mining industry in the South of the Russian Empire which become the driving force for economic development in Ukraine. The first stage occurred in 1869–1881 and connected with the process of the mining environment formation. These were mainly the interest area of local landlords, local and some foreign merchants. In small-scale coal mining were engaged Cossacks and peasants. They didn’t use mercenaries or advanced equipment. The second stage was characterized by the 1882–1893 economy crises, which led to the internal industry concentration. Small and even some medium-sized enterprises have ceased operations and large enterprises have changed owners. A lot of the local landlords and merchants bankrupted. Entrepreneurs from the central part of the Russian Empire gained market share that became free. The third stage (1894–1899) was characterized by the rapid development of heavy industry. Most of the mines are concentrated in the hands of joint-stock companies with the participation of foreign investors. These companies were led by the second generation of Donbas entrepreneurs with a professional background. The heads of these joint-stock companies became the so-called “technical intelligentsia” – mining local and foreign engineers. Many of this

generation have become mine-owners or have acquired significant stakes in coal companies.

The activities of the mining industry in the South of the Russian Empire were considered in the scientific publications (McCaffray, 1987, Zhurilo, 2011, Shandra, 2011, Zhurilo & Zhurilo, 2014, Brivko, 2014). However, with the onset of the anti-terrorist operation in the Donbas, the interest of science historians has changed the vector of research and this region has ceased to be the subject of research in that way. Despite existing publications, the issue of railway construction in the southern region, changes in legislation tariff from the mining congresses decisions point of view did not form the subject of a separate historical study. After all, the growth of the industrial revolution in Ukraine depended on coal production.

Research methods

The methodological basis of the study consists of the basic principles of modern historical science – the principles of historicism and objectivity. The principle of objectivity implies consideration of the studied historical events in their interrelation and development, the principle of objectivity is focused on a comprehensive analysis and reliable assessment of historical facts. The use of methods of bibliographic and source study analysis contributed to the search and systematization of primary information, and the use of the system method allowed to investigate comprehensively the impact of Mining Industrialists Congresses decisions on the Ukrainian industrial revolution at the end of the XIX century.

Results and discussion

The 1st Congress of the Association of South Russian Miners was convened On November 10, 1874 in Taganrog. Only two issues there were discussed here: 1. About the order of goods transportation on the southern railways 2. About the labour involvement in the mining industry. The question about newly formed representative organization activities was not even discussed at that time.

The first discussion about “The Regulations on Mining Congresses of Southern Russia” was raised only at the VII Congress of Mining Industrialists in November 1882. That was 8 years after the organization began work. Subsequently, these conventions were held annually until the end of the First World War. So, before the twentieth century began, 25 regular and 5 emergency congresses were held. The council of the Association of South Russian Miners was a permanent executive authority that functioned between the congresses. It was organized in 1887 and located in Kharkiv along Sumska Street (fig. 1). Essentially, it was an organization that represented the interests of the Russian Empire’s big capital by taking into account the peculiarities of the region (Potolov, 1959).

A wide range of issues was discussed at those congresses. Among them were even those that did not address the mining industry's problems but did affect its development as a whole. Discussed issues included workers, higher and secondary

special education, mining credits, insurance, mining industry's attitude land taxation of mining enterprises, taxes, land relations, postal, telegraph and telephone traffic, passenger traffic in the Southern Russia area, duties, ports, marinas, navigable rivers and canals, shipbuilding and merchant shipping, mineral fuel exports abroad, construction of new railways, etc.

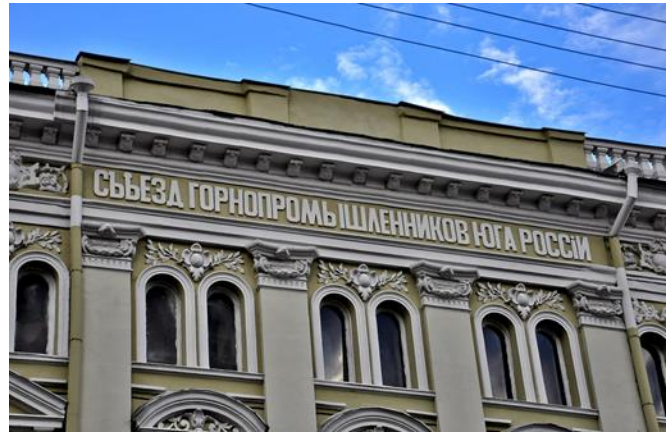


Figure 1 – Kharkiv, Sumska 18-20

The council of the Association of South Russian Miners has purchased a house on Sumska 18 from the nobility of O. G. Harina. According to the architect Boleslav Mikhailovsky's design another floor was added to this building.

The neighbouring building on Sumska 20 was bought from the merchant A.Yu. Sapozhnikov and rebuilt by architects Sergii and Ilidor Zagoskin in combination with the neighbouring house.

It should be noted that the issue of tariffs was the central one that discussed at almost all mining conventions. It was no accidental. This question directly concerned the industrialists' markets.

Therefore this problem time constantly arose. The question of road tariffs was the most important for the coal industry in Southern Russia. The lack of a railway freight unified paying system has led to the availability of individual tariffs for each rail. That has hampered the transportation of coal.

On January 1, 1869, a new customs tariff was introduced. It was believed that this tariff excluded "third-party patronage" of the industry. However, it was lenient for foreign goods. It undermined the domestic industry. The discovery of large coal deposits in the South of the Russian Empire and its industrial development (Gutnyk, 2013) led to a revision of customs issues. Already at the first mining industrialists meeting, mine owners raised the issue about imported through the ports of the Azov and Black Sea coal and coke imposing duties. At the second congress in 1877, this proposal was supplemented by a petition to impose a customs duty on coal coming from the southwestern railway (Moskin & Belonozhko, 2010). This was the first step

towards the unification of tariffs. The decision of the congress offered the introduction of the same tariffs on all the railways.

The exchange committees of maritime cities were also opposed to the idea of cast iron duties increasing. They also opposed the introduction of a duty on cheap foreign coal. On the contrary, the Moscow Stock Exchange Committee, the Ivano-Voznesens'kij Committee of Trade and Manufactures, and the Nizhny Novgorod Stock Exchange Committee spoke in favour of raising the tariff on cast iron. Also, the unification of tariffs was opposed by the railway administration, which believed that the introduction of the same tariffs would lead to significant losses.

The Russo-Turkish War of 1877–1878 led to financial difficulties. These circumstances forced the Ministry of Finance to revise customs policy. In 1879, Minister of Finance S. O. Greig proposed to reduce the cast-iron duty, to increase the iron and steel duty, to abolish the duty-free importation of metals for machine-building plants and the taxation of foreign-made machinery. The State Council approved a lot of the Minister's proposal. There was only one exception connected with reduction cast-iron duty. In addition, the transportation of foreign coal duty was imposed. The latter point was particularly sought by the mining industry (Fomin, 1908).

The 3rd Mining Congress was held in Kharkiv, the IV was held in Novochoerkassk. But from 1880 the congresses were held in Kharkiv. At the fifth congress, the petition to establish a unified tariff on pood (~16.4 kg) and mile (~1.06 km) on all railways was raised again. This petition became a key one. The Ministry of Railways has considered it. It was a great step. After that, it was made an order for the reduction of the coal tariff in the Kursk – Kharkiv – Azov railway compared to other routes.

Despite the measures taken by the Ministry, coal from the Donbas did not find widespread sales in local markets, as the factory industry of Ukraine was poorly developed; there was no railway communication between the South and the Central regions of the empire.

Due to the construction of railways, coal markets have changed. There was an internal competition between Polish, Moscow coal miners, and external competition with the mining industry of England. It should be noted that it was the primary objective of Donbas coal miners that counteracted the presence of English coal in the empire, as well as entering into international markets. This problem was repeatedly given publicity to the authorities. In particular, mining engineer A. F. Mevius, in his note to the Minister of State Property O. O. Liven described the problems of the Donetsk Basin coal industry. The note raised the issue of private homes, public, country and city buildings, factories, plants, bakeries, etc. heating by coal (Kupriyanova, 1994).

At the VIth Congress, the question of introducing a differential tariff was raised for the first time. Under this tariff, for long distance would be set at a lower tax by increasing it at shorter distances. As early as 1882, a decision was made at the VIIth Congress on the need for a tax on foreign coal. The mining industry's small victory in

this question can be seen as an order passed on June 16, 1884, which imposed a tax on foreign coal to support the southern coal industry.

The issue of further protectionism was repeatedly discussed at the mining conferences in 1884–1886. The condition was set to raise the tariff from 2 to 3.5 kopecks to coal imported through the Black Sea-Azov ports. The Moscow Stock Exchange Committee and the Moscow Branch of the Trade and Manufactory Council supported the requirements of the X Congress. And the Odessa, Riga, Libavsky (now the city of Liepaja in Latvia) and the St. Petersburg Stock Exchange Committees rejected the demands of the Donbas coal industry. It should be noted that the Minister of Finance M. Kh. Bunge proposed to the State Economy Department of the State Council the proposals of the miners of the south of the country and since May 1886 the duty from the pood increased to 3 kopecks on the Black Sea-Azov border. As can be seen, the set rates were lower than required by the coalman, but the main goal was achieved – the position of Ukrainian industrialists strengthened.

It should be noted that although the successes in the development of the coal industry were evident, in 1888 the coal crisis began throughout the empire. Today, it is believed that this crisis was organized by the coal industry itself. Several short-term agreements on price increases between large coal miners for higher monopoly profits have just led to crises. Thus, at the beginning of 1888, due to the sharp decline in the price of coal, large coal-miners in the Donbas “held back coal production” (Potolov, 1959). At the same time, coal imports were also reduced. As it turned out, there were more than 7 million poods of coal in the mines.

As a result of this conspiracy, the price of coal jumped to 8 kopecks per pood in mining sites and up to 40 kopecks and above in cities. The coalman considered these prices fair and tried in every way to secure them at this mark (Proceedings of the Congress, 1888). The government has intimidated industrialists with the abolition of the duty on foreign coal and prices have been reduced. Miners tried to reverse the conspiracy in 1893 when 15 million poods of coal were not supplied to railways and metallurgical enterprises. Because of this, some metallurgical plants stopped and coal prices were raised again. The main production of coal was concentrated in several large mines, which completely monopolized the coal trade, which already reached 30 kopecks per pood.

South industrialists have successfully speculated on temporary fuel difficulties, seeking various benefits from the government. In the spring of 1890, the Ministry of Finance introduced a series of preferential tariffs for the transportation of Donetsk coal to Moscow and St. Petersburg, at the same time increasing the tariff for foreign coal for these cities (Ministry of Finance, 1902).

The late 1890s were marked by particularly high rates of development of the Donbas coal industry. Only in the last five years of the XIX century coal production increased by 2.3 times. First of all these high rates were the success of the large coal producers who have completely bought the lands of Donbas.

Among the largest mining industry businessmen of the South of the empire O. K. Alchevsky, O. A. Auerbach, P. M. Gorlov, I. G. Ilovaysky, M. F. von Dietmar can be mentioned.

O. K. Alchevsky was one of the first Ukrainian oligarchs, banker and philanthropist. His family made an invaluable contribution to the development of Kharkiv at that time. His wife – Kh. D. Alchevska patronized the education for women in the city. By projects of his son-in-law – architect O. M. Beketov in the centre of the city about ten luxury buildings were built (Rofe-Beketova, 2019). The industrialist O. A. Auerbach was considered the “mercury king of Russia” – he founded the first mercury plant in Russia (Fomin, 1915).

Geological engineer P. M. Gorlov is one of the pioneers of coal mining in the Donbas. I. G. Ilovayskiy founded the Makeyevka Coal Mine and Mechanical Plant in Zuyivka Sloboda. M. F. von Dietmar participated in the construction of the Ryazan-Kazan and Balashov-Kharkiv railways. He was the owner of plants specializing in the production of equipment for the mining and metallurgical industries (Gaiko & Biletsky, 2013, 2016).

In 1898, keeping the coal market tense, these owners conspired to increase coke production. A significant amount of coal was converted to coke. Only in 1899, the number of coke furnaces increases from 3 to 4 thousand, with a capacity of up to 147 millions pood of coke (Potolov, 1959). As a result of these measures, in the following years, locally the price for coal per pood ranged from 11 to 14 kopecks.

The tsarist government tried to regulate the coal industry but to no avail. All this resulted in the consolidation of large capital in the Donbas.

At the same time, a special reduced tariff was introduced for the export abroad of Donetsk coal. As a result, the competitiveness of Donetsk fuel has increased markedly. The results of the tariff issue were summarized at the XXVIII Congress, held in 1903.

Congresses of Mining Industrialists of the Southern Russia that took place before and during the World War I gradually moved away from discussing tariff issues and focused on analyzing the current state of the mining and processing industries in wartime, as well as issues of a legal nature (eg, “About the law on subsoil that contains mineral resources”) and social issues (eg, “Mining and technical education”, “Fund for the provision of enterprises in the case of mass accidents”, etc.).

Conclusions

Thus, Congresses of Mining Industrialists can be considered as an association that represented the interests of large capital in tsarist Russia, of which Ukraine was a part at that time. The decisions of these congresses influenced on the railway tariff policy. In the late XIX century, the empire made a significant leap in the development of production. New factories and plans were being built, railways were being expanded, and new territories were being developed. Businesses have consolidated. Small and medium-sized businesses were not able to compete with big

capital. The city of Kharkiv became the centre of investment life for the mining industry of the South of the empire. It was the great miners like O. K. Alchevsky, O. A. Auerbach, P. M. Gorlov, I. G. Ilovaysky, M. F. von Ditmar and others were the progressive pioneers of the country's industrial revolution.

The study on mining industry activity in the late XIX century in Ukraine requires further scientific research.

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Вплив рішень з'їздів гірничопромисловців на розгортання промислової революції в Україні у другій чверті XIX ст.

***Анотація.** Аналізується діяльність гірничопромисловців півдня Російської імперії, частиною якої на той час була Україна. Наголошується, що бурхливий розвиток промисловості Російської імперії після скасування кріпацтва у 1861 р. відкрив можливості інвесторам для збільшення капіталу. Подано відомості про те чому саме Харків став центром інвестиційного життя гірничопромисловців. Надані дані про чисельність мешканців міста та кількість закладів торгівлі. Виокремлено етапи у формуванні гірничопромисловців Півдня Російської імперії як рушійної сили розвитку економіки в Україні. Показані причини слабого збуту вугілля з Донбасу та розвиток фабрично-заводської промисловості України у 1860-ті. Показано, яким чином було вирішено ці проблеми. Зокрема, вказано, що саме для обговорення та вирішення цих питань було організовано з'їзди гірничопромисловців. Встановлено, яким чином рішення з'їздів гірничопромисловців впливали на розвиток економіки країни наприкінці XIX ст. Наведено приклади питань, що обговорювалися на цих з'їздах. Серед них: робітники, вища і середня спеціальна освіта, гірничопромисловий кредит, страхування, відношення гірничої промисловості до земств і земського оподаткування підприємств гірничозаводської промисловості, податки, земельні відносини, поштово-телеграфне і телефонне повідомлення і пасажирський рух у районі рудників і заводів півдня Росії, мита, порти, пристані, судноплавні річки і канали, суднобудування і торговельне мореплавство, експорт мінерального палива за кордон, будівництво нових залізниць і т.д. Треба зазначити, що питання тарифів обговорювалося практично на всіх гірничопромислових з'їздах. Це було не випадково, адже воно безпосередньо стосувалося ринків збуту для промисловців, без яких не могло розвиватися виробництво, а з ним й інтенсифікація промислової революції. Тому ця проблема, в тій чи іншій формі, виникала постійно. Подано інформацію про кількість таких з'їздів, а також створення постійно діючого органу – Ради з'їздів гірничопромисловців півдня Російської імперії. Здійснено аналіз так званої «вугільної кризи» та роль великих гірничопромисловців у зговорі. Розглянуто монополізацію ринку. Акцентовується увага на митній політиці царського уряду, спекуляціях на тимчасових паливних труднощах.*

Наголошується, що на кінець 1890-х років припали особливо високі темпи вугільної промисловості Донбасу. Було запроваджено спеціальні тарифи для вивезення донецького вугілля за кордон. Таким чином в останні чверті XIX ст. відбулося укрупнення та монополізація гірничо-видобувальної галузі півдня Російської імперії.

Ключові слова: з'їзд гірничопромисловців; південь Російської імперії; вугілля; тарифи; біржові комітети; промислова революція

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Влияние решений съездов горнопромышленников на развертывание промышленной революции в Украине во второй четверти XIX в.

***Аннотация.** Анализируется деятельность горнопромышленников юга Российской империи, частью которой в то время была Украина. Отмечается, что бурное развитие промышленности Российской империи после отмены крепостного права в 1861 г. открыло возможности инвесторам для увеличения капитала. Представлены сведения о том, почему именно Харьков стал центром инвестиционной жизни горнопромышленников. Приведены данные о численности жителей города и количестве предприятий торговли. Выделены этапы формирования горнопромышленников Юга Российской империи как движущей силы развития экономики в Украине. Показаны причины слабого сбыта угля из Донбасса и развитие фабрично-заводской промышленности Украины в 1860-е. Приведена информация, каким образом было решено эти проблемы. В частности, указано, что именно для обсуждения и решения этих проблем было организовано съезды горнопромышленников. Определено, каким образом решения съездов горнопромышленников влияли на развитие экономики страны в конце XIX в. Приведены примеры вопросов, которые выносились на обсуждение на этих съездах. Среди них: рабочие, высшее и среднее специальное образование, горнопромышленный кредит, страхование, отношение горной промышленности к земствам и земское налогообложение предприятий горнозаводской промышленности, налоги, земельные отношения, почтово-телеграфное и телефонное сообщение, и пассажирское движение в районе рудников заводов юга России, пошлины, порты, пристани, судоходные реки и каналы, судостроение и торговое мореплавание, экспорт минерального топлива за рубеж, строительство новых железных дорог и т.д. Надо*

отметить, что вопрос тарифов обсуждался практически на всех горнопромышленных съездах. Это не было случайностью, ведь он непосредственно касался рынков сбыта для промышленников, без которых не могло развиваться производство, а с ним и интенсификация промышленной революции. Поэтому эта проблема в той или иной форме, возникала постоянно. Представлена информация о количестве таких съездов, а также создании постоянно действующего органа – Совета съездов горнопромышленников юга Российской империи. Проанализирован т.н. «угольный кризис» и роль крупных горнопромышленников в сговоре. Рассмотрена монополизация рынка. Акцентируется внимание на таможенной политике царского правительства. Спекуляция на временных топливных трудностях. Отмечается, что на конец 1890-х годов пришли особенно высокие темпы угольной промышленности Донбасса. Были введены специальные тарифы для вывоза донецкого угля за границу. Таким образом, в последние четверти XIX в. произошло укрупнение и монополизация горнодобывающей области юга Российской империи.

Ключевые слова: съезд горнопромышленников; юг Российской империи; уголь; тарифы; биржевые комитеты; промышленная революция

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UDC 94(477):929 Ліhin (Lihin)

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The role of V. Lihin's scientific publications in international journals

Abstract. *In the 21st century, we live in the stage of human history when any information is as accessible as possible. The modern scientific world is based on an extensive network of journals. Thanks to them, we have the opportunity to get acquainted with the latest research results. In the 21st century, every reputable journal also has an online version, which makes the dissemination of scientific information almost instantaneous. We are so accustomed to the conveniences of the information age that it is difficult for us to imagine the difficulties that scientists faced a little over 150 years ago. In the second half of the nineteenth century, almost most of the sciences known to mankind were formed. The genesis of science launched the process of forming branch scientific communities and demanded stable ways of communication for productive and effective development of the branch. Scientific journals have become an ideal means of disseminating information, and a scientific article has been transformed from an ordinary letter into a modern form and has taken on an ideal form. Given all the above, it is important to consider the experience of V. Lihin in publishing articles in scientific journals abroad. Valerian Mykolaiovych was the first scientist from Odessa to join a new type of scientific communication. He became the first Russian-speaking member of one of the oldest Mathematical Societies in Europe - the French. The young mathematician conquered with his erudition, attention to detail, thorough approach and comprehensive analysis of research issues. During his life, V. Lihin wrote more than 30 scientific papers, a third of which were presented in scientific journals abroad. These were complete author's translations or articles based on part of the study. Not infrequently, on the pages of magazines, you could see scientific discussions, in which our compatriot also took an active part. In Odessa, the fate of Valerian Mykolaiovych changed quite radically several times: he was a professor and dean of the Faculty of Physics and Mathematics of Novorossiysk University; an adviser of the mayor, and later the mayor; became a trustee of the Warsaw Educational District. And in Europe, his authority as a scientist was highly valued. He showed that science has no state borders, that it can develop harmoniously - imitating the results of research from all over the world. V. Lihin broke the tradition of "isolated" science when*



discoveries in the Russian Empire (and later in the USSR) were made separately from the rest of the world. Scientists, who speak the language of science - speak the language of peace and development. And so, in 2020, the language of medical science has united the world despite its borders, nations and religions.

Keywords: V. Lihin; scientific journal; scientific article; M. Chasles; Mathematical Society of France

Introduction

Valerian Mykolaiovych Lihin was one of the forgotten names of national history. A scientist, a public figure, a person of progressive thinking, whose activity is difficult to overestimate for the development of science and education in Odessa, the region as a whole. And, if for historians of science and technology he was known as a maths and a mechanic scientist, who first developed the questions of kinematics in domestic science, then other aspects of his scientific activity, represented abroad, remain uncovered. The purpose of the article is to highlight the importance of publications abroad both for Lihin himself and for the development of science in general.

Research methods

The basis of this work is the general scientific principles of research, such as objectivity, scientific, historicism, systemic, complexity. When writing the work was applied: historical, problem-chronological, historiographical and biographical methods. Widespread use of analysis and comparative-historical methods allowed identifying and tracking the main milestones of Valerian Lihin's life and work.

Results and discussion

The appearance of the first scientific journals in Europe in the second half of the 18th century became a turning point in the history of science. The age of The Enlightenment came – the development of scientific, philosophical and social thought. The main condition for the emergence of magazines was the formation of a certain intellectual environment, scholars, free from theological restrictions, needed regular scientific communication. But scientific correspondence could not fully meet the needs of the scientific community in the dissemination of new knowledge, information opportunities for periodicals were much greater. Scientific journals arose from the exchange of letters between scientists about the results of research.

In the modern world, when the dissemination of any information is almost instantaneous, it is difficult to understand the complexities of scientists in the second half of the nineteenth century. The desire to bring the results of their research to the international arena was considered revolutionary: it took courage, effort, international connections, multilingualism, and a truly global vision of science.

The need to create a sustainable system of scientific communication has led to the formation of intellectual communities, which became the basis for the creation of scientific journals and new scientific societies. The peculiarity of the first European

journals was the scientific and information orientation, the articles were in the form of letters.

In the 19th century, specialized journals in the fields of science began to develop, and the optimal form of publications was discovered. In the second half of the 19th century, the scientific article took on a modern form. Due to the formation of the practice of bibliographic research, it was possible to trace the sequence in science, which formed the international nature of research (Kharlamova, 2014, p. 175).

In the 19th century, the first national specialized mathematical journals began to appear, first in England, then in France and other European countries. In the second half of the 19th century, a number of mathematical societies were formed, which began to publish new mathematical journals, some of which are still published today.

One of the first domestic mathematicians to become famous abroad was Valerian Lihin. We can say that his chosen scientific path led him to world science.

Valerian Mykolaiovych Lihin was born on July 26, 1846, in St. Petersburg. Subsequently, in 1854 his family moved to Odesa. In 1864 Valerian Mykolaiovych Lihin entered the Reshylevskyi Lyceum, and then, in connection with the opening of the Novorossiysk University in 1865, he was enrolled as a student of the Faculty of Physics and Mathematics of the same university. In 1869, V. Lihin graduated it with the Candidate of Mathematical Sciences degree and received a gold medal for the work "On the gravity of ellipsoids".

On September 9, 1870, Valerian Mykolaiovych was enrolled in the position of associate professor of the Department of Applied Mechanics. Almost a year later, on July 30, 1871, V. M. Lihin was sent abroad for training for 2 years. There he attended the Zurich Polytechnic School to listen to lectures on practical mechanics. A year later, he returned to Odessa, where during a short vacation he defended his dissertation for a master's degree in applied mathematics "Geometric theory of absolute motion of a fixed system" (Formal list, 1876, pp. 2–11).

The process of defense itself was very unusual, as we can learn from the memoirs of a close friend – Sergei Vitte. "... After graduating, Lihin went abroad, where he listened to lectures in Karlsruhe, that is, preparation for the professorship. Returning to Odessa, he wrote a dissertation on new geometry.... Since there was no mathematical faculty then (and there is still no in university), but there was a physics and mathematics faculty, which studied all-natural sciences, and therefore the professors of natural sciences were full members of the faculty council, then, in the end, the majority votes, dissertation of Lihin was declared unfit. Then I – although I did not belong to the college of professors, because I had just graduated from university - still intervened in this matter and told one of the professors (who I do not remember: either Mechnikov or Sechenov) that their decision is extremely unfair. They told me that they had received information that all the professors of the mathematics department had given an excellent response to Lihin's work only for personal reasons. Then I advised them to send Lihin's dissertation to Paris to Chasles, which, in fact, was the creator of the new geometry, which is now a subject of special

science in all universities. Chasles, having received this dissertation (which was translated into French by Lihin), after a while gave the answer that it is a "wonderful job" and that, since he knows that there are two degrees: master's and doctoral, and you can give a doctor in addition to master's, then he, Chasles, for his part for such a wonderful job would have made Lihin a doctor of mechanics, bypassing the title of master of mechanics. After such a response, the faculty immediately gathered and recognized Lihin worthy of a master's degree in mechanics ... "(Vitte, 1924, p. 57–60).

After his defense, Lihin returned abroad, where he continued his studies, personally met Chasles and became his student.

Michel Chasles was born in 1793 near Paris. After graduating from high school, he entered the Paris Polytechnic School in 1812, which he graduated in 1814.

M. Chasles's first works concerned various issues of geometry, analysis and history of mathematics. In 1830 he drew attention to the fundamental work "Historical sketch of the origin and development of methods in geometry."

In 1841, Shall, already gaining a strong scientific reputation for his publications, was invited to teach at the École Polytechnique in Paris. In 1846 he moved to a specially founded department of higher geometry at the Sorbonne. He devoted 20 years to teaching and then retired. He continued his scientific activity until his death in 1880.

His work entitled "Historical Review of the Origin and Development of Geometric Methods" (généraux de la science, la dualité et l'homographie) was published in 1837 and according to Bertrand it "is the most scientific, most profound and most original of the works that have ever appeared in the history of mathematics" (Lihin, 1881, p. 21). The work consists of 3 parts - books, the first of which is entirely an essay on the history of geometry, from Pythagoras and Euclid to the early nineteenth century. The second and third books, to a greater extent, contain data on the scientific developments of Michel Chasles himself. This work marked the beginning of an era of new geometry. Chasles proved that geometry is an independent mathematical science, has its own scientific apparatus and significant practical value.

Thus, after the founding of the Department of Higher Geometry at the University of Paris in 1846, M. Chasles began work on an academic textbook of Higher Geometry. The textbook was published in 1852, which actually confirmed the birth of new science.

In the second half of the XIX century. France became a leader in the development of mathematical sciences, which naturally contributed to the emergence of scientific societies. The French Mathematical Society (French: Société mathématique de France, abbreviated SMF) is a public professional organization of mathematicians in France. Founded in 1872 by Emile Lemoine and is one of the oldest mathematical societies in the world. The main purpose of the Society in the charter is to promote the development of pure and applied mathematics. The Society publishes several magazines. One of them comes from the day of its foundation and to this day. *Bulletin de la Société Mathématique de France* (since 1872).

In 1873 the president of the society became Michel Chasles. It is quite natural that among the first authors of the magazine were students and acquaintances of the French academician. M. Chasles quite actively contributed to the young scientist from Odessa. He was introduced to French mathematicians and invited to the Mathematical Society of France, of which he became a member in 1873. It should be noted that V. Lihin was the first mathematician of the Russian Empire admitted to the Mathematical Society of France. Next precedents for membership in the Society of Representatives of the Russian Empire occurred almost a decade later (in 1882 – D. Selivanov and P. Chebyshev, 1886 – V. Maksimovich) (Vie de la société. Bulletin de la S. M. F. 1888, pp. 5–14).

Valerian Mykolaiovych doctoral dissertation consists of two sections, one of which "On the acceleration of higher orders in the motion of a constant system" contains a generalization in the case of n -th accelerations of the theorem of Rezal, Bress and others and represents the natural development of the idea laid in Somov and Jordan and on these issues. In the second part of the dissertation "On the geometric properties of the displacements of flat figures" for the first time raises the question of the motion of a system by a plane collinear variable, and their main properties of its displacement - variable and immutable systems, previously studied by Chasles.

Valerian Mykolaiovych became the first scientist-mathematician to be the first to present his research to the European scientific community. ***Sur le lieu des points d'un système invariable mobile d'une manière générale dans l'espace, dont les accélérations du premier ordre sont constantes.*** The article was received in May 1873, and the dissertation was defended in March 1874. The article reflects the material on the history of the issue and refers to the first part of the dissertation. It should be noted that this was the first case of approbation of dissertation research at the international level in domestic science (Liguine, 1873a, pp. 152–154).

But the Bulletin of SMF was not the only mathematical journal in France. It was M. Chasles who stood at the origins of the first international mathematical journal – Bulletin des Sciences Mathématiques et Astronomiques.

Chasles in 1869 persuaded the French Ministry of Public Instructions to create the Bulletin. He handpicked his former doctoral student Jean Gaston Darboux as the editor-in-chief. The 27-year-old Darboux was energetic, bold, spoke German, and almost always a dissident. He shared Chasles's opinion that French mathematics had to reform immediately. He had, in fact, long thought that all French geometers of his time are old-fashioned like dinosaurs.

The *Bulletin* was officially launched in 1870 and appeared monthly. Before 1878, each issue had 32 pages, containing four parts

- ✓ Revue Bibliographique (Book reviews)
- ✓ Bulletin Bibliographique (List of books recommended to readers)
- ✓ Revue des Publications Périodiques (Review of journal articles)
- ✓ Mélanges (Featured research articles or summary of an author's previous research).

In 1876, the Bulletin published a 6-year collection with a list of all its authors and contributors during the previous 11 volumes: there are more than 2000 authors listed, spanning from the United States to Russia, and everywhere in Europe. In a world without Facebook, le Bulletin Darboux accomplished a mission impossible (Gaston Darboux in “the beautiful years”, 2019).

On the movement of an invariable figure; properties relating to areas, arcs of curves described and the volumes of the trajectory surfaces. In the geometric study of the movement of a planar figure invariable in its plane, we mainly dealt with the relations which take place between the tangents, the normals and the radii of curvature of the trajectories described by the different points of the moving figure, as well as between the speeds and accelerations of various orders of these points, and, from the point of view of these problems, the theory of planar movements is perhaps the chapter the most complete of Pure Cinematics (Liguine, 1878, pp. 306-333). The questions raised by Lihin were immediately answered by the magazine's editor-in-chief and in the same volume: The very interesting work of M. Liguine has recalled my attention to research which I did, quite a long time ago... To complete Mr Liguine's history, we will point out two very remarkable statements, due to Mr Zeuthen and published in the *Nouvelles Annales de Mathématiques*, 1871, p. 90. The first of the theorems of this learned geometer, suitably developed, could give everything you know about the areas described by the different points of a plane figure moving in its plane (Darboux, 1878, pp. 333–356).

As a teacher and scientist, Lihin was engaged in methodical work. So, he compiled several bibliographic guides – ***List of works on the ovals of Descartes***. The author gave the following description of this list: Interrupted, by special circumstances, in the preparation of a monograph on Descartes' ovals, I thought it there would be some interest in publishing this list separately, enough I hope to complete books and memoirs concerning these curves, list that I was led to draw up by studying the history of the question. In addition to the works of a certain extent, there were instead of citing many questions, proposed on ovals in various newspapers, mainly in the Educational Times; to these quotes, I added the very statements of the theorems to prove, in order to save readers from tedious research and to present at the same time a series of relatively less known properties of ovals (Liguine, 1882b, pp. 40-49).

List of works on articulated systems. The list of publications includes monographs and articles for almost 100 years (from 1796 to 1882) (Liguine, 1883, pp. 145–160).

The *Nouvelles Annales de Mathématiques* was a French scientific journal in mathematics. It was established in 1842 by Olry Terquem and Camille-Christophe Gerono and continued publication until 1927.

On some geometric properties of the displacement of a plane figure in their plan. The article is another approbation of Lihin's dissertation, where he studied the laws of finite and infinite displacements of points without the notion of time, and in

the mechanical part, we studied the laws of change of velocities and accelerations of points, which were deduced as a consequence of the geometric part. (Liguine, 1873b, pp. 481–494).

"On Hinged Systems Poselie, Hart, Kempe" He developed the theory of hinged guides, derived the relationship between the kinematic characteristics of this and transformed motion in each of the mechanisms Poselie-Lipkin, Hart, and Kempe (Liguine, 1882a, pp. 153–163).

Conclusion

These are just some of the works that Valerian Lihin presented to the world scientific community. The works are diverse both in their issues and in form. The main leitmotif of all his works was consistent in the development of science, the author always paid attention to the history of the problem and tried to find solutions in the context of world knowledge. Thus he tried to unite domestic science with the world. A profound connoisseur of the latest ideas of European machine science, he constantly acquainted the domestic scientific community with the works of its founders, stimulated the development of applied mechanics in Russian Empire.

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Ольга Олійник

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Роль наукових публікацій В. Лігіна в міжнародних часописах

Анотація. В XXI столітті ми проживаємо той етап людської історії, коли будь яка інформація є максимально доступною. Сучасний науковий світ базується на розгалуженій мережі журналів. Завдяки їм ми маємо можливість знайомитись з останніми результатами досліджень. В XXI столітті кожен поважний журнал має ще й он-лайн версію, що робить розповсюдження наукової інформації майже миттєвим. Ми настільки звикли до зручностей, що

дає інформаційна епоха, що нам важко уявити труднощі, з якими стикались вчені трохи більше 150 років тому. В другій половині XIX століття сформувалась майже більшість відомих людству наук. Генеза наук запустила процес формування галузевих наукових спільнот і вимагала сталих шляхів комунікації для продуктивного та ефективного розвитку галузі. Наукові журнали стали ідеальним засобом для розповсюдження інформації, а наукова стаття пройшла трансформацію від звичайного листа до сучасного виду і набула ідеальної форми. Зважаючи на все вище вказане, важливо розглянути досвід В. Лігіна в публікації статей в наукових журналах за кордоном. Валеріан Миколайович був першим вченим з Одеси, що долучився до нового виду наукового спілкування. Він став першим російськомовним членом одного з найстаріших Математичних товариств Європи – Французького. Юний математик підкорив своєю ерудованістю, увагою до деталей, ґрунтовним підходом та всебічним аналізом проблематики дослідження. За своє життя В. Лігін написав більше 30 наукових робіт, третину з них було представлено в наукових журналах за кордоном. Це були і повні авторські переклади, і статті на основі частини дослідження. Не рідко, на сторінках журналів можна було спостерігати і наукові дискусії, в яких брав активну участь і наш співвітчизник. В Одесі доля Валеріана Миколайовича кілька разів досить кардинально змінювалась: він був викладачем та деканом фізико-математичного факультету Новоросійського університету; товаришем голови, а згодом і головою міста; став попечителем Варшавського навчального округу. А в Європі високо цінили його авторитет, як ученого. Він показав, що наука не має державних кордонів, що вона може розвиватись гармонійно – наслідуючи результати досліджень з усіх куточків світу. В. Лігін розірвав традицію «ізолюваної» науки, коли відкриття в Російській імперії (а згодом і в СРСР) робились окремо від усього світу. Вчені, що говорять мовою науки – говорять мовою миру та розвитку. Так, у 2020 році мова медичної науки об'єднала світ не дивлячись на кордони, нації та віросповідання.

Ключові слова: В. Лігін; науковий журнал; наукова стаття; М. Шаль; Математичне товариство Франції

Ольга Олейник

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Роль научных публикаций В. Лигина в международных журналах

Аннотация. В XXI веке мы проживаем тот этап человеческой истории, когда любая информация является максимально доступной. Современный научный мир базируется на разветвленной сети журналов. Благодаря им мы имеем возможность знакомиться с последними результатами исследований. В XXI веке каждый уважаемый журнал имеет еще и онлайн версию, что делает

распространение научной информации почти мгновенной. Мы настолько привыкли к удобствам, которые дает информационная эпоха, что нам сложно представить трудности, с которыми сталкивались ученые чуть более 150 лет назад. Во второй половине XIX века сформировалось почти большинство известных человечеству наук. Генезис наук запустил процесс формирования отраслевых научных сообществ и требовал постоянных путей коммуникации для продуктивного и эффективного развития отрасли. Научные журналы стали идеальным средством для распространения информации, а научная статья прошла трансформацию от обычного письма до современного вида и приобрела идеальную форму. Учитывая все выше указанное, важно рассмотреть опыт В. Лигина в публикации статей в научных журналах за рубежом. Валериан Николаевич был первым ученым из Одессы, кто присоединился к новому виду научного общения. Он стал первым русскоязычным членом одного из старейших математических обществ Европы – Французского. Юный математик покориł своей эрудицией, вниманием к деталям, основательным подходом и всесторонним анализом проблематики исследования. За свою жизнь В. Лигин написал более 30 научных работ, треть из них была представлена в научных журналах за рубежом. Это были и полные авторские переводы, и статьи на основе части исследования. Нередко, на страницах журналов можно было наблюдать и научные дискуссии, в которых принимал активное участие и наш соотечественник. В Одессе судьба Валериана Николаевича несколько раз довольно кардинально менялась: он был преподавателем и деканом физико-математического факультета Новороссийского университета; товарищем головы, а затем и главой города; стал попечителем Варшавского учебного округа. А в Европе высоко ценили его авторитет, как ученого. Он показал, что наука не имеет государственных границ, она может развиваться гармонично – используя результаты исследований со всего мира. В. Лигин разорвал традицию «изолированной» науки, когда открытия в Российской империи (а впоследствии, и в СССР) делались отдельно от всего мира. Ученые, говорящие на языке науки – говорят на языке мира и развития. Так, в 2020 году язык медицинской науки объединил мир, не смотря на границы, нации и вероисповедания.

Ключевые слова: В. Лигин; научный журнал; научная статья; М. Шаль; Математическое общество Франции

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Prerequisites of formation and development of mainline electric locomotives engineering at the Luhansk diesel locomotives engineering plant (1957–2014)

Abstract. *In the article an attempt to investigate in a chronological order the historical circumstances of the formation and development of the mainline electric locomotives engineering at the Luhansk diesel locomotives engineering plant (1957–2014) has been made. The circumstances of the activity of the electric locomotives workshop of the Luhansk plant (1957–1967), within which the production of crew parts and units of the legendary locomotives VL8 and VL10 for Novocherkask and Tbilisi factories have been analyzed. In the late 1980s, due to the absence of a solid convertible currency for the import of traction rolling stock from Czechoslovakia in the wake of the economic crisis of the USSR, the Luhansk plant received orders for the development and production of self-propelled electric locomotives. However, with the proclamation of the Independence of Ukraine, due to the lobbying of the new government, promising projects of Luhansk electric locomotives were rejected, and the Dnipro electric locomotives engineering plant was defined the basic enterprise for the creation of mainline electric locomotives for the Ukrainian railways. Due to the unstable economic situation in the country and the lack of targeted financing, the Dnipro plant was unable to start mass production of a number of types of locomotives, HC «Luhanskteplovoz» together with the Novocherkask plant began production of freight electric locomotives on the technological basis of Russian locomotives. Further development and prospects of serial electric locomotives engineering at the Luhansk plant were interrupted by the aggravation of the military-political situation in the region. However, it is clear that the historical experience of becoming a domestic scientific-production base of the mainline electrical production needs its proper understanding in the context of current tendencies of import of traction rolling stock with an attempt to localize its production in Ukraine.*

Keywords: *Luhansk diesel locomotives engineering plant; transport engineering; mainline electric locomotives engineering; Ukrainian railways*



Introduction

As, according to official data, the wear of the domestic electric locomotive fleet is more than 90%, for a long time in Ukraine the issue of import of traction rolling stock has been actively considered, with the prospect of further localization of its production at Ukrainian enterprises. For the first time, the problem of updating a locomotive fleet arose in the early 1990s, when, in the absence of foreign exchange for the acquisition of a sufficient number of locomotives abroad, it was decided to combine imports with the organization of production of rail machinery at domestic factories (Moskalenko & Mukminova, 1996, p. 94). Ukrainian engineering has a deep historical tradition. The first domestic locomotives of the tandem compound system were built based on the Odesa Railway Workshops of the South-Western Railways Society from 1894 to 1897 (Berdnychenko & Kyrychenko, 2018, p. 288). At the end of the nineteenth century. Leading specialized centers of steam engineering in Kharkiv and Luhansk were formed. In the postwar period (1947–1961) the staff of the Kharkiv transport engineering plant started a new era of locomotive building in the USSR, developing a sound technical base for the creation of most future series of locomotives of the Luhansk plant (Bystrichenko & Dobrovolsky & Drobotenko et al, 1995). The electric power industry in Ukraine was represented by specialized products of the Dnipro plant, which since 1958 produced shunting and industrial electric locomotives (Ruban & Baka, 2020, p. 107). The Luhansk plant staff had extensive experience in the manufacture of electric locomotives, which in 1990 was commissioned by the Ministry of Railways of the USSR to develop their projects of freight passenger locomotives.

Unfortunately, for a long time the preconditions for the formation and the circumstances of the development of backbone electrical production in independent Ukraine have not found their comprehensive coverage in the national historiography, the exception is only the author's exploration. The history of the Luhansk diesel locomotives engineering plant and its products are presented in the monographs by G. Zhdanov, V. Rybinets, Y. Tsygankov-Serebriakov, V. Rakov, and A. Haruk (Zhdanov, 1981; Rybinets, 1996; Tsygankov-Serebryakov, 2006; Rakov, 1990, 1995, 1999; Haruk, 2019). However, these studies focus mainly on the Soviet period of the history of the plant, do not exhaust the completeness of the outlined topic and require the introduction of additional advanced scientific sources. The analysis on the history of production activity of the enterprises of the transport machine-building industry of Ukraine acquires its relevance on the background of the general reformation of the domestic industry, the need to update the traction rolling stock, taking into account the historical experience of solving the said issue.

Therefore, the subject of the proposed research is the production activity of the Luhansk diesel locomotive engineering plant, which provides for the following research problems: first, to consider the history of the functioning of the electric-locomotive shop of the Luhansk Plant (1957–1967); secondly, to investigate the attempt to develop promising Luhansk electric locomotives against the background of

the formation of domestic electric locomotive engineering in independent Ukraine (1991–1993); thirdly, to trace the circumstances of the introduction of the mainline electric locomotives at the Luhansk plant in the composition of Russian beneficiary company (2004–2014). The chronological boundaries of the study cover the period from the beginning of the manufacture of electric locomotive's units at the Luhansk plant in 1957 to the forced shutdown of the enterprise in 2014.

The purpose of the article is to reproduce a complete picture of the historical preconditions for the formation and circumstances of the development of the mainline electric locomotives at the Luhansk diesel locomotive engineering plant, on the basis of a comprehensive analysis of historical sources, periodicals and scientific literature.

Research Methods

In writing the proposed intelligence, general scientific methods and principles of historical research were used, in particular, historicism, objectivity, continuity, multifactoriality, complexity and comprehensive knowledge (Fullerton, 2011), which made it possible to carry out a study of the historical preconditions for the formation and development of the mainline electric locomotives engineering at the Luhansk diesel locomotive engineering plant in clear chronological order.

Results and discussion

In 1953, the designers of the Novocherkask electric locomotives engineering plant developed and introduced into mass production the legendary N8 Series electric locomotive (from 1963 – VL8) with a power of 4200 kW (Rakov, 1995, p. 422). In February 1956, at the XX Congress of the CPSU, it was decided in the transport engineering to develop the production of electric locomotives and diesel locomotives and stop the production of mainline steam locomotives. The Congressional Directives set out to deliver at least 2000 electric locomotives over a five-year period, including 400 eight-axle locomotives with a capacity of 5700 hp, as well as 2250 mainline two-section locomotives. Ensure the creation of new powerful locomotives, design and manufacture in 1956–1957 experimental models of freight diesel locomotives with a capacity of 2500–3000 hp in one section, passenger diesel locomotives and electric locomotives, as well as gas-powered locomotives (Naporko, 1957, p. 371–372). October 19, 1956 Minister of Transport Engineering of the USSR S.O. Stepanov signed Order No. 284 concerning the renaming of the Voroshilovgrad steam locomotive engineering plant into a diesel locomotive engineering plant (Zhdanov, 1981, p. 131). On February 9, 1956, the company released its first diesel locomotive – TE3-2001, and at the end of December – the last steam locomotive LV-0522 (Rybinets, 1996, p. 103, 116).

The electric locomotives workshop of the Luhansk plant (1957–1967)

During 1956 the main works on reconstruction of Voroshilovgrad plant, organization of specialized sites were completed. The metallurgical and other

workshops were restructured, taking into account the extension of third-party orders, in particular, the steel shop was casting locomotives for the Novochoerkask plant (Rybinets, 1996, p. 118). In mid-March 1957, the manufacture of electric locomotive parts began on the 6th span of the mechanical assembly shop. At the end of June 1957 the first two electric locomotive frames were delivered. The team of non-standard equipment department took an active part in the restructuring of the former tendering and stocking in the locomotive shop, which did a great job of creating sections and lines for machining of locomotive parts, and also installed new high-performance equipment (Rybinets, 1996, p. 120).

Production of VL8 locomotives at the Tbilisi plant was started in 1957. As production increased, their production at the Novochoerkask plant began to decline, and from 1963 it ceased. The Novochoerkask plant, as a basic electrical engineering company, has started the development of new electric locomotive designs, including VL80. The two-section crew of the VL8 locomotive consisted of four articulated two-axle carts with solid cast frames and axle roller bearings (Rakov, 1999, p. 21). Having no foundry production, the Tbilisi plant could not produce such trolleys, and their production at the Novochoerkask plant was already discontinued. In 1962, with the aim of assisting in the establishment of the Tbilisi plant, with the agreement of the line ministries, the Luhansk plant began to manufacture complete crew units for VL8 locomotives (Buyanov, 2005, p. 166). The cast frames of the trolleys were very complex and cumbersome, but the Luhansk foundries mastered their production, were molded in a large frame shop, and sent to a steel shop for molding of frame shapes. In 1961, the designers of the Tbilisi plant developed a 5200 kW VL10 electric locomotive, which was supposed to replace the VL8 locomotives (Rakov, 1999, p. 30). In 1962 a group of Luhansk designers was sent to Tbilisi. The teams of three factories participated in the construction of the crew unit of the VL10 locomotive: the carts were manufactured at the Novochoerkask plant, the rest of the units were performed by the staff of the Luhansk plant (Buyanov, 2005, p. 166). The first specimens of the VL10 locomotives were unified on the body with the locomotive 2TE10L and the carts with the locomotive VL80. The mass production of bodies and units of electric locomotives VL10 at the Luhansk plant lasted until 1967 (Rakov, 1999, p. 33).

The Luhansk plant built two single-axle two-axle trolleys for the passenger electric locomotive of VL40, developed by the staff of the Special Design Bureau of the Tbilisi Plant (Buyanov, 2005, p. 167). While preparing the trolleys for production, the specialists encountered the unpredictable complexity of the individual components and components, conducting a number of unanticipated experiments. The difficulty was that the wheel diameter was 1250 mm, while for all locomotives in the 1960s it was adopted 1050 mm. Chief engineer of the plant N.M. Naish, refusing to make models, instructed the designers to work out a variant of manufacturing wheel centers from the forging. Trolley Bureau Chief Robertman R.M. and the crew of the electric locomotive VL10 Buianov A.F. Categorically opposed to this variant of the wheel center of the forging carts, since

the machining would cut the metal fibers and would not have the strength. In worldwide practice, the rolling stock centers were made rolled or cast. The models under the two-wheel centers were nevertheless manufactured, molded parts, machined and assembled into wheel pairs. Trolley frames and gearboxes were sophisticated. Two carts were manufactured and shipped to Tbilisi (Buyanov, 2005, p. 167). In 1966 the first pilot electric locomotive VL40 was built, and in 1969 – the second one, which differed by types of traction motors. However, the low power of the locomotive (no more than 3200 kW) did not satisfy the increased weight of passenger trains, which necessitated the ordering of the more powerful six-axle Czechoslovakian electric locomotives of CS4 (hourly power of 5100 kW) (Rakov, 1999, p. 116).

In this regard, VL40 locomotives have not been introduced into mass production and operation. In the mid-1960s, the Tbilisi Plant created a new crew unit for the VL10 locomotive, based on the VL80 locomotive, to build the Novochoerkask plant, which since 1967 has supplied crews to Tbilisi. New body types were installed on electric locomotives, starting with VL10-021 (Rakov, 1999, p. 33). In September 1967, the Tbilisi plant produced the last electric locomotive VL8-1723 and, due to the curtailment of the production of crew parts, the locomotive shop of the Luhansk plant was reorganized into a mechanical assembly shop No. 3.

Perspective projects of freight-passenger electric locomotives EL-1 and EL-2

For a long time, the fleet of passenger electric locomotives of the USSR was largely replenished by supplies from Czechoslovakia. Since 1989, the volume of imports of rail technology has started to decline significantly due to the lack of hard currency. Hence the need to expand the production of locomotives for electrified railways at one of the enterprises of the country. In the summer of 1990, a preliminary agreement was signed between the Ministry of Railways of the USSR and the Production Association «Luhanskteplovoz», and in early 1991, Deputy Minister B. D. Nikiforov signed an application for the creation of direct and alternating current electric locomotives. The annual issue had 100 locomotives each series. The conventional designation of an electric locomotive with a voltage of 25 kV – EL-1, a direct current of 3 kV – EL-2 (Ladyzhensky, 1992).

The project envisaged the use of the crew part of the locomotive TE136 – the length of one-section two-cab locomotive had to fit the dimensions of the locomotive section. It was planned to use high-power traction motors, as the design capacity of the locomotives was expected to be 8700 hp vs. 6000 hp the locomotive. In December 1991 in Moscow with the participation of the leading engineer of the electric locomotive M. G. Lozovoi was protected by a preliminary sketch project of the locomotive. At the beginning of 1992, the development of technical documentation for both modifications of the locomotive began. According to the contract the design was to be completed in January 1993, the production of the

prototype of the electric locomotive EL-2 – in the 1st quarter of 1994, the EL1 – IV quarter of 1994 Lyman Donetsk Railway (Ladyzhensky, 1992).

Due to the fundamental differences between the technologies of electric locomotive engineering, a new experimental production base was expected to be created. It was necessary to begin preparation of special equipment for checking electrical circuits, special punching devices at a voltage of 2.5 kilowatts, as well as to build devices for testing the lubricant cooling system of transformers, experimental verification of pantograph receivers and other units. During the creation of the locomotive, the design, technological and testing services of Luhanskteplovoz cooperated fruitfully with the All-Union Research Institute of Railway Transport (Moscow), the All-Union Scientific-Research Diesel Institute (Kolomna), and the Electric Company (Kharkiv). Transformer Research Institute (Zaporizhzhia) by Luhansk Mechanical Engineering Institute, etc. Advisory meetings were held with representatives of the Novochoerkask plant. The management of the Luhansk plant confirmed its readiness to release new locomotives and hoped that demand for them would be high among the CIS republics (Ladyzhensky, 1992).

After the proclamation of the Independence of Ukraine, the question of coordination of main transportation on the territory of the republic arose. In order to effectively manage rail transport and meet the needs of the economy and the population in transportation, on December 14, 1991, the Cabinet of Ministers of Ukraine adopted a resolution «On Establishment of the State Railway Administration of Ukraine» – «Ukrzaliznytsia» (Moskalenko & Mukminova, 1996, p. 8). In the early 1990's, the issue of transition of the whole network of Ukrainian railways to electricity was considered. At that time from 22700 km only 8400 km of railway lines were electrified. There was a need for the primary electrification of cargo-stretched sections – about 3000 km. Ukrzaliznytsia developed the main provisions of the railway electrification program by 2005, which was intended to electrify 1667 km of the track in the first place. The implementation of this program was to reduce the annual consumption of petroleum products by 454000 tons, to increase the transportation of goods by electric power on average from 64.5 to 75%. The conversion of 1% of freight to electric traction reduced rail costs by 2.7 billion rubles annually for 1984's prices (Moskalenko & Mukminova, 1996, p. 21).

In July 1992, the Ministry of Mechanical Engineering, Military-Industrial Complex and Conversion approved the «Program of development of railway transport of Ukraine», calculated until 1998. During this time, the Luhansk plant had to establish the production of 7 new types of rail cars, including DC and AC electric locomotives, and the establishment itself provided for the creation of a test site for rolling stock testing (Krayevoy, 1992; Lozovoy, 1992). In order to coordinate the activities of manufacturers, scientific organizations and railways, a section of scientific and technical cooperation was established at «Ukrzaliznytsia», which included representatives of 6 Ukrainian railways, specialized departments of Ukrzaliznytsia, rolling stock manufacturers and railway systems. The functions of

SNTS in the field of locomotive economy were: development, testing, commissioning of traction rolling stock, modernization of existing TRS, change of technology and rules of operation of TRS, development of safety systems on railways, etc. The first organizational meeting of the section took place in Luhansk on August 19, 1992, during which the priority terms of the stages of creation and serial production of new machinery were agreed (Krayevoy, 1992).

At the same time, the special design and technological bureau of the Dnepropetrovsk electric locomotive engineering plant, which specialized in the production of shunting and specialized industrial electric locomotives, was developing its own project of an eight-axle freight locomotive. Finally, following a change in the composition of the Government, during a series of technical meetings the projects of Luhansk electric locomotives were rejected (Zhuzhgin, 1993). On June 26, 1993, the Cabinet of Ministers of Ukraine approved Resolution No. 480 «On the Development and Production in 1993–2000 of Main Freight and Passenger Electric Locomotives», according to which the Scientific and Production Association «Dnepropetrovsk electric locomotive engineering plant» was designated as the main manufacturer of main freight and passenger electric locomotives plant (Postanova Kabinetu Ministriv Ukrayiny vid 26 chervnya 1993 no. 480 «Pro rozrobku i vyrobnytstvo u 1993–2000 rokakh mahistral'nykh vantazhnykh i pasazhyrs'kykh elektrovoziv»). According to the plan, up to 2000, 230 DC electric locomotives, 85 DC direct electric locomotives, 80 AC electric locomotives and 35 AC electric locomotives were to be manufactured inclusive. The Dnipro SKTB was reorganized into the Ukrainian Research Institute of Electrical Locomotive Engineering (Gereilo, 1996). It envisaged a profound modernization of the Dnipro plant and institutions that were to be part of the state-owned electric engineering corporation Ukrelektrovoz, which had the responsibility of coordinating research and design work on the creation of main freight and passenger electric locomotives.

In the summer of 1996, the teams of SPA «DELEP» and USRI of Electrical Locomotive Engineering developed and built the first Ukrainian eight-axle mainline electric DC electric locomotive – DE1 with a power of 6260 kW (Likhushyn, 2018, p. 12). In the fall of 1996, the Deputy Director of UNI Electric Engineering V. Savysko announced the completion of the development of the passenger mainline electric locomotive DE2, in turn there should be series DE3 and DE4 (Gereilo, 1996), however, further development and introduction to the production of these models were discontinued. the lack of funding, despite the fact that in 1996 investing in the modernization of the electric locomotive fleet was identified as a priority in the overall sequence of calculations by Ukrzaliznytsia (Moskalenko & Mukminova, 1996, p. 66). In 2002, the designers of the Dnipro plant together with the German concern Siemens created a universal passenger electric locomotive of alternating current – DS3 with power of 4800 kW. It is noteworthy that the Russian company «Transmashholding» interfered with the demonstration of the Ukrainian-German locomotive at Russian exhibitions (Shvaiko, 2003). In 2003, the teams of SPA «DELEP» and USPI of

electrical engineering were merged into the State Enterprise «Dnipropetrovsk Scientific and Production Complex «Elektrovozobuduvannia». Soon, SPC «Elektrovozobuduvannia», together with the Siemens concern, started to develop a two-engine DS4 locomotive at the speed of 200–220 km/h on the basis of the electric locomotives DS-3 (Ruban & Baka, 2020, p. 108, 110).

Freight locomotives 2EL4 and 2EL5 (2005–2014)

Another attempt of introduction of the mainline electric locomotive engineering at the Lugansk diesel locomotive engineering plant was connected with the privatization of the enterprise. In 1998, the first tender for the sale of shares of the Luhansk plant was announced, and in 2001, the State Property Fund of Ukraine put 76% of the plant's shares for sale. However, a number of attempts to privatize the controlling stake in the enterprise have remained unsuccessful (Yurova & Spektor, 2011).

As the Dnipro plant did not set up production of domestic freight electric locomotive of alternating current, on December 1, 2004 a contract was signed between HC «Luhanskteplovoy» and Novochoerkassk electric locomotive engineering plant to supply and organize production of 50 locomotives for the needs of Ukrzaliznytsia amounted to 100 million euros, which included the development of design and technological documentation, the production and testing of the first pilot electric locomotive, as well as the cost of sets of equipment for the manufacturers electric locomotives (Tsygankov-Serebriakov, 2006, p. 336). Release of the prototype of the locomotive was planned for August 2005. Starting from the second locomotive, the manufacture of most units, assembly and assembly of locomotives had to be carried out at the Luhansk plant when supplying sets of electric vehicles, traction and auxiliary electric machines manufactured by Novochoerkassk plant. As the production of part of the equipment at Ukrainian enterprises was mastered, the share of Russian equipment had to gradually decrease to 35–40% of the initial volume.

In December 2005, at the Novochoerkassk plant, together with the specialists of HC «Luhanskteplovoy», the first two-section electric locomotive with collector traction motors of 2EL5-001 developed on the basis of the Russian electric locomotive 2ES5K manufactured by the Novochoerkassk plant was manufactured. A distinctive feature of the 2EL5 electric locomotive was the modified control cabin with sloping buffer lanterns, elongated trapezoidal shape, united in a single block headlamp, designed by the Design Bureau of the Dnipro Innovation Company «International Business Cooperation». The electric locomotive was equipped with Ukrainian safety devices (Tsygankov-Serebriakov, 2006, p. 349).

On July 19, 2006, the State Property Fund of Ukraine again authorized the sale of 76% of the shares of the Luhansk plant, and on March 23, 2007, the company was sold to the Russian company «Transmashholding» for \$ 58 million (Pavliuk, 2010). In December 2007, a series of acceptance tests for the 2EL5 electric locomotive was successfully completed, the main purpose of which was to confirm the strength characteristics of the machine and to determine the operational parameters

(Borisenko, 2010, p. 8; Spektor, 2009). HC «Luhanskteplovoz» made the crew part, thus creating a minimal additional cost of production. The factory developed and commissioned an improved electric locomotive cart for the manufacture of which more than 120 pieces of equipment, stands, other equipment were introduced in the workshops, and new technologies of processing of complex components and parts were mastered (Borisenko, 2010). The first carts of Luhansk production were installed on electric locomotive 2EL5-008. As of 2008, the company was ready to manufacture up to 10 sets of carts and main frames of electric locomotives per month.

In October 2008, the Ministry of Transport of Ukraine approved the «Comprehensive program for updating the railway rolling stock of Ukraine for 2008–2020», which determined that for the organization of high-speed traffic by 2020 it is necessary to replenish the railway fleet of Ukraine by direct and alternating current electric locomotives 282 units, two-passenger passenger locomotives – 110 units. In 2008, the plant produced 18 sections of the 2EL5 electric locomotive (Spektor, 2009). As a result of 11 months of work in 2008, the enterprise's output amounted to UAH 1 billion, which became a record economic indicator for 17 years. Production growth was almost 200%. In 2009, Ukrzaliznytsia's financial plan provided for the purchase of 6 electric locomotives from HC «Luhanskteplovoz». At that time, work on restructuring and optimization of the number of employees at the enterprise was conducted on the basis of the order of «Ukrzaliznytsia» (Osobova, 2009).

The global economic crisis of 2008 significantly complicated the position of railway engineering enterprises in Ukraine, in particular, SPA «Elektrovozobuduvannia». Supplies of DS3 electric locomotives sharply decreased: out of 101 planned units, only 18 were purchased (Hrebeniuk, 2009). In 2008, he received the certificate of conformity of the Russian electric locomotive 2ES4K of the Novocherkask plant development and the prospects of introducing mass production of its Ukrainian counterpart at the facilities of the Luhansk plant arose. Since the Dnipropetrovsk plant did not established serial production of the electric locomotive DE1 (all 40 locomotives were experimental), its electronics was morally outdated, and the cost of the Russian electric locomotive 2ES4K, taking into account transportation and customs clearance was lower than the cost of production DE1, a Dnipro electric locomotive couldn't stand the competition and its orders were ceased (Likhushyn, 2018, p. 14). According to «Ukrzaliznytsia» CEO Mikhail Kostiuk: «We are not satisfied with the belated policy of a domestic manufacturer who invests in the development of outdated technology» (Hrebeniuk, 2009). This meant that the products of the state-owned SPC «Elektrovozobuduvannia», in particular, created the project of a two-system electric locomotive DS-4, became completely uninteresting for the management of «Ukrzaliznytsia».

As the complex program of updating of the railway rolling stock of Ukraine envisaged the order of 110 two-way passenger electric locomotives with asynchronous drive, the heads of the Luhansk plant expressed their readiness to start developing such a locomotive. As part of the technical cooperation between the

French machine-building company Alstom and the owner of the controlling stake in the Luhansk plant, «Transmashholding» developed a project for a passenger dual-propulsion electric locomotive EP20 at speeds up to 200 km/h (Konovalov, 2010). «We have the necessary documentation and documentation. As soon as the pre-financed order appears, we will be able to make a prototype» said Viktor Bikadorov, General Director of HC «Luhanskteplovoz». According to him, the cost of building the prototype was at least 3 million euros (Hrebeniuk, 2009).

In March 2009, HC «Luhanskteplovoz», together with the Novochoerkask plant, began production of two-section 2EL4 DC electric locomotives, developed on the basis of the Russian 2ES4K Donchak electric locomotive (Pervyy Luganskiy, 2009). The first prototype of locomotive 2EL4-001 was put into operation in Donetsk railway. The 2EL4 electric locomotive was as unified as possible with the 2EL5 electric locomotive. The electric locomotive was equipped with the latest traffic safety systems, the Ukrainian fire extinguishing and signaling system, a modern control cabin, a switch that provided high switching ability and long service life; three-phase asynchronous motors for the drive of cooling fans of traction motors, compressors powered by a static converter; fridge and plumbing equipment. Rated voltage of the control circuits – 110 V. Basic parameters of the electric locomotive 2EL4: power in hour mode on the shafts of traction motors not less than 6400 kW; design speed of 120 km/h; the thrust force in the hour mode – not less than 44 tons; load from the wheelset on the rails – 23.5 tons. Among the main structural advantages of the new machine were improved running properties, more efficient use of the coupling weight, reduction of harmful effects on the track, which reduced the wear of rails and bandages of wheel pairs. In addition, traction electrical equipment has been used to reduce cooling air consumption, while individual in-wheel ventilation on the basis of asynchronous motors has increased efficiency and reliability. In the wiring diagram, units of mainly domestic mass production were used, which made it easier to organize maintenance and repair at Ukrzaliznytsia locomotive depots (Pervyy Luganskiy, 2009).

At the beginning of November 2009, the decision of the Commercial Court of Luhansk region canceled the results of the privatization auction of the Luhansk plant (Pavlyuk, 2010). In the spring of 2010, French machine-building corporation Alstom Transport with a stake of 26% + 1 became one of the shareholders of the Russian company «Transmashholding», and already on June 15, 2010 Briansk mechanical engineering plant, which was a part of the «Transmashholding» Company, re-bought the stake of the Luhansk plant for \$ 51 million (Pavliuk, 2010). As one of the actual beneficiaries of the Luhansk plant was Alstom, the world's leading manufacturer of railway equipment, it was hoped that this factor would have a positive impact on the technological reconstruction of the enterprise (Yurova & Spektor, 2011; Gerasimova, 2010).

During 2009, the Luhansk plant reduced production by three times, producing two electric locomotives – 2EL4-001 and 2EL5-013. In 2010, according to the signed

financial plan, «Ukrzaliznytsya» planned to purchase 9 trunk electric locomotives from PJSC «Luhanskteplovoyz» (5 DC and 4 AC), however, the plant released only two sections of the 2EL4 locomotive and six sections of the 2EL5 locomotive (Luganskim teplovozem – zelenyy svet, 2010). It is planned to produce 3 DC electric locomotives for the Donetsk railway in 2011 (Yurova & Spektor, 2011). During January–September 2011 PJSC «Luhanskteplovoyz» produced 4 sections of electric locomotives of both series («Luganskteplovoyz» vypolnyayet zakazy RZHD, 2011).

In the spring of 2013, PJSC «Luhanskteplovoyz» within the framework of the Decree of the Cabinet of Ministers of Ukraine on the renewal of the rolling stock of Ukrainian railways received a state order for the production of 300 DC and AC freight locomotives. The estimated amount of the contract was estimated at over UAH 12 billion. There were plans to create a service center for servicing Luhansk locomotives on the basis of the Yasinovata Donetsk Railway locomotive depot. The plant has planned to purchase new machining and harvesting equipment to increase production volumes and improve the quality of work (Luganskteplovoyz postavit Ukrzaliznitsi 300 elektrovozov, 2013). In the fall of 2013, PJSC «Luhanskteplovoyz» signed an agreement with the Odessa Railway to supply 70 trunk electric locomotives of the 2EL5 series by 2017. Deliveries were to be divided into three years: in 2014 – 5 units, in 2015 – 30 units, and in 2016 – 35 units. («Luganskteplovoyz» pomozhet odessitam, 2013).

As part of the process of restructuring and concretization of production, inter-workshop movement of equipment was carried out. At the meeting of the Interagency Commission, the final decision was made regarding the serial production of 2EL4 and 2EL5 electric locomotives. Designers and technologists worked out layout decisions on the installation of Ukrainian equipment on electric locomotives, organization of technological process of production in the shops of the plant. In November 2013, the last 4 sections of the 2EL4 electric locomotive were manufactured (PAO «Luganskteplovoyz» narashchivayet tempy, 2013).

Unfortunately, with the start of hostilities in the spring of 2014, the economic activity of the Luhansk plant was complicated. In October 2014, the company resumed its production activity, and even managed to execute the plan as a result of the year. However, since the main customer of Luhansk electric locomotives was «Ukrzaliznytsia», due to the complicated military and political situation, the mainline electric locomotive engineering at the enterprise was discontinued, but today only single sections of shops that perform mechanical processing of Novochoerkask and Briansk plants parts are functioning.

Conclusions

Thus, for a long time Luhansk diesel locomotives plant, having a strong scientific and production potential, carried out the development and created unique samples of rail technology, including a new generation of electric locomotives and their units to meet the needs of the national locomotive park. Unfortunately, due to the traditional lack of

financing of state orders and lobbying from both political groups and foreign machine-building enterprises, Luhansk locomotives have not become the main locomotives of Ukrainian railways. However, the analysis on the historical experience of the formation of the mainline electric locomotive engineering in Ukraine is of fundamental importance both in the general perspective of the development of the Ukrainian industry, and of the railway industry in particular.

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Передумови становлення та розвиток магістрального електровозобудування на Луганському тепловозобудівному заводі (1957–2014)

Анотація. У статті здійснено спробу дослідити в хронологічному порядку історичні обставини становлення та розвитку магістрального електровозобудування на Луганському тепловозобудівному заводі (1957–2014 рр.). Проаналізовано обставини діяльності електровозного цеху Луганського заводу (1957–1967 рр.), у рамках якої протягом 10 років здійснювалось виробництво екіпажних частин та вузлів легендарних електровозів ВЛ8 і ВЛ10 для Новочеркаського та Тбіліського заводів. Наприкінці 1980-х рр. у зв'язку з відсутністю твердої конвертованої валюти для імпорту тягового рухомого складу з Чехословаччини на хвилі економічної кризи СРСР, Луганський завод отримав замовлення на розробку та виробництво вантажопасажирських електровозів власної конструкції. Однак, з проголошенням Незалежності України, через лобізм нового керівництва уряду, перспективні проекти луганських електровозів були відхилені, а базовим підприємством зі створення магістральних електровозів для українських залізниць був визначений Дніпровський електровозобудівний завод. Оскільки внаслідок нестабільної економічної ситуації в країні та відсутності цільового фінансування Дніпровський завод не спромігся налагодити серійне виробництво низки типів електровозів, ХК «Луганськтепловоз» спільно з Новочеркаським заводом розпочали виготовлення вантажних електровозів на технологічній основі російських локомотивів. Подальший розвиток та перспективи серійного електровозобудування на Луганському заводі був перерваний із загостренням військово-політичної ситуації в регіоні. Однак, безумовно, що історичний досвід становлення вітчизняної науково-виробничої бази магістрального електровозобудування потребує свого належного осмислення в контексті сучасних тенденцій імпорту тягового рухомого складу зі спробою подальшої локалізації його виробництва в Україні.

Ключові слова: Луганський тепловозобудівний завод; транспортне машинобудування; магістральне електровозобудування; українські залізниці

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**Предпосылки становления и развитие магистрального
электровозостроения на Луганском тепловозостроительном заводе
(1957–2014)**

Аннотация. В статье предпринята попытка исследовать в хронологическом порядке исторические обстоятельства становления и развития магистрального электровозостроения на Луганском тепловозостроительном заводе (1957–2014 гг.). Проанализированы обстоятельства деятельности электровозного цеха Луганского завода (1957 – 1967 гг.) в рамках которой в течение 10 лет осуществлялось производство экипажных частей и узлов легендарных электровозов ВЛ8 и ВЛ10 для Новочеркасского и Тбилисского заводов. В конце 1980-х гг. в связи с отсутствием твердой конвертируемой валюты для импорта тягового подвижного состава из Чехословакии на волне экономического кризиса СССР, Луганский завод получил заказ на разработку и производство грузопассажирских электровозов собственной конструкции. Однако, с провозглашением независимости Украины, через лоббизм нового руководства правительства, перспективные проекты луганских электровозов были отклонены, а базовым предприятием по созданию магистральных электровозов для украинских железных дорог был определен Днепровский электровозостроительный завод. Поскольку в результате нестабильной экономической ситуации в стране и отсутствия целевого финансирования Днепровский завод не смог наладить серийное производство ряда типов электровозов, ХК «Лугансктепловоз» совместно с Новочеркасским заводом начали изготовление грузовых электровозов на технологической основе российских локомотивов. Дальнейшее развитие и перспективы серийного электровозостроения на Луганском заводе были прерваны с обострением военно-политической ситуации в регионе. Однако, безусловно, что исторический опыт становления отечественной научно-производственной базы магистрального электровозостроения требует своего должного осмысления в контексте современных тенденций импорта тягового подвижного состава с попыткой дальнейшей локализации его производства в Украине.

Ключевые слова: Луганский тепловозостроительный завод; транспортное машиностроение; магистральное электровозостроение; украинские железные дороги

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**Engineer of the communication lines Mykola Pavlovych Petrov (1836–1920):
factors for his scientific views' formation**

Abstract. *The article reviews the factors of the scientific views' formation of Mykola Pavlovych Petrov – formidable Russian scientist and engineer in relation to his administrative efforts of development of the native scientific and technical community XIX–XX. The special focus was made on the biographical component, especially his study in Petersburg institutions. The crucial impact on the scientific destiny of M. P. Petrov was made by his studying in the Engineer Academy. In that time the intellectual basement for the future activities was formed. As a matter of fact, later M.P. Petrov became the formidable engineer and scientist. M. P. Petrov was the student of the formidable mathematician, academician of the Petersburg Academy of Science Mykhailo Vasylovych Ostrohradskyi (1801–1862). M. P. Petrov gained a lot of useful skills and knowledge from his teacher. Among those the following: high mathematical culture, abstract thinking, knowledge of the theoretical and practical problems in various areas of science, especially the ones that were related to railway transport. Work as the lecturer in the Technological Institute, communication with I. A. Vyshniehradskyi, A. P. Borodin and other scientists and specialists played a role of some kind of push for M. P. Petrov to study applied disciplines, mainly related to the friction of lubricated materials. Among the teachers of M. P. Petrov in the Academy was Herman Yehorovych Pauker (1822–1889). M. P. Petrov always recalled him as the wonderful engineer and teacher, who was the creator of the school for the engineers-teachers. The main goal of the school was the harmonious connection between engineer work and science. In the Academy M. P. Petrov met the lecturer of mechanics of the Institute of the communication paths engineer corps Stanislav Valerianovych Kerbedz. During the studying in the Academy M. P. Petrov was formed as the future scientist and specialist, who had the character which helped him to communicate easily with people. He had humane views and always acted alone and fairly. These features of his character in conjunction with his great mind helped him to achieve all his goals while solving the complicated engineer and administrative tasks. Aspiration to knowledge, original and brave thinking were among the main features of M. P. Petrov's nature.*



Keywords: *scientist; engineer; hydrodynamic theory of lubrication; building mechanics; teacher; railway worker*

Introduction

Nowadays, historians of science and technology more often focus their attention on the issues related to the period of the foundation and development of the railway transport during the second half of the XIX century – beginning of the XX century. They included to the scientific founds and analysed a lot of new facts due to the archive researches. However, despite it, there are considerable amount of issues that are not investigated by the researchers. Among such issues, there is one that relates to the activities of the formidable scientists and engineers, who were the pioneers of the scientific, technical, engineer, and teaching thoughts and ideas, when the questions related to the promotion of the development of the different industries arose. In addition, those persons paid a lot of attention to the teaching and sharing their knowledge with the wide people masses.

That is why there is a great need of observing the scientific and educational activities of the different scientists in Ukraine because of their hard work in the scientific field remains unknown for the native history. Professor M. P. Petrov was among those scientists and engineers.

Methods of the research

This study was based on the historical method. Thanks to this method of research it was possible to analyze the sources related to the life and work of M. P. Petrov, namely the literature that characterizes the factors to shape his scientific worldview. The use of the historical method allowed a deeper study of the early period of life and work of M. P. Petrov, which has not yet been done in scientific and popular literature (Yanin, 2018).

Analysis of the researches and publications

Activities of M. P. Petrov, the formidable Russian scientist, who worked a lot on the territory of the modern Ukraine, was observed in works of O. S. Akhmietov, O. G. Burhvyts, M. O. Zenzinov, S. M. Petrov, S. M. Tretiakov. However, a lot of issues related to his scientific and educational activities are mostly not researched. In the available sources we are able to find only some pieces of information related to the formation of his views as the scientist and teacher considering the period of the development of the science in Russian Empire of the second half of the XIX century – beginning of the XX century (Burhvyts, 1984).

Results and discussion

Petrov Mykola Pavlovych – formidable Russian scientist and engineer, honourable member of the emperor's Academy of science in Petersburg (since 1894), follower of the formidable Ukrainian mathematician M. V. Ostrohradskyi, professor

of the Technological institute and Mykolaivska Engineer Academy, Engineer – general, head of the state railway council (1882–1892), head of the Engineer Council of the communicational path Ministry of Russian Empire (1893–1900), head of the Russian technical fellowship (1896–1905), Member of the State Council, founder of the hydrodynamic theory of lubrication, awardee of the Lomonosov prize of the Petersburg Academy of science (1884), author of the scientific works related to the calculation of the rail strength, theory of the interaction between rail and rolling stock, head of the council of the communication paths Ministry, head of the special railway research council (1908–1912), head of the Russian technical fellowship council, cavalier of the various native and foreign orders, honourable member of the technical institutions and scientific fellowships (Zenzinov & Ryzhak, 1978).

Mykola Pavlovych Petrov was born 13 of May 1836 in Trubchevsk of the Orlovskaya region in the military family (see fig.1). There were seven children in the Petrov's family – three boys and four girls. As it was common in not so rich noble families, children were taught at home, and Mykola Petrov till 13 was living in his father's house where he gained his primary education (Akhmetov, 1965, pp. 240-246). There was a tradition for noble boys to gain education in military institutions. However, it was possible to start the engineer's career without breaking the traditions. This possibility was found in the Institute of Railway Engineers in Petersburg. Although, the specialists taught in the Institute were for the civil needs, in addition to the common courses there were also military disciplines and the institution was of the closed format, only for the nobles. It was not the ordinary military institute, it was more like cadets corps. According to the rules only boys from 11 to 13 were able to enter the institution and after graduating there became cadets (Petrov, 1925).



Figure 1. Mykola Pavlovych Petrov (1836–1920) (https://biblioclub.ru/index.php?page=author_red&id=13118&contrast=1)

During that period the railway Petersburg – Moscow was on the final stage of construction, which was the brilliant example of the Russian engineering. That is why studying in the Institute of the Corps of the communicational path engineers was considered as a prestigious one and 13 years old boys choose it not because of their skills but because of the will of their parents.

While studying at home Mykola showed some engineering skills and when he was 13 in 1849 his father brought him in Petersburg to enter the Cadets Corps. However, due to yet unknown for us reasons Mykola was not able to enter the Cadets Corps and was forced to enter the “Noble regiment” – military institution alike the Cadets corps. According to the feedbacks of the graduates the studying process in the following institution was quite average, however, during the engineer`s courses among the disciplines, there were Algebra, analytics Geometry, Physics, Architecture, Engineer Drawing, and Art of building. Everyone who finished the engineer`s courses met the requirements to enter the Engineer Academy which was found in 1819 and was situated in Engineer Palace in Petersburg. Among those who graduated the Noble regiment 11th of June 1855 and entered the Mykolaivska Engineer Academy was young M. P. Petrov (Tretiakov, 1948).

Studying in the academy had a considerable influence on the scientific fate of M. P. Petrov. During that period was formed his intellectual “basement” which in the future transformed into the formidable engineer and scientist. In the academy he was taught by the formidable mathematician, academician of the Petersburg Academy of science, Ukrainian born in Poltava, Mykhailo Vasyliovych Ostrohradskyi (1881–1862) (see fig.2).



Figure 2. Mykhailo Vasyliovych Ostrohradskyi (1881–1862)
(https://ru.wikipedia.org/wiki/Остроградский_Михаил_Васильевич)

Since August 1830 M. V. Ostrohradskyi was the professor of mechanics and astronomy and has been working in the Institute of the Corps of communicational paths engineers for almost 25 years. Almost any mechanics or mathematics courses, no matter civil or military, were taught under the mentorship of M. V. Ostrohradskyi. Moreover, he was working with the researches related to the hydrostatics, hydrodynamics, resilience theory, caloric theory, which had a considerable impact on the activities of the communicational paths engineers and also on the other sciences related to the mathematics.

Communication with this scientist made a huge impact on the whole life of Mykola Pavlovych. Even during his last days, M. P. Petrov remembered his teacher: “he was a formidable scientist and in addition was able to explain in the fantastic manner, abstract mathematics principals. This ability helped him to teach a lot of great mathematicians. Right now I remember those happy hours when due to his teaching manner some kind of magic force drew in my mind new knowledge. As everything powerful has a force of gravity, the science also attracted us, forcing to learn it deeper and serve to it, with the only reward, understanding the high honor to be servant of science. Here are the consequences of being a student of Ostrohradskyi” (Petrov, 1883, p. 84). From his teacher M. P. Petrov learnt not only mathematics culture and abstract thinking but also the knowledge in theoretical and practical issues of other sciences, especially related to the transport.

Excellent knowledge in mathematics in solving practical issues placed M. P. Petrov among the formidable scientists. In Academy M. P. Petrov got to know the lecturer of the building and mechanics course of the Institute of Corps communicational paths engineers Stanislav Valerianovych Kerbedz (1800–1899). Their communication prompt the interest of Mykola Pavlovych to the disciplines that were taught in the Institute and contacts with the scientists made it possible for him to gain the latest knowledge for that time.

After graduating from the Engineer Academy in 1858 M. P. Petrov left in the academy where he started to work under the mentorship of M. V. Ostrohradskyi i. At the same time he visited mathematics and mechanics lectures in the Petersburg practical institute, founded in 1828. Those lectures were held by scientist and engineer Ivan Oleksiiovych Vyshnehradskyi (1832–1895). The relation between the theory and practical tasks, independence from the foreign schools were among the key issues of I. O. Vyshnehradskyi (see fig.3) as an innovator in mechanics. Work under his mentorship granted vast possibilities for the development of M. P. Petrov’s skills.

After the death of M. V. Ostrohradskyi in 1862 M. P. Petrov began to lead the mathematics course in Engineer Academy and also mechanics in Practical institute from 1866. Being a teacher in the institute and communication with I. O. Vyshnehradskyi, O. P. Borodyn and other scientists and specialists prompt M. P. Petrov to focus his attention on the issues related to the friction.

Among the teachers of M. P. Petrov in the Academy was Herman Yehorovych Pauker (1822–1889) (see fig.4). M. P. Petrov always remembered him as a wonderful

engineer and teacher, who created the school of teachers – engineers. Their main goal was to gain the harmonic connection between the exact sciences and engineering art. Later, in 1888–1889 H. Y. Pauker, as the minister of the communicational paths of the Russian Empire, who made a considerable impact on the M. P. Petrov`s career.



Figure 3. Ivan Oleksiiovych Vyshnehradskyi (https://uk.wikipedia.org/wiki/Вишнеградський_Іван_Олексійович)



Figure 4. Herman Yehorovych Pauker (1822–1889) (https://ru.wikipedia.org/wiki/Паукер,_Герман_Егорович)

H. Y. Pauker was a well-known specialist among the Russian engineers (Strelko, 2016; Pylypchuk & Strelko, 2018). He was teaching not only during the lectures, also he practised the private discussions in the lecturer's room, speaking to the young teachers about various engineer issues. M. P. Petrov learnt from him to love engineering and to understand the ways of its development. In the Academy was found the school of the Russian military – engineering art.

During the studying in the Academy M. P. Petrov was formed as a future specialist and scientist, who had the character that made it easy for him to communicate with others. He was independent, truthful, and humane. In addition to his formidable mind it helped him to achieve all his goals, solve the hardest engineer task, and managerial tasks. The main feature of his nature was to be original and brave in thinking, and to seek learning.

Influence of the various dominating scientific schools and views on the further works of M. P. Petrov is quite hard to evaluate nowadays. The reason for it is that all his works are quite individual and original, but mostly they relate to the French school with its priority inaccurate mathematical analysis of the technical issues.

When M. P. Petrov came back after the foreign business trip he started to teach mechanics in Engineer academy and Technological institute in Petersburg. Soon, the first scientific researches appeared. In 1873 he started to work on the railways as an auditor of the Main Russian railways' fellowship. The same year M. P. Petrov founded the new discipline in Technological institute – “Railway rolling stock”, and he made the first step that had a huge impact on the development of the railway transport of the Russian empire.

In the first edition of this course some absolutely new ideas of the author and plans for the further work could be found. Among those for the first time the theoretical base for the formula of the train resistance while moving on the rails (Petrov, 1889). The founder of the discussion of this issue was English designer and inventor, founder of the development of the steam railway transport G. Stephenson. Later on, all European experimental areas were held the experiments and a lot of empirical formulas of the rolling stock resistance on the railway calculations were offered.

However, M. P. Petrov thought that the results of those experiments could not be considered scientific or technical because the researchers did not differentiate the separate elements of the whole issue. As the matter of fact, the general conclusion of those experiments could not be made that is why it was possible that the conditions and results for one railway could be quite opposite for other railways. So, the results of the experiments were quite different and were leading to different conclusions. M. P. Petrov did not choose the way of using the empirical formulas while solving the train resistance issue. The scientific way that he had chosen was complicated and required a lot of time for completion. However, that method in the future solved the crucial issue about the train movement resistance – friction impact on train movement. Solving this issue was extra important for science.

Even in the first his works related to this issue, he countered the theory that “coefficient of the friction in bearings does not depend on velocity, pressure and temperature”. Based on the works of N. Kirhgofer, S. Bokelberg, D. Velkner and his own works on the Warsaw railway he showed that the factors like velocity, pressure and temperature had a considerable impact.

The views of M. P. Petrov on the problem of train movement resistance hundred years ago were complex and considered all the elements of this resistance: “From the very beginning of the train movement resistance research the scientists mentioned that it consists of separate parts that do not relate one with another. Some of those aspects were researched and some appeared unknown or less known. For the research of the last ones, scientists made various experiments that gave us new knowledge. To determine the elements of the train movement resistance it should be mentioned that keeping the same velocity of two same trains on the rails of the same construction two different powers needed if the rails are placed on the surface with the different angle. The power that needed for the elevated surface differs and the difference is equal to the projection of the power of train`s gravity that is moving, which was taken in the direction parallel to rails. While moving up this power is adding to other resistances that are present while moving on the horizontal surface, and while moving down it should be subtracted from the total resistance”.

All the elements that included to the total resistance of the train while moving on the horizontal surface are easy to determine. They are:

- Air resistance;
- Friction between wheels and rails resistance;
- Axis friction resistance caused by the friction of lubricated solids;
- Resistance made by the hits between wheels and rails caused by the unevenness of the surfaces, rails or wheels, or caused by the third-party solids.
- Rolling resistance of wheels on the rails.
- During the acceleration of the train to the total resistance should be added to the resistances that depend on the powers of the inertia.

On the non-horizontal rails, but the straight ones, the resistance of the power of gravity should be also added.

Also, the curves of the rails are increasing the total resistance. The reason for it is that it increases the friction of solids. For the research of the train movement resistance, it is mandatory to evaluate all the elements of the total resistance.

In the works of M. P. Petrov that were published, we may find a lot of researches that solve not only the resistance issue but also the methods of the determining the main dimensions of the train, calculation of the wheels and so on. It is obvious, that further improvements and separate conclusions made by M. P. Petrov were justified, later they were changed by the more modern ones, however, the methods that were found while solving the issue are the same even nowadays.

Rolling stock course made it possible for M. P. Petrov to organize the professors` cathedra in 1873. He taught this course improving it till 1892. 1892 was

the last year of his lecturer's activities in the Technological Institute. The same year he was promoted to the position of the vice Minister of the communicational paths of the Russian empire and at the same time till 1900, he taught the steam mechanics course in Engineer Academy in Petersburg.

As a professor, M. P. Petrov treated well the students that had some lack of knowledge in the technical details, but he demanded from them accurate knowledge in differential calculations and mechanics basics. Those demands made him a reputation of a sharp examiner. On the other hand, everyone knew that he demanded the knowledge of the issue basics, not the additional details.

Conclusions

The period of the formation of the scientific views of M. P. Petrov had a couple of stages: 1849–1855) – studying in “Noble regiment”; (1855–1858) – studying in Mykolaiv Engineer Academy and Technical Institute in Petersburg. The considerable influence on the scientific views of M. P. Petrov was made by O. P. Borodin, I. O. Vyshnehradskyi, S. V. Kerbedz, H. Y Pauker, M. V Ostrohradskyi and others.

We determined that M. P. Petrov developed the learning about the hydrodynamic theory of lubrication. He found the main systematic parameters of the hydrodynamic lubrication that caused the foundation of his concepts in the development of the railway transport. His communication with the formidable scientists and engineers of that time could be considered as the most important factor of the formation of M. P. Petrov as a scientist, engineer and lecturer.

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Володимир Янін

Незалежний дослідник, Україна

Інженер шляхів сполучення Микола Павлович Петров (1836–1920): чинники формування наукового світогляду

Анотація. У статті розглянуто чинники формування наукового світогляду Миколи Павловича Петрова – видатного російського вченого та інженера на тлі його ініціативно-організаційних зусиль розбудови вітчизняного науково-технічного простору кінця XIX – початку XX століть. На особливу увагу заслуговує його біографічна компонента, навчання у вузах Санкт-Петербурга. На творчу долю М. П. Петрова вирішальний вплив мало навчання в Інженерній Академі. В цей час було закладено його інтелектуальний

фундамент, на якому пізніше він сформувався як видатний інженер і вчений. Там він навчався у видатного математика академіка Сакт-Петербурзької Академії наук, уродженця м. Полтави, Михайла Васильовича Остроградського (1801–1862). Від свого вчителя М. П. Петров сприйняв не тільки високу математичну культуру і глибину абстрактного мислення, а й знайомство з теоретичними і практичними проблемами в інших науках, в тому числі приналежних до транспорту. Викладацька робота в Технологічному інституті, спілкування з І. О. Вишнеградським, О. П. Бородінін, іншими вченими і спеціалістами послужили поштовхом до вивчення прикладних дисциплін, в першу чергу пов'язаних з тертям в умовах змащування. Одним з учителів М. П. Петрова в Академії був Герман Єгорович Паукер (1822–1889), про якого він завжди згадував з особливою теплотою як про чудового інженера і педагога, який створив школу інженерів-викладачів, яка прагнула до гармонійного зв'язку між точними науками та інженерним мистецтвом. В Академії М. П. Петров близько познайомився з викладачем курсів побудов і прикладної механіки Інституту Корпусу інженерів шляхів сполучення Станіславом Валеріановичем Кербедзом. Під час навчання в Академії М. П. Петров сформувався як майбутній вчений і спеціаліст, який володів такими рисами характеру, які сприяли звичайним і невимушеним відносинам його з людьми. Він володів жвавим характером і гуманними поглядами, діяв завжди самостійно і справедливо. Ці риси характеру у поєднанні з особливим розумом допомагали йому досягати мети і при вирішенні дуже складних не тільки інженерних завдань, а й у його адміністративно-організаторській діяльності. Головним в його натурі було стремління до знань, оригінальність і сміливість мислення.

Ключові слова: вчений; інженер; гідродинамічна теорія змащування; будівельна механіка; педагог; залізничник

Владимир Янин

Независимый исследователь, Украина

Инженер путей сообщения Николай Павлович Петров (18936–1920): факторы формирования научного мировоззрения

Аннотация. В статье рассмотрены факторы формирования научного мировоззрения Николая Павловича Петрова – выдающегося русского ученого и инженера на фоне его инициативно-организационных усилий развития отечественного научно-технического пространства конца XIX – начала XX веков. На особенное внимание заслуживает его биографическая компонента, учеба в вузах Санкт-Петербурга. На творческую судьбу М. П. Петрова решающее влияние имела учеба в Инженерной Академии. В это время было заложено его интеллектуальный фундамент, на котором позже он

сформировался как выдающийся инженер и ученый. Там он учился у выдающегося математика академика Санкт-Петербургской Академии наук, уроженца г. Полтавы, Михаила Васильевича Остроградского (1801–1862). От своего учителя М. П. Петров воспринял не только высокую математическую культуру и глубину абстрактного мышления, но и знакомство с теоретическими и практическими проблемами в других науках, в том числе относящихся к транспорту. Преподавательская работа в Технологическом институте, общение из И. А. Вишнеградским, А. П. Бородиным, другими учеными и специалистами послужили толчком к изучению прикладных дисциплин, в первую очередь связанных с трением в условиях смазки. Одним из учителей М. П. Петрова в Академии был Герман Егорович Паукер (1822-1889), о котором он всегда вспоминал с особенной теплотой как о чудесном инженере и педагоге, который создал школу инженеров-преподавателей, которая стремилась к гармоничной связи между точными науками и инженерным искусством. В Академии М. П. Петров близко познакомился с преподавателем курсов построений и прикладной механики Института Корпуса инженеров путей сообщения Станиславом Валериановичем Кербедзом. Во время учебы в Академии М. П. Петров сформировался как будущий ученый и специалист, который владел такими чертами характера, которые способствовали обычным и непринужденным отношениям его с людьми. Он владел оживленным характером и гуманными взглядами, действовал всегда самостоятельно и справедливо. Эти черты характера в сочетании с особенным умом помогали ему достигать цели и при решении очень сложных не только инженерных заданий, но и в его административно-организаторской деятельности. Главным в его натуре было стремление к знаниям, оригинальность и смелость мышления.

Ключевые слова: ученый; инженер; гидродинамическая теория смазки; строительная механика; педагог; железнодорожник

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Academician Pavlova Mariia Vasylivna (1854–1938): life and scientific work

Abstract. *The article is devoted to the study of dedicated contribution of academician Mariia Vasylivna Pavlova (Gortynskaya) in the development of Paleozoology Science. It is noted that her research was carried out in several directions including studying the causes of extinction of animals in the past geological epochs, investigating the remains of fossil elephants, rhinos, tapirs, notartiodactyls and artiodactyls, describing the remains of mammals in Tiraspol gravel. M. V. Pavlova described hipparions and horses, found mainly in the southern regions of Ukraine and the Crimea. By this new material she proved that horses had originated from American protogippus. The idea of a single trunk development of horses both the Old and New World caused objections, especially in America, as in Europe, there were no finds of ancient forms of horse series – anchitheriinae and protogippus. M. V. Pavlova consistently sought them in Eurasia, and in 1903 she discovered the remains of the bones of the limbs of these ancient horses. Analysis of the scientific heritage of Academician M. V. Pavlova, an outstanding national paleoscientist, a specialist in evolutionary theory, an organizer of Paleozoology science and a teacher, makes it possible to understand the processes of development of national biological science. She takes one of the places of honor in the world of paleontological science. Her name is associated with the development of Paleozoology science of late XIX – the first third of the twentieth century and the scientific outlook on the development of various Paleozoology concepts, laws and ideas. It suggests the urgency and necessity of this research. Its relevance is also caused by significant civil and scientific value of a person M. V. Pavlova in Paleozoology science, the lack of special comprehensive study of her life, scientific, organizational and administrative activities in the history of science, the need to create the most objective biography of M. V. Pavlova, the analysis of creative works and the importance of the introduction of solid scientific use of new sources and facts.*



Scientific activities of Pavlova as the scientific leader and founder of scientific school and her contribution in Paleozoology science has been marginally disclosed yet.

Keywords: *paleontology; paleozoology; fossil animals; science; education; M. V. Pavlova*

Introduction

81 years have passed since the death of Mariia Vasylivna Pavlova, who in the first third of the twentieth century was a brilliant figure in the history of biological science, including Paleontology (Paleozoology). However, her scientific heritage is still not properly studied, analyzed, duly evaluated and not fully communicated to the contemporary. Unfortunately, there are almost no papers devoted directly to the scientific research activities of her. Also her biography is missing. One reason is that the study of M. V. Pavlova's heritage was conducted by specialists from various sciences (biologists, geologists, geographers) who pursued a specific goal. Of course, it was not possible to cover all the multifaceted and interdisciplinary nature of Mariia Vasylivna unique heritage. Although the national historical and biological scientific literature her role in the development of world paleozoologic science sometimes was covered, yet the diversity of her research interests is crushing a complete image into many individual biographical details. Research of M. V. Pavlova's life and scientific activity was illustrated in the Article of R. A. Chaurina (Chaurina, 2000), in the Articles of Z. A. Bessudnova (Bessudnova, 2004 and 2009), biographical reference of the employee from RAS archives in Moscow V. N. Zahrebayeva (Zahrebayeva, 2015) and a monograph summarizing the works of the author of this article (Deforzh, 2015). Unfortunately, we have not encountered the examples of M. V. Pavlova's articles reprint in the scientific literature at present time, her epistolary heritage is shown not sufficiently, there is no any analytical publication of her scientific achievements.

The purpose of this article is to analyze the special features and potential of M. V. Pavlova's scientific works, their world importance and influence on the development of paleozoology.

Research methods

Methodological principles are based on the general principles of historical research, including objectivity, continuity, dialectical understanding of the historical process, priority of documents and literary origins that allow analyzing the activity of M. V. Pavlova fully. The important aspect for this study is the use of research methods: general scientific (typology, classification) interdisciplinary (structural and systemic approach), historical facts (problem-chronological, comparative historical and narrative).

Results and Discussion

Mariia Pavlova (1854–1938) is an outstanding Ukrainian and Russian paleozoologist researcher, the academician of Ukrainian Academy of Sciences

(1921), the member of the Academy of Sciences USSR (1925), honorary academician of the USSR (1930), Honored Scientist of RSFSR (1928). She has described the numerous remains of fossil mammals collected in the former USSR. M. V. Pavlova described hipparions and horses, found mainly in the southern regions of Ukraine and Crimea. This new material proved that horses had descended from American protohippus. The idea of a single trunk in horse development of Old and New Worlds was controversial, especially in America, as in Europe there were no finds of ancient forms of horse series – anchitheriinae and protohippus. M. V. Pavlova consistently sought them in Eurasia, and in 1903 she found the remains of the old leg bones of horses. Later, in the 1930s the study of A. A. Borisiak and E. I. Belyaev confirmed the correctness of the conclusions of M. V. Pavlova. Together with her husband, academician A. P. Pavlov, she created Geology Museum at Moscow University with separate paleontological department (until recently the museum was at the Moscow Geological Exploration Institute and was named A.P. and M. V. Pavlovs). The author of the textbook “Paleozoology” (Part.1–2, 1927, 1929).

M. V. Pavlova was born on June 27, 1854 in Kozelets Chernihiv Province. She got initial education and training at home, and then got secondary education at Kiev Institute for Noble Maidens that graduated from together with her sister in 1872 with the title of a home mentor and the right to teach the Russian language and literature, Natural History, Physics, German language and Literature, French language and Literature and Arithmetics. Having received no access to higher education in Russian Empire, she decided to study abroad.

Her choice was Paris. She listened to the lectures at Sorbonne, one of the oldest universities in the world, and worked in the National Museum of Natural History in Paris. Being a free listener Mariia listened to lectures of Botany from Van Tieghem, whom she always remembered with admiration and bright lectures of Zoology from Edmund Perrier. Simultaneously she was working in the laboratory of Milne-Edwards. But mostly she was under the influence of the lectures from the famous paleontologist Albert Gaudry, one of the first French evolutionary paleontologists, who played a special role in the spread of evolutionary theory in France. Along with Mariia, Gaudry’s lectures were attended by Henry Osborn (1857–1935), who later became a prominent paleontologist of North America and a close friend of Mariya Vasylivna. At Sorbonne M. V. Pavlova studied for 4 years. In 1884, when Mariia was preparing for the final examinations at Sorbonne in a family of associate professor zoologist M. A. Menzbier from Moscow, she meets a young geologist Master Alexey Petrovich Pavlov, a friend of Menzbier at Moscow University. This meeting for Mariia Vasylivna was fateful. Further Mariia became his wife, a friend, a colleague and a soulmate of Alexey Petrovich, he invited her to Moscow and since then they worked together at Moscow University and the Geological Museum and created a separate paleontological department. The main contribution of M. V. Pavlova is that she has become a pioneer in our paleontology as an independent biological science, laid the foundation on which Paleozoology could develop. She is the first organizer

of Tertiary and Quaternary mammals of Russia and Ukraine, Moldova and the Volga region. She had a close connection with many museums of the world, she often helped in the scientific work of paleontological collections.

In 1910 M. V. Pavlova became the professor of Paleontology in National University named after A. L. Shanyavsky. Dr Zoology (honoris causa) of Moscow University (1916). From 1919 to 1930 she headed the first department of paleontology at Moscow State University organized by the. In 1919 Mariia was also the head of the Paleontological Museum of the University.

M. V. Pavlova successfully conducted her research in several research areas. She was fond of Paleozoology problems, studying the causes of animal extinction in the past geological eras, she studied fossils of elephants, rhinos, tapirs, and odd-toed artiodactyl, lower ammonit. She described numerous fossil mammals of Tiraspol gravel. Her talent was clearly manifested in the field of natural science. It was extraordinary ability in the history of science, and in promoting paleozoological knowledge. By multifaceted scientific, social and teaching activity M. V. Pavlova made a significant contribution to the world science and education.

Mariia Pavlova (Gortynskaia) was born in Kozelets Chernihiv region, she belongs to the most prominent paleontologists and paleozoologists of Ukraine and the world in general. She has written a number of scientific papers relating to the evolution of fossil mammals on the territory of modern Ukraine, which did not have any existing notions. Specifically, M. V. Pavlova identified the ancestor of the modern horse. She mentioned her opinion about the place of tertiary horse-hipparion in the evolutionary tree of horses. Before her, Hipparion was considered a direct ancestor of the horse. Mariia convincingly proved that it is only the side branch.

It should be noted that the life of Mariia Vasylivna began in feudal Russia when women could not even dream of higher education, let alone be engaged in scientific activities. Instead, she succeeded. Here is how academician A. A. Borisiak and Professor V. V. Menner spoke in the obituary on the death of the scientist:

“December 23, 1938 Mariia Pavlova completed her life way, the oldest paleontologist of the Union, an honorary member of the All-Union Academy of Sciences, the member of the Ukrainian Academy of Sciences, the professor at Moscow State University and the member of many scientific societies of both Soviet and foreign origin.

The death of this Academic specialist completed a stage in the development of national paleontology that was headed for a long time by a prominent representative M. V. Pavlova. An outstanding talent of Mariia made her name very well known not only here but also in the international community of scientists.

The main contribution of M. V. Pavlova is that she has become a pioneer in our paleontology as an independent biological science, laid the foundation, which was able to develop our national Paleozoology” (Borisyak & Menner, 1939).

Outstanding Russian paleontologist R.F. Hecker in the “Preface” to the book “A. A. Borisyak. Selected works: the centenary of the birth” (1973) wrote about

paleontology, “Paleontology, the study of organisms of the past on the Earth, shaped on the basis of geology and remains closely associated with it. For this reason, until recently, most scientists considered paleontology as geological discipline. However, the remains of once living creatures during their study, of course, also require deep biological approach: only the results of research will be valuable. This truth, which seemingly did not require the evidence became public domain in the last decade.

The main proponent of Biological science and evolutionary Paleontology (paleozoology) in the country was Academician Alexey Borisyak” (Hecker, 1973). These words best suit Mariia Vasylivna Pavlova who enjoyed international recognition.

Nature has generously rewarded her with many talents. Therefore, she successfully conducted her researches in several research areas. She was fond of Paleozoology problems, studying the causes of extinction of animals in the past geological eras, Mariia studied fossils of elephants, rhinos, tapirs, and odd-toed artiodactyl, Lower ammonites, described numerous fossil mammals of Tiraspol gravel.

Her talent was clearly manifested in the field of natural science. It was her extraordinary ability in the history of science, and in promoting paleozoological knowledge. By her multifaceted scientific, social and teaching work M. V. Pavlova made a significant contribution to the world of science.

She has invaluable merits in establishing national paleozoological school. Paleozoological work of this school is known worldwide. The notable place among scientific papers of M. V. Pavlova is occupied by those studies that were the result of synthesis, critical reflection of new concepts: (phylogenetic series of ungulates, the impact of the environment on ungulates). The analysis of these concepts allowed her to draw important conclusions that are in tune with our time.

M. V. Pavlova was an outstanding, unique figure in the national Paleozoology at the end of XIX – the first third of the twentieth century. Thanks to good preparation both in Biology and Geology, she was a very broad-minded. The researcher also showed a special interest in the history of science. Hence her proper historical premonition in solving scientific and organizational issues, M. V. Pavlova was a talented scientist and teacher, a tireless organizer of science and a significant public figure. Considering the state of the early Paleozoology century and right identifying ways of further development, M. V. Pavlova was the tribune of Paleozoology as an independent biological discipline.

Simultaneously, M. V. Pavlova worried about the correct setting and increase of paleozoological researches in biological facilities and high level of teaching Paleontology in higher education. It was mostly thanks to participation of Mariia in different geological congresses, meetings on paleozoology where she touched the problems of studying fauna of Cenozoic era in European part of the USSR and the Urals, as well as on paleozoology teaching at universities. Popularization of paleozoological knowledge M. V. Pavlova also considered as one of her tasks. Comprehensive and in-depth coverage of issues related to paleozoology, bold

initiative and abundant experience in organizational matters scientist actually provided one of the best in the industry of Paleozoology in Soviet Ukraine.

The success of her endeavors and how much she has done throughout her academic life have been related to the fact that she did not work alone, but united around her and inspired a great team of paleozoologists. Mariia believed that an in-depth biological study of fossil remains of mammals not only contribute to a better understanding of ancient organisms and biological laws that are based on the development of the organic world, but also to satisfy the needs of geology.

The most productive period of life and activity of M. Pavlova began with the advent of Soviet power in 1917. Her versatile activity found its expression in the publication of paleozoological books and articles, paleozoological textbooks, manuals, reviews of location of fossil mammals, the work program, the final and theoretical content of training courses in Paleozoology and Paleontology for high school, sketches of life and work of prominent scientists, paleontologists and the history of science, popular articles, editing and translation of many publications (Deforz, 2019).

Highlights of the life and work of M. Pavlova are reflected in a number of biographical sketches, which list her scientific papers as well.

Paleozoological researches of M. V. Pavlova were originally dedicated to ammonites, and then ungulates and Tertiary periods. Later, after Crimea finding of hipparionov mammals, she devoted much time to the study of many other forms of tertiary mammals. As a result of these studies, we see that M. V. Pavlova was one of the prominent specialists of the world importance. Her research has laid a solid foundation of paleozoology vertebrates, centered in the paleontology department of Moscow University.

M. V. Pavlova attracted the attention of scientists who began to work in paleozoology vertebrates – from paleozoology mammals, reptiles, amphibians and fish. This had a significant impact on the formulation and execution of works of fossil mammals as well as in other scientific centers of the Soviet Union and Ukraine in particular. As a result of M. V. Pavlova and her staff's activity there were opened and described several faunas of four-Permian, Triassic and Tertiary periods.

Proceedings of M. V. Pavlova, dedicated to fossil mammals, are examples of depth study of fossils of animals of paleozoological research. In these writings she made a detailed morphological description of skeletal remains, applied functional analysis of the structural features of the animals, figured out the ecology of animals that have died, established their phylogenetic relationship, the progress of individual branches of hoofed mammals have suggested centers of formation and direction of migration in tertiary terrestrial faunas.

The remains of vertebrates described by M. V. Pavlova and her staff got to the Museum of Natural History at Moscow University and Paleontology Department of the Geological Museum in Geological Institute. Animal fossil museum of M. V. Pavlova always attached great importance. Some skeletons are collected and displayed in museums by her personal initiative and control. She is always involved

in the matters of searching fossils, excavations and study their location, organization preserving and processing the obtained materials. A lot of articles M. V. Pavlova are especially devoted to evolutionary Paleozoology.

M. V. Pavlova was always interested in the works of classical sciences such as geology, biology and paleontology (paleozoology). She studied it and felt it her duty to acquaint them with the wide range of readers. At the same time, reading classic works disclosed Mariya stages of science and pointed the way for further development. Foremost in historical and scientific legacy of the rank of V. Kovalevsky, A. Gaudry E. Cope, L. Rutimeyer etc. Mariya highly valued achievements of these scientists in front of science and did all that was in her power to continue the case. In her research she guided the ideas of V. Kovalevsky. The collected materials about her proboscidian subsequently played an important role in the dismemberment of Quaternary and Pliocene. She studied history of ungulates (horses, rhinos, tapirs, etc.). She developed exemplary method of paleozoological practical exercises. She is a honorary member of the Union Paleontological Society (since 1931). She received the Gold Medal of A. Gaudry Geological Society of France (1926).

M. V. Pavlova was a researcher enthusiast; she loved her science of paleozoology and actively participated in its development. Her works are written in clear, sometimes even artistic language. Many publications of M. V. Pavlova were recommended for the general readership of her time, but with the same interest they are read today and by future generations of paleozoologists, biologists, geologists, geographers.

M. V. Pavlova was always true to herself, to go where her mind asked. She always risked, she went to a new, unfamiliar sphere of activity. She sought to reveal herself in all the skills that have been released to her by nature; she has sought to serve the sphere of activity in which she believed.

Conclusions

The article contains theoretical generalization and new decision of scientific task that is manifested in discovering the phenomenon of scientific achievements of M. Pavlova. This problem is solved by using managed system approach, modern research methods, theoretical understanding of the processes of science, which demonstrated the urgent need for national science in such an individual as M. V. Pavlova, considering her life and activity in the context of socio-political and cultural life of the Russian Empire and Ukraine, as well as the global research and education process, especially in evolutionary biology and paleozoology as well. Detection of M. V. Pavlova contribution in the development of science and education allowed her to enter as original academic research in paleozoological corporation in the history of not only domestic but also world science. A systematic analysis of life and work of M. Pavlova enables a comprehensive approach to the study of current topics, previous researchers disclosed only partially.

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Академік Павлова Марія Василівна (1854–1938): життя та наукові праці

Анотація. Дана стаття присвячена висвітленню внеску академіка Марії Василівни Павлової (Гортинської) в розвиток палеозоологічної науки.

Наголошується, що свої дослідження вона здійснювала за кількома напрямками: вивчала причини вимирання тварин у минулих геологічних епохах, досліджувала викопні рештки слонів, носорогів, тапірів, непарнокопитних і парнокопитних, описала рештки ссавців Тираспільського гравію. М. В. Павлова описала гіппаріонів і коней, знайдених в основному в південних областях України та Криму. На цьому новому матеріалі вона довела, що коні походять від американського протогіппуса. Уявлення про єдиний стовбур розвитку кінцевих Старого і Нового Світу викликало заперечення, особливо в Америці, тому що у Європі були відсутні знахідки давніх форм кінцевого ряду – анхітерія і протогіппуса. М. В. Павлова вперто шукала їх у Євразії, і у 1903 р. виявила рештки кісток кінцівок цих давніх коней. Аналіз наукової спадщини академіка М. В. Павлової – видатного вітчизняного палеозоолога, фахівця в галузі еволюційної теорії, організатора палеозоологічної науки і педагога – робить можливим розуміння процесів розвитку вітчизняної біологічної науки. Вона посідає одне з почесних місць у світовій палеонтологічній науці. З її ім'ям пов'язаний розвиток палеозоологічної науки наприкінці XIX – першої третини XX століть і наукового світогляду стосовно розвитку різних палеозоологічних концепцій, законів та ідей. Це дозволяє стверджувати про актуальність і необхідність проведення даного дослідження. Його актуальність зумовлена також значним громадянським і науковим значенням постаті М. В. Павлової в палеозоологічній науці, відсутністю в історії науки спеціального комплексного дослідження її життя, наукової, організаційної та адміністративної діяльності, необхідністю створення максимально об'єктивної біографії М. В. Павлової, аналізу її творчого доробку, а також важливістю введення до наукового обігу масиву нових джерел і фактів. Досі було мало розкрито діяльність М. В. Павлової як наукового лідера та засновника наукової палеозоологічної школи, її внеску в палеозоологічну науку.

Ключові слова: палеонтологія; палеозоологія; викопні тварини; наука; освіта; М. В. Павлова

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Академик Павлова Мария Васильевна (1854-1938): жизнь и научные труды

Аннотация. Данная статья посвящена освещению вклада академика Марии Васильевны Павловой (Гортынской) в развитие палеозоологической науки. Отмечается, что свои исследования она осуществляла по нескольким направлениям: изучала причины вымирания животных в прошлых геологических эпохах, исследовала ископаемые останки слонов, носорогов, тапиров, непарнокопытных и парнокопытных, описала остатки

млекопитающих Тираспольского гравия. М. В. Павлова описала гиппариона и лошадей, найденных в основном в южных областях Украины и Крыму. На этом новом материале она доказала, что лошади произошли от американского протогиппуса. Представление о едином стволе развития лошадиных Старого и Нового Света вызвало возражения, особенно в Америке, потому что в Европе отсутствовали находки древних форм лошадиного ряда – анхитерия и протогиппуса. М. В. Павлова упорно искала их в Евразии, и в 1903 обнаружила останки костей конечностей этих древних лошадей. Анализ научного наследия академика М. В. Павловой – выдающегося отечественного палеозоолога, специалиста в области эволюционной теории, организатора палеозоологической науки и педагога – делает возможным понимание процессов развития отечественной биологической науки. Она занимает одно из почетных мест в мировой палеонтологической науке. С ее именем связано развитие палеозоологической науки в конце XIX – первой трети XX века и научного мировоззрения по развитию различных палеозоологических концепций, законов и идей. Это позволяет утверждать об актуальности и необходимости проведения данного исследования. Его актуальность обусловлена также значительным общественным и научным значением фигуры М. В. Павловой в палеозоологической науке, отсутствием в истории науки специального комплексного исследования её жизни, научной, организационной и административной деятельности, необходимостью создания максимально объективной биографии М. В. Павловой, анализа ее творчества, а также важности введения в научный оборот массива новых источников и фактов. До сих пор была мало раскрыта деятельность М. В. Павловой как научного лидера и основателя научной палеозоологической школы, ее вклада в палеозоологическую науку.

Ключевые слова: палеонтология; палеозоология; ископаемые животные; наука; образование; М. В. Павлова

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Russian women at the beginning of human genetics

Abstract. *This paper reviews the studies on human genetics, carried out by Russian women in the 1920s and 1930s. Its main objective is to determine the contribution of women scientists to the development of different fields of human genetics. Particular attention is given to reconstructing women geneticists' research work, reviewing the content of their publications, and analysing the theoretical and methodological approaches they employed to tackle different scientific problems. The biographies of the pioneers in Russian "anthropogenetics" (knowledge of human heredity), R. I. Serebrovskaya, G. V. Soboleva, and N. N. Malkova, were restored on the basis of archival sources. The first women geneticists received their higher education at the Higher Women's Courses, as, in the Russian Empire, it was prohibited for women to study at the universities. These women came into genetics from traditional biological sciences or medicine at the time when human genetics as a discipline began to emerge in Russia in the 1920s. The first works in the field of anthropogenetics, conducted by these women on their own, began to appear in 1923. By the mid – 1920s, women geneticists began to use genealogical and twin methods for studying human heredity extensively. The number of women's publications peaked in the late 1920s. Studies in the field of population genetics and medical genetics gained popularity and new biochemical and cytological methods of analysis were added to the repertoire of analytical techniques. In the 1930s, with the beginning of attacks on eugenics, studies in human genetics were rapidly wound down to be completely arrested by the 1940s. The results of the studies carried out by the Russian women anthropogeneticists in the 1920s – 1930s included demonstrating hereditary nature of premature graying (R. I. Serebrovskaya), hemorrhagic diathesis and inguinal hernia (N. N. Malkova), deaf-mutism and stutter (G. V. Soboleva); determining the incidence of different genes in the populations; organizing large-scale twin studies to elucidate the role of heredity and environment in the manifestation of psychological traits; and introducing new methods for hereditary*



disease diagnostics and the effective practices for teaching preschool and school age children.

Keywords: *women geneticists; formation of medical genetics; gender history; 1920-1930*

Introduction

A human genetics as the scientific discipline passed the complex way of its formation during XX century, and it occupies in the beginning of XXI century the leading positions among the most actively developed sciences by attracting to itself the attention of large sections of public.

The study of discrete heritable properties and diseases was put on the scientific base by the reopening of Mendel laws and the subsequent development of chromosome theory of heredity. The investigations of heritable basis of diseases, morphological, physiologic and psychological peculiar properties of human were actively used in medicine and education in the first half of XX century. 1920s years could be considered as the time of official appearance of human genetics in Russia. This direction of genetic investigations in our country has been formed practically simultaneously with the similar investigations in Europe and United States of America.

The initial stages of formation in the USSR of medical genetics (Babkov, 1998, 2001, 2006; Harper, 2018), neurogenetics (Korochkin, 2004) as well as the special features of Russian eugenic movement (Graham, 1977; Adams, 1990; Babkov, 2008; Fando, 2014; Kremmentsov, 2010, 2014, 2015, 2018; Rudling, 2014) were described in the historical and scientific literature. The investigations in the area of eugenics, medical genetics and anthropogenesis were led by the prominent scientists: S. G. Levit, S. N. Davidenkov, Yu. A. Filipchenko, N. K. Koltsov, A. S. Serebrovsky. The scientific and organizational activity of leaders of Russian genetics is well known to the broad sections of specialists. Sometimes the impression is given that the human' genetics was created exclusively by man's scientists, because there was no historical-and-scientific investigations devoted to the role of women in the formation of Russian anthropogenetics. Let us try to remove the disappointing injustice and analyze the works of the first woman geneticists in the area of studying the human heredity.

Research methods

The methodological basis of the study was the systemic, integrated, interdisciplinary and personality-psychological approaches. The complex use of the special historical methods: historical-genetic, problem-chronological, and biographical methods, made it possible to analyze the contribution of women scientists to the development of human genetics.

Results and discussion

A large volume of scientific works published in the periodical editions from 1917 to 1948, i.e. by a time of destroying the Soviet genetics, was used for analyzing the human genetics investigations fulfilled by the first Russian woman's scientists. The articles from all numbers and issues up to 1948 were under consideration for the following scientific journals and collected papers: "Bulletin of Moscow Society of Naturalists", "Russian Eugenic Journal", "Biological Journal", "Papers of the Academy of Sciences", "Medico-Biological Journal", "Success of Experimental Biology", "Bulletin of Moscow State University (MSU)", "Anthropological Journal", "Proceedings of the Academy of Sciences", "Proceedings of Eugenics Bureau", "Journal of experimental biology and medicine", "Proceedings of the Institute of experimental biology".

The sharp rise in developing the new interesting problems, methods and techniques of investigation was observed at the beginning of Russian anthropogenetics' development. Topics on the human's biological nature, the effect of heredity and medium on determining the psychological characteristics of people were actively discussed in this period of time in society. The eugenic views on the improvement of human race, the possible increasing of lifetime, the creation of superman were also becoming popular. It is not unlikely that the state of public opinion had an influence on the interest of scientists to study the human genetics. However the women were engaged in anthropogenetics a little later on and their first pioneering works had been appeared only in 1923–1925. The detailed analysis of publications interested for us has shown that the problems of human heterochromosome texture (Breslavets, 1923) and inheriting of different peculiar properties in families (Soboleva, 1924, Krasovskaya & Popov, 1925) were mainly interesting for woman geneticists at the beginning of 1920s. The twin pair (Soboleva, 1926) and genealogical (Strogaya, 1926) methods of studying human heredity became especially popular in the middle of 1920s. A comparison of a number of publications on humans genetics in the different years allowed to install that the peak of such publications for woman scientists took place in 1929, the spectrum of investigations that were carried out by them increased substantially as well as the new problems and methods of medical genetics (Krytova, 1929; Serebrovskaya, 1929b; Soboleva, 1929b; Teulina, 1929) and human genetic of population (Malkova, 1929; Serebrovskaya, 1929a) were actively developed. It turned out that the woman anthropogeneticists had no peculiarity to publish the eugenic ideas and programmatic articles on the problem of improving the human race in contrast to the known man geneticists (Bunak, 1922; Koltsov, 1922; Volotskoy, 1923; Lyublinsky, 1926; Lass, 1927; Serebrovsky, 1923, 1929). It can be connected with the psychological peculiarities of women: as a rule, they keep the permanency, try to create the family comfort, were sensible and not satisfied with the role, which the supporters of eugenic transformations of society assigned to them.

The considerable reduction of publications on the problems of inheriting the different human properties has been observed since 1930. Because of started criticism, the “Russian eugenic journal” has been already not published since 1930. The first attempts of state interference in genetics were made in that time, and the control was finally established by All-Union Conference on planning the genetics and selection carried out in Leningrad in 1932. It was decided at this conference that since that time the works on genetics would be carried out on the directions corresponding the official doctrine of dialectical materialism. Therefore if in the beginning of 30s you could find some publications of women anthropogeneticists, you will find only the single publications in the period from 1935 to 1945 (Soboleva, 1937). Articles on the problems of carcinogenetic including the works of R. P. Martynova appeared in the end of 1940s (Martynova, 1948a, 1948b).

The scientists-anthropogeneticists were criticized for the underestimation of new social conditions in the process of forming personalities. In the same time the thoughts on a possible selection work in human society were subject to the harsh criticism. Not many people could stand to such nerve-strain, especially when the politically-loaded and ideologized factors, which were alien to the science, had interfered in the scientific disputes. The most woman geneticists turned switch for working with the new objects of investigations and tried not to advertise their early works in human’s genetics. As a result these works have been forgotten for long time. It was perhaps the reason of absence of any historical-and-scientific investigations of anthtropogenetic works of Russian woman scientists. Let us correct this unfortunate mistake and try to tell about the first woman anthropogeneticists and women works in field of human heredity.

Raisa Issakovna Serebrovskaya (1888–1981) took a great interest to anthtropogenetics owing to her husband A.S. Serebrovsky, the prominent Russian geneticist, who has begun to read his lectures on human genetics on Anikovskaya station already in 1922. Raisa Isaakovna was born in Simbirsk in the family of Jewish doctor. It was accepted to believe that the maiden name of Raisa Isaakovna was Galperina. The historical inaccuracy was corrected after regeneration of archive documents. Raisa Isaakovna had a family name Galperin (TsGAM. F. 363. Ser. 4. File 6639. P. 1). After entering the Faculty of Physics and Mathematics of Petersburg Higher Woman’s Courses (Bestuzhev’s Courses) in 1905, since the first days she took a great interest in studying the nature. Having left the courses in 1910 she received the specialty of zoologist. In 1905–1907 Raisa Isaakovna took part in the revolutionary movement. In September 1911 Raisa Isaakovna submitted the application for her enrolment on the medical faculty of Moscow Higher Woman’s Courses however she was refused. We found in the Central State Archive of the City of Moscow this refusal. It was explained by the fact she had by that time the higher natural-scientific education, while the graduates of gymnasium were, first of all, admitted at the Courses (TsGAM. F. 363. S. 4. F. 6639. P. 3). In our opinion, the

reason of this refusal could be quite different. Really there was a spot of Raisa Isaakovna reputation connected with her participation in the revolutionary movement.

However the thirst for science took upon itself and Rasa Isaakovna went to the A. L. Shaniavsky Moscow City People's University, where she was acquainted with A. S. Serebrovsky. After interesting work in Shaniavsky University and at the Biological Station in Sevastopol, R. I. Serebrovskaya continued scientific studies at Tuskaya Entomological Station, where she worked from 1915 to 1918. In 1918–1920 she was a coworker of Poultry station (in Tuskaya guberniya), while in 1920–1923 – of Central Genetic Station in Annikovo. Raisa Isaakovna was occupied since 1928 with the problems of human's heredity as a scientific researcher of Medical and biological Institute (AMGU. F. O/K. S. 2. F. 8188. p. 1–9).

A. S. Serebrovsky, who had stood near the sources of Russian genetics, managed to load his wife by the problems of mathematical analysis of population. By regret, the methods of genetic analysis, especially if it applied to the human, were not quite well developed. The formulae for calculating the frequencies of different genes concerned only the cases, when the hereditary properties became apparent in full. However many properties become apparent not obligatory with the existence of corresponding gene. A per cent of appearance could be different for the different properties and it is possible to calculate some value K named as a coefficient of manifestation. R. I. Serebrovskaya described the different variants of accounting the properties' appearance by using the coefficient of manifestation based on the determination of phenotypes' frequency and genotypes' ratio in the posterity of different marriages (Serebrovskaya, 1929a).

The fulfillment of detailed analysis on some or other inheriting property demanded the processing of sufficient amount of materials. Therefore the Medical and biological institute organized the required research expeditions in the different regions of the country. During the study of early graying inheriting R. I. Serebrovskaya had analyzed the family trees of a few families of Northern Caucasus, where this property became apparent over some generations.

As it is well known the hair graying begins after the age of 30, and it begins much earlier only for a small amount of people. At that the process occurs quicker than usually. As a result of investigation 12-years old girl was met in one Kabardian village. Her half of the head was completely grey, while the graying for all family trees described by R.I. Serebrovskaya was begun in the period from 14 to 23-years. She found the direct correlation between the existence of goiter and the early graying (Serebrovskaya, 1929b). The wide spreading of early graying was remarked in summer 1929 during the inspection of Kabardinian and Balkarian villages at Northern Caucasus. At that the Balkarians were proud by existence of this property as a symbol of noble origin. The observation of Serebrovskaya showed that the wide spreading of crop was typical for the mountain villages, for example, 22% of men and 100% of women in Higher Chegem had the hypertrophy of thyroid gland.

In 1931 Raisa Isaakovna ceased to engage in human genetics and had left the Medical and biological institute because of started criticism of this science. Her husband had suffered seriously because of these accusations. His article “Anthropogenetics and eugenics in socialistic society” (Serebrovsky, 1929) was published in 1929. He stated in this article that the mutation process stipulated the change of mankind’s gene fund; at that the influence of harmful mutations is increased in time. As a result the degeneration will threaten to the mankind in future, while the prevention of that is possible by undertaking the effective measures. At that it is necessary to revise the usual social conditionality’s in society, for example, the love relations in marriage should be separated from the child-bearing, while the bank of spermatozoa from the talented persons free from the inherited deceases should be created for improving the human race and for carrying out the large-scale artificial insemination.

The scientist was subject to the public persecution for this article even after many years. The eugenic views have being brought as a fault to Serebrovsky from 1930s to the death (1948). Raisa Isaakovna Serebrovskaya switched over to the new matter of investigation after transferring in 1931 to the MSU chair of genetics and selection. It was the fruit-fly *Drosophila*. Serebrovskaya devoted herself to the problems of mutation variability and development of the methods for calculating the quantitative properties.

The inheritance of different human properties was studied by N. N. Malkova worked with R.I. Serebrovskaya in Genetic Department of Medical and biological Institute. Nina Nickolaevna Malkova was born in the family of military man in 1896. She received the education in Tashkent female gymnasium. In autumn 1913 she entered at the evening courses attached to the same gymnasium for taking the exam on gymnasium-leaving certificate. After the successful exam, N. N. Malkova being the daughter of light colonel went on the front-line forces as a nurse. In 1915 her desire to continue education resulted in her joining to Moscow Higher Woman Courses, which were transformed in the Second MSU in the time of her leaving them (TsGaM. F. 363. S. 4. F. 16026. P. 10). After receiving the higher medical education N. N. Malkova devoted herself to the scientific-research work – the genetics of some medical deceases.

N. N. Malkova paid a special attention to the stationary study of human’s population – to the method, which has been yet not used by somebody (Malkova, 1929, 1930). The essence of this method consisted of studying the close population of people such as the countryside. She undertook the measures on organizing the anthropogenic station in countryside. By means of inspection of some districts of Moscow guberniya she chose the Petrovskaya volost of Zvenigorod uyezd. This district corresponded to all necessary requirements. The volost consisted of 30 villages and had 100000 people of population, which were mainly engaged in agriculture and handicraft.

N. N. Malkova began to work on the 15th January 1929. First of all she was recovering the family trees of peasants carrying out in parallel the overall medical inspection of villages' population. The dactyloscopy and blood test of each peasant was carried out as well as all properties accessibly for study were noted: the color of hairs and eyes, the type of teeth growth, the times of graying and growing bald beginning. The family cases of inherited deceases were described and the type of some properties of inheritance was determined as a result of fulfilled titanic work.

The doctors of Petrovskaya hospital rendered the large assistance to this work. Nevertheless, some difficulties have been met in carrying out the genetic analysis of population. The rumors about "the end of the world", "the Antichrist seal" (dactyloscopy), "the trade of Christian blood" were spread etc. The support of investigations by the local Party and public organization had saved the situation.

It was noted the large spreading of hernia during the carrying out the stationary investigations; the occurrence of hernias among the different families was compared separately. The spreading of different typed of hernias (omphalocele, groin, crural, epigastric ones) was different for men and women. In this connection the analysis of inheriting the disease was carried out for the different sexes.

The groin hernia is most spread among the men (94.1% from all cases): the positive correlation of this disease was observed in the families. The amount of omphaloceles among the men and women was practically the same. N. N. Malkova installed that the age was rendering the influence on omphalocele occurrence. At that this influence is different for the men and women: if the per cent of omphalocele carriers is decreases in age for males, it is increased for females up to 40-years and is then decreased modestly. I.e. the omphalocele is appearing more often for men in the childhood, while for women – in the higher age. The correlation on this type of hernia was absent for families.

The N. N. Malkova's work on the stationary study of people population allowed implementing actively the new methods of investigation for solving the nodal problem of medicine – the determination of diseases etiology.

In the process of studying the hemorrhagic diathesis N. N. Malkova and S. G. Levit ran across the new disease, which has not been described before. The thoroughgoing study of this disease's genealogy allowed to state that this case is connected with the appeared mutation (Levit & Malkova, 1929). The mutant gene was dominant, while the disease excited by it was called heterohaemophiliya. The ailment startled men and women to the same extent and was begun in the early childhood (mainly for the babies). The ill people suffer from the strong bleeding at the nose and gingivae, which can appear spontaneously or after the least trauma. For some persons the bleeding became stronger by 8-12 years, for the other ones the bleeding is decreased by this age. The strong bleeding uninterrupted for a long time is observed for all ill people in the case of cuts. The work of describing the heterohaemophiliya gene included the genogeographical aspects installing the region of mutation origin and the processes reconstructing its spreading.

There is no one publication in historical Russian genetics about the input of Galina Vasilievna Soboleva in the human genetics development. Nevertheless, her pioneer investigations laid the base for understanding the nature of different morphophysiological human properties.

Galina Vasilievna was born in 1896 in Kharkov in the family of doctor Vasily Grigorievich Sobolev. In 1913 she graduated from the Nickolaevskaya gymnasium, while in 1914 she entered the Physical and mathematical faculty of Natural-scientific department of Moscow Higher Woman Courses. After receiving the higher education G. V. Soboleva was occupied for a long time with the problems of anthrop genetics introducing the new approaches and methods of investigation (TsGAM. F. 363. S. 4. F. 23536. pp. 12–16).

The twin method suggested by F. Galton in 1876 remains one of the most popular methods of human genetics since the moment of this science origin and up to the present time. In spite of sufficient spreading of this method, there was yet not sufficient amount of methods for the genetic analysis of twins in 1920s.

The investigations of twins in city Moscow were planned by the Eugenic Department of Experimental Biology Institute. The program of investigations was developed by Prof. V. V. Bunak; the carrying out of corresponding inspection of twins was assigned to G. V. Soboleva. The undertaken work was consisted of two stages:

1. Composition of family trees of twins under investigation.
2. Investigation of twins themselves for determining the role of inheriting and medium in formation of some property or other.

The family tree for twins was constituted in detail, in the same time the data for each member of family concerning the most important diseases and professions were written. The investigations of twins themselves included the morphological, physiological and psychological parts. The pigmentation (the color of eyes, hairs and skin), the special features of hairs, the form of lips and ears, the height, weight, width of shoulders, the circle of chest, the volume of muscles and adipopexis were taken into account in the morphological study. The circumference of head, its longitudinal diameter the width of face, a length and width of nose were taken into account as the morphological characteristics of head. The form and sizes of teeth, the bite and a form of upper palate, the dactyloscopic properties were also described. The physiological analysis included the general characteristics of twins state of health from their birthday and the reaction of isohaemoagglutination. The psychological part of inspection had to answer the question on the similarity and differences in the twin spirits. The total inspection was carried out by G. V. Soboleva during the visiting of twins families. The necessary addresses were mainly obtained from the pedagogical collectives of Moscow schools. The inspection has been fulfilled in 1923–1924. From 105 twin couples 40 couples were one-oviparous (38%) and 65 couples – were fraternal twins (62%). The usual percent of twin birth constitutes 1.1% from all births. In the same time it was widely believed that the probability of twin birth was

increased with the growth of mother age. However the results of investigations carried out by G. V. Soboleva rejected the existed mistake that the most number of twins were born from the women in the age of 35–39 years. G.V. Soboleva installed that the maximum percent of twin's birth accounted for the mothers in the age 25–30 years, i.e. in the most reproductive period (Soboleva, 1926).

The investigations of G. V. Soboleva deflated also the mistaken viewpoints that the twins were overburdened, as a rule, by the different mental disorders. Only during the first year of life they remained behind the normal children. The most retarded twins were the fraternal digeneous twins, which gave as well the highest percent of twins growing in the different way: one – normally and the second one – with the more or less delay.

An estimate of the state of health of the children under inspection showed that the one-oviparous twins had the satisfactory health, while the fraternal twins had a reduction of the state of health; in the same time the fraternal one-sex twins exceeded in this case the one-oviparous twins.

Another aspect of anthropogenetic investigations of G. V. Soboleva was the analysis of different inheriting diseases (Soboleva, 1929a, 1929b, 1931). She had proved that the stuttering is a disease passing from the generation to generation. The inspection was mainly carried out on the ill stutterers from Nervomental dispensary attached to the Institute of social sanitation and Psychiatric patronage no.2 in Moscow. 136 family trees of 136 probationers suffering from stuttering were constituted as a result of fulfilled work. The stuttering for the majority of people under inspection appeared in the age of 5–7 years. A number of stutterers among the men were almost in six times more than for the women (116 men and 20 women).

For installing the endogenous reason of stuttering, G. V. Soboleva used the methods of genetic analysis by comparing the percent of stuttering spreading among the total population (1%) with its spreading among the relatives of persons under investigation (6.7%) and among their own brothers and sisters (15.2%). In addition it was possible to trace the character of stutter inheriting – it transferred on the principle of recession. G. V. Soboleva noted that the abundance of mental diseases was observed among the stutterers. She explained it by the possible polymorphous nature of stuttering gene.

One of the G. V. Soboleva merits consisted of the study of different forms of deafness and dumbness, which were not limited by the exclusively inborn cases of disease. She has applied to the Moscow club of deaf people and in the schools for deaf and dumb children, where she received the addresses of families with the corresponding deviations. The translator of sounding speech by means of the fingers language for the deaf people attracted specially for it has helped to G. V. Soboleva in collecting materials and carrying out the necessary survey. The clinical analysis of deaf probationers together with the members of their families was carried out simultaneously with obtaining the genetic data. The goal of clinic investigations was

the installation of objective reasons of appearing the deaf and dumb cases for some man or other.

The fulfilled investigations allowed approving that the gene of congenital deafness was recessive, because the children from a marriage of deaf people had inherited this property in full (Soboleva, 1931). A large amount of families, in which the hereditary deaf children were born from the healthy parents, pointed out as well on the recessive nature of this disease. The polyhybrid theories of deafness inheritance were also not confirmed in the result of genetic analysis.

The acquired forms of deafness and dumbness were divided by G. V. Soboleva into groups: a) the accidental traumatic forms; b) the cases conditioned by inherited predisposition, for which there are the combined action of outside and inside reasons. G. V. Soboleva called to the more detailed study of reasons of appearing the deafness in each individual case that is important for the family planning and the organization of efficient treatment of acquired forms of disease.

In addition to the development of different techniques of twin analysis and the study of inheriting diseases, Soboleva G. V. was busy herself with the genetics of different morphological and physiological features of human. One of her works was devoted to the color heritability of iris of the eye (Bunak and Soboleva, 1925).

There were for a long time the contradictory opinions on the problem of iris of the eyes. The investigators of different countries denoted by the identical names the quite not identical colors. For example, something that was considered as light-brown or grey for Italian anthropologists became dark-brown for Swedish anthropologists. The different authors had also the different number of tints – from 4 to 13. For clarifying this question and finding the criteria for division of separate tints, V. V. Bunak, who was the scientific supervisor of G. V. Soboleva, carried out the special investigation: he described the possible tints, which are adopted by the same eye in the different conditions of illumination and in the different distance. The work on the clarification of different groups of tints in the result of carrying out the statistical analysis of humans' population was entrusted to G. V. Soboleva. During spring and autumn of 1921 she had investigated the elements of iris colors approximately for one thousand children from the different Moscow schools. The predominant color of eyes was determined for the children under investigation in the conditions of good lighting first in the far (about 1 m) and then at a short distance. G. V. Soboleva allocated the following main iris colors: black, brown, yellow, green, grey, light blue and dark blue. The dark kind without a picture and the light kind with a picture were allocated among the brown eyes. The allocation of tints on lightness in the iris of other colors is excessive, because the dark-green eyes correspond to the yellow-green ones, the light green – to grey-green, dark-blue – to grey- light blue, dark grey – to grey-blue. This extrinsic element seemed to be very typical for all similar eyes; these types of eyes were related to the transitional just due to this element. The given work attracted the large statistical material and allowed to criticize severely many before adopted typologies of eyes coloration.

Elaborations and methods, obtained by anthropogeneticists required the active implementation in the practice of diagnostic, medical, correctional and educational institutions. Many advanced doctors and teachers became not only to use the achievement of science on inheriting properties of human, but also took part in the development-experimental work on the collection of statistical material, carrying out the survey, composition of family trees. So, for example, the Medical and biological Institute leaded by S. G. Levit worked in the close collaboration with the different organizations (Babkov, 2001). In 1933 the institute organized the Department of Psychology. The kindergarten was working in institute and the twins were especially attracted there. The twins-teenagers were patronized for taking out the education and choosing the profession. So, in accordance with S. G. Levit's desire the five couples of twins learned in the conservatoire for the detailed study of talent for music and the clarification of effective methods of training.

By regret, the events turned around the Russian genetics in 1930–1940s didn't avoid the practically oriented investigations of the first woman geneticists. The open persecution of the research workers of Medical and Genetic Institute (the former Medical and Biological Institute) was begun in 1936, and it was finished by closing the institute in summer of 1937. In 1938 the director of institute S. G. Levit was arrested and shot afterwards. The secret prohibition was laid on the medical and pedagogical genetics still in 1930s, and it was legalized in August 1948 after the ruefully known session of VASKhNIL. Many geneticists had lost the work and were forced to change the profession. It was equally hard both for the man and woman geneticists. It happened to get a job as school-teachers, educator in boarding school, translators, and librarians or simply to stay without means of subsistence.

Conclusions

The fates of many women anthropogeneticists were similar in some way. They had the excellent gymnasium education, and then they graduated the higher women courses and could firmly survive the troubles of WWI, Civil War and WWII, devastation of revolution and rout or defeat of genetics. By regret it was impossible to follow the further trajectories of vital fates of N. N. Malkova, G. V. Soboleva. There is a hope that it will be possible with time to reestablish the gaps in the history of Russian human's genetics connected with activity of the first woman's scientists.

Nevertheless, the fulfilled study of woman genetics publications allow to state that they were mainly occupied with the problems of medical pedagogical genetics, i.e. the directions, which are closely connected with the cognitive and practical woman interests. Nobody from mentioned woman scientists promoted the ideas about the radical eugenic methods, which were necessary for perfecting the human race and reducing the birth of inheriting pathologies. The theoretical substantiation of importance of carrying out the social hygiene and the specific methods for its realization could be met only in the works of prominent man geneticists.

It is natural that in the period of “soviet feminism”, when the women began to play the active public and political role, to work in the spheres and branches traditionally considered as “man’s”, the vulgar ideas of eugenic undertakings aroused the avalanche of protests and critics primarily from the representatives of “already far not fair sex”. The woman workers of factories and simple woman kolkhozniks wrote in the Party bodies and printing publications protesting against the undertakings on the conversion of genetic properties of mankind. It is possible that the company of fighting with genetics was prepared and realized by means of other forces. Nevertheless, the crying public voice heated up the negative relation to the entire anthropogenetics and to the genetics on the whole.

The begun persecutions on genetics have been continued still up to 60s of XX century. But even after the official rehabilitation of human genetics there was a fear of biologizing tendencies in soft science: the works on genetics of behavior and psychics, inheriting of intellectual ability were recognized as doubtful. The idea on the social human nature predominated in the tradition of Soviet psychology and pedagogy, while the psychoanalysis and behaviorism were subject to the serious criticism.

Nevertheless, the phenomena and mechanisms of inheritance as well as the genetic methods opened in 1920–1930s have been actively used until now. It is not strange that the reconstruction of history of Russian anthropogenetics and the description of woman scientist’s activity in investigating the inherited human properties become relevant in the present time, when the discoveries in the field of human genetics have practically revolutionary character. It is not illegal to forget about woman geneticists, who managed to realize themselves in servicing to the precious ideals of human inheritance science. Don’t forget that the women scientists managed to achieve the unprecedented success in the area of medicine and pedagogical genetics as well as to implement the obtained results in the practical activity of educational and medico-diagnostic institutions for the comparatively short period of Russian anthropogenetics formation.

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Російської академії наук

Російські жінки біля витоків генетики людини

Анотація. У статті розглянуті дослідження російських жінок в області генетики людини в 1920-1930 рр. Основним завданням статті стало визначення внеску жінок-вчених у розвиток різних напрямків генетики людини. Велику увагу в роботі приділено реконструкції науково-дослідної діяльності жінок-генетиків, змісту їх публікацій, аналізу запропонованих ними теоретичних і методологічних підходів при вирішенні різних наукових проблем. На основі архівних джерел відновлені біографії піонерів російської антропогенетики: Р. І. Серебровської, Г. В. Соболевої, Н. М. Малкової. Перші жінки-генетики отримали вищу освіту на Вищих жіночих курсах, так як в Російській Імперії існувала заборона на навчання жінок в університетах, в область генетики вони прийшли з традиційних біологічних наук або медицини. Цей прихід збігся з початком формування генетики людини в Росії в 1920-і рр. Перші самостійні роботи жінок з антропогенетики стали з'являтися вже в 1923 р. до середини 1920-х рр. жінки-генетики стали активно використовувати в своїй роботі близнюковий і генеалогічний методи аналізу спадковості людини. Наприкінці 1920-х рр. спостерігався пік публікацій жінок в області генетики людини, популярними стали популяційно-генетичні та медико-генетичні дослідження, в арсенал були включені нові біохімічні та цитологічні методи аналізу. У 1930-і рр. у зв'язку з початком гонінь на євгеніку дослідження з генетики людини були різко згорнуті, а до кінця 1940-х рр. повністю припинені. Результатами досліджень російських жінок-антропогенетиків 1920–1930-х рр. став доказ успадкування раннього посивіння (Р. І. Серебровська), геморагічного діатезу і пахової грижі (Н. М. Малкова), глухонімоти, заїкання (Г. В. Соболева), виявлення частоти зустрічальності різних генів в популяціях, організація масштабних близнюкових досліджень для з'ясування ролі спадковості і середовища в прояві психічних ознак, впровадження нових методів діагностики спадкових захворювань і ефективних прийомів навчання дітей дошкільного та шкільного віку.

Ключові слова: жінки-генетики; формування медичної генетики; гендерна історія; 1920-1930

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Российские женщины у истоков генетики человека

Аннотация. В статье рассмотрены исследования российских женщин в области генетики человека в 1920–1930 гг. Основной задачей статьи стало определение вклада женщин-ученых в развитие различных направлений генетики человека. Большое внимание в работе уделено реконструкции научно-исследовательской деятельности женщин-генетиков, содержанию их публикаций, анализу предложенных ими теоретических и методологических подходов при решении различных научных проблем. На основе архивных источников восстановлены биографии пионеров российской антропогенетики: Р. И. Серебровской, Г. В. Соболевой, Н. Н. Малковой. Первые женщины-генетики получили высшее образование на Высших женских курсах, так как в Российской Империи существовал запрет на обучение женщин в университетах, в область генетики они пришли из традиционных биологических наук или медицины. Этот приход совпал с началом формирования генетики человека в России в 1920-е гг. Первые самостоятельные работы женщин по антропогенетике стали появляться уже в 1923 г. К середине 1920-х гг. женщины-генетики стали активно использовать в своей работе близнецовый и генеалогический методы анализа наследственности человека. В конце 1920-х гг. наблюдался пик публикаций женщин в области генетики человека, популярными стали популяционно-генетические и медико-генетические исследования, в арсенал были включены новые биохимические и цитологические методы анализа. В 1930-е гг. в связи с началом гонений на евгенику исследования по генетике человека были резко свернуты, а к концу 1940-х гг. полностью прекращены. Результатами исследований российских женщин-антропогенетиков 1920-1930-х гг. стало доказательство наследования раннего поселения (Р. И. Серебровская), геморрагического диатеза и паховой грыжи (Н. Н. Малкова), глухоноты, заикания (Г. В. Соболева), выявление частоты встречаемости различных генов в популяциях, организация масштабных близнецовых исследований для выяснения роли наследственности и среды в проявлении психических признаков, внедрение новых методов диагностики наследственных заболеваний и эффективных приемов обучения детей дошкольного и школьного возраста.

Ключевые слова: женщины-генетики; формирование медицинской генетики; гендерная история; 1920-1930

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Contribution of Yu. A. Kulakovskiy to the development of antique archeology in the Nestor Chronicler Historical Society

Abstract. *In the history of Ukrainian archeology there are many names of outstanding researchers who have devoted their lives to the study of our antiquity. Among them – Yulian Kulakovskiy, a well-known domestic historian and archeologist. For many years of his life he devoted to the scientific and pedagogical activity at the Kyiv University of St. Vladimir, where he had worked at the Faculty of History and Philology. After moving to Kyiv, Yu. A. Kulakovskiy began interesting in the late Ancient Christian archeology of the Crimea. In 1883 Yu. A. Kulakovskiy had joined the Nestor Chronicler Historical Society. Since that time, his life and career have been closely linked to this scientific union. For many years he represented the Nestor Chronicler Society at the All-Russian Archaeological Congresses. In 1905, for his extraordinary merits, Yu. A. Kulakovskiy was admitted to the Honorary Members of the Society, and from 1907 to 1911 performed the duties of its President. Kulakovskiy's presidency was one of the most productive periods of the Society's activity, meetings and public lectures were held during which scientific reports were read. The fascination of Yu. A. Kulakovskiy with archeology began after his move to Kyiv. For many years he was an active participant in archaeological research in the outskirts of Kerch, near Mithridat mountain. The results of these studies have been dedicated to a series of reports published on the pages of “Readings in the Nestor Chronicler Historical Society”. It is possible to consider that he initiated the direction of research in the field of Late Antique archeology of the Crimea in the Society. For the first time in the history of Bosporan archeology, the researcher not only conducted excavations of the most valuable early Christian funeral sites, but he also explored much of the necropolis, discovered unique burial sites, some of them are known for their wall paintings. Thanks to the efforts of the scientist it was possible to solve important questions of the borders of the ancient necropolis, chronology and cultural identity of the ancient population of Crimea. The researches of Yu. A. Kulakovskiy made it possible to begin systematic excavations of the ancient Panticapeus, which allowed to preserve the unique*



archaeological materials, which later became the subject of careful study of modern scientists.

Keywords: Yu. A. Kulakovskiy; Nestor Chronicler Historical Society; history of archeology; Crimea

Introduction

The richest legacy of our historical science is the works of domestic historian scientist Yulian Andriiovych Kulakovskiy. The scope of his passions was extremely multifaceted. Yulian Kulakovskiy was a historian, archeologist, philologist and Byzantologist. Many years of his life he devoted to Kyiv University of St. Vladimir, and intense activity as a member of the Nestor Chronicler Historical Society (NCHS) which operated at the University. The purpose of our work is to illuminate the figure of Yu. Kulakovskiy as an archeologist and the founder of research in the field of antiquity archeology in NCHS, because, in our opinion, this area of his activity is the poor studied and described.

Research methods

During the preparation of the article, chronological, comparative methods of historical knowledge, classification, and systematization of historical sources and bibliographic material have been used (Pylypchuk & Strelko, 2019, p. 20).

Results and discussions

Famous scientist, historian and archaeologist yulian Kulakovskiy was born in 1855 in Kovenska province in the territory of Lithuania in the family of an Orthodox priest. He gets his primary education in the Vilnius gymnasium, from 1871 he studied at the Lyceum of Tsarevich Nikolai at Moscow University, which he graduated in 1873.

His passionate about history began quite early, during his school years, and was associated with the name of a talented history teacher of Vilnius Gymnasium – V. G. Vasilyevsky, in the future – a famous Byzantinist scientist. B. Kulakovskiy's contemporary B. Warneke wrote: *“Enrolling in the Vilnius Gymnasium, Kulakovskiy was highly fortunate to find among the teachers the famous byzantinist V. G. Vasilyevsky. If we take into consideration the special power of impressions at a young age, the influence of the appealing personality of the famous historian who produced a charming impression on everyone in contact with him even in the last years of his life...”* (Varneke, 1907, p. 15).

From Vilnius gymnasium, Yulian as a talented student was awarded a scholarship, and in 1871, after graduating from sixth grade, he was transferred to a scholarship of the newly founded Imperial Lyceum Tsarevich Nicholas, an exemplary institution at that time in Moscow. Among its mentors was the first place took P. M. Leont'ev, who had broadened and deepened scientific training started by V. G. Vasilyevsky.

After graduating from the lyceum with a gold medal in 1873, Y. Kulakovskiy had studied at the university department of the same institution, this later helped him

to continue his studies at Moscow University, where he also taught P. M. Leont'ev. In September 1876, for the outstanding achievements Yu. A. Kulakovskiy was approved with the rank of candidate of Classical Philology Department. Yulian Kulakovskiy has begun teaching Latin.

In December 1877, Kulakovskiy was granted a business trip to Germany, where since January 1878 until the autumn of 1880 he had been working at the largest European centres of historical and philological science. In Germany, Kulakovskiy attended lectures and scientific seminars of the famous German historian T. Mommsen that struck the young scientist. Yulian Kulakovskiy considered him as his teacher called T. Mommsen "world-famous", "the great and powerful king of science" (Kulakovskiy, 1904).

From 1881 Yu. Kulakovskiy began working at the Faculty of History and Philology at the Kyiv University of St. Vladimir. Yu. Kulakovskiy's teaching activity began at the Department of Roman Literature at the University and lasted 38 years. In the first decade of his activity, Yulian Kulakovskiy outlined the range of scientific research that began the Kyiv period of his life. The young scientist, of course, had attracted by the idea of continuing to pursue classical philology and history. He was paying attention to the latest discoveries in the ancient history of Rome and Greece, was working on the problems of Roman history. In November 1881, Yu. Kulakovskiy obtains the position of a private associate professor at the mentioned department.

Along with his teaching, Yu. Kulakovskiy continued to work on scientific problems. In January 1883, at Moscow University, he defended his dissertation "Collegia in ancient Rome" and got a master's degree in Roman literature. He continued to work at St. Volodymyr University, and at the same time began teaching at higher women's courses. For higher women's courses, Yu. Kulakovskiy composed a course of lectures on Roman literature, where had seen classical literature (Greece and Rome) and determines its importance in the development of Western European culture.

In 1884 Yu. Kulakovskiy was tasked to teach the history of Rome and during 1885–1886 he had compiled a course of lectures, which in 1886 was published in lithographic print. An important stage in the creative life of Yu. Kulakovskiy was the defence of his doctoral thesis at St. Petersburg University in 1888 and he obtained a doctoral degree in Roman Literature. At that time, he was known as a prominent researcher of classical history.

The main work of the last years of life is the three-volume "History of Byzantium" – for the first time composed by Yu. Kulakovskiy a meticulous chronicle of the central events of the Eastern Roman Empire. The last years of his life, the scientist spent in Kyiv, died in 1919 (Matvieieva, 1998).

Scientific achievements Kulakovskiy consists of a large number of works devoted to the ancient history of the peoples who inhabited the south of Ukraine and the Crimea. One of the first attempts at a universal historical interpretation of the final stage of Bosphorus history in the 3–4 centuries belongs to him. The advantage of Kulakovskiy's research was that he turned not only to written but also to

archaeological sources. In general, archaeological studies were a significant part of the scientific activity of the scientist.

Fascination with archeology began after Kulakovskiy moved to Kyiv, the historian had started interesting poorly studied aspects of archeology and epigraphy of the Northern Black Sea. Investigations were carried out on behalf of the Imperial Archaeological Commission, to which Yu. A. Kulakovskiy sent a letter, where he expressed a desire to take part in the study of the south of the country. At that time, the young researcher was already well known among epigraphists for his publications in Russian national and European journals devoted to classical philology (Nepomniashchyi, 2016, p. 126).

Stressing the importance of archeological methods in the investigation of the south of Ukraine and the Crimea Yu. Kulakovskiy wrote: *“The light of history illuminated this land for a millennium before its rays dawned for the most ancient centres of our statehood. The connection of Crimea with the ancient world and the great Hellenic culture is a special charm of the history of this land and its consequence is the finding in its soil of inexhaustible archaeological wealth, the development of which is an important task of Russian science”* (Kulakovskiy, 1906, p. 2).

For many years Yu. A. Kulakovskiy was an active participant in the All-Russian Archeological Congresses. He first attended the Seventh Congress, held in 1887 in Yaroslavl. He was a delegate from St. Vladimir University. At the Eighth Congress in Moscow in 1890, Yu. A. Kulakovskiy stated a report entitled: “Elements in the legend about roman kings in relation to material artefacts”. On the next, ninth congress in Vilno, he was delegated to a preliminary committee as the member of Nestor Chronicler Historical Society and took a part in organizing work. Kulakovskiy was chosen as secretary of section VII: Antiquity classical and Byzantine. Besides, he made a report: “Kerch catacombs with frescoes” in which he gave a definition term of “catacombs”. In his report, Kulakovskiy also had paid attention to a problem of barbaric looting ancient Greek city Olvia, situated on the right bank of Buzky’s estuary near v. Parutino. He had offered appeal to the owners of this lands they'd let access scientists to excavation (Kulakovskiy, 1897). At the tenth congress in Riga Yu. A. Kulakovskiy except organizational work presented the report: “Excavation of Crimean tumulus in summer 1896” (Kulakovskiy, 1899).

Important contribution Yu. A. Kulakovskiy had made in the organization of eleven Archeological Congress which took place in Kyiv in 1899. He became a part of the preliminary committee since he had a big experience in organizational issues. One of the fields of work was the organization of the archeological exhibition, so Kulakovskiy was requested to pick up artefacts for Classical Antiquities division (Katalog vy`stavki XI arkheologicheskogo s`ezda, 1899). At sessions during the Congress meetings Kulakovskiy had represented two reports: “About painted skeletons” and “To the history of the Bosphorus in XI–XII cent.”

In the second half of the nineteenth century began to develop a new direction in historical science – Byzantine. Initially, this course was taught within the history of

antiquity, but the subject of Byzantine studies was expanding, gradually becoming separate in its own direction (Hrytsiuta, 2018). The XII Archaeological Congress, which took place in August 1902, became a significant event for the Byzantine historians. It brought together the most reputable experts in this field. In total, more than a dozen reports were submitted. Kulakovskiy made a presentation "Byzantine Camp of the X Century", the scientist submitted the results of the study of the newfound Byzantine source "De castrametatione" ("On the structure of the camp") (Kulakovskiy, 1905). Besides he actively participated in discussions. After the report of V. G. Savva, there revived the debate about the pagan nature of imperial power in Byzantium, attended by M. A. Ostroumov, and M. I. Troitsky. This was the question about the borrowing of certain traditions by the Byzantine emperors from the Roman ones, who had a direct connection with paganism. Yu. A. Kulakovskiy considered that Byzantines emperor was a continuer of tradition Romans emperors which were identified with the idea of God and the influence of Christianity couldn't blur this pagan tradition (Protokoly` zasedaniy XII Arkheologicheskogo s`ezda, 1905).

After moving to Kyiv Yu. A. Kulakovskiy was plunging into scientific live in the local university community. In 1883 he joined to the Nestor Chronicler Historical Society (NCHS). Since that his life and career had been closely linked with this scientific association. During his acting as a member of NCHS Kulakovskiy had performed on sessions results of his researches in the field of history of Byzantium and antiquity archeology. For extraordinary merits Yu. A. Kulakovskiy was promoted to honorary members in 1905.

Scientific activity researcher joined with organizational work. Every year, before the general annual meeting, a special Audit Committee checked financial resources of money, libraries and property. The member of the Audit Committee in different years most often was Yu. Kulakovskiy, and also he became the part of the Bureau of the Society (Svedeniya o zasedaniyakh, 1903, 50). In October 1903 he was elected to the Council of Nestor Chronicler Historical Society (Yasinskij, 1904, 51). In 1904 he was the first time chosen as a President of the Society for next 2 years. In 1907 President of the NCHS N. P. Dashkevych, who had occupied this post since 1899, resigned. Yu. A. Kulakovskiy was appointed an interim president until the next election. Nineteenth of October 1908 elections were held, Kulakovskiy had become the President of the NCHS and staid on this post until 1911 (Loboda, 1909, p. 88).

Kulakovskiy's presidency was one of the most productive in Society, meetings and public lectures were held during which scientific reports were read. September 20, 1909 on the proposal of the Yu. Kulakovskiy has started work on the finishing of the manuscript of the ancient Russian dictionary begun by P. Ternovsky. Was creating committee which included famous researchers: V. Ikonnikov as chairman, Iv. Kamanin, M. Istomin, P. Smirnov, A. Loboda, V. Zavitnevich, S. Maslov and others. (Svedeniya o zasedaniyakh, 1911, p. 31).

As we said before, one of the fields of research of Kulakovskiy was antiquity archeology. Major part of Kulakovskiy reports on sessions NCHS was devoted to his

archeological researches in Crimea. During 1890-s he had provided excavation on Mithridate mountain.

In the article “Excavation in Crimea in 1890” The author had written about the most important discovery on Mithridate mountain near Kerch. In the first season of excavation in the Mithridate Mountain, he managed to open several crypts with inscriptions and murals, including a unique Christian crypt with a date written on the wall 491. The walls of the crypt were covered with inscriptions, representing the psalms and prayers, according to the author, they corresponded to the ceremony of consecration of the cave, where the crypt was located. It was the only example of a funerary cave with a specific chronological date. Also was noticed, that the way of building a crypt is not different from pagan caves of the same time which has allowed to suggest that the burial belonged to local Goths who did not lose Christianity under the influence of the Huns. representing a single example funerary cave with the definite chronological date. Further excavations were continued, it's results had great importance for studying the ancient history of Crimea (Kulakovskiy, 1891).

Next year, Kulakovskiy had continued his study in the neighbourhood of Kerch. He excavated necropolis near v. Hlinishche in Kerch area. On necropolis were discovered more than 20 tombs. They were situated into the ground and covered by stone overlap. In tombs were found rings, bracelets, buckles, ceramic and glasses tableware, the same type as were found before. According to the author which based on finding coins and other types of artefacts of the necropolis, it could be attributed to 1st cent. A. D. On the north side of the Mithridate was excavated 12 crypts dated 5th cent. A more interesting finding in this place was crypt decorated by fresco (Kulakovskiy, 1893).

In 1894 work on the archaeological study of the Mithridat has been continued. In 1894, the Archaeological Commission organized an archaeological expedition to the Crimea. Her leadership was entrusted to Kulakovskiy. The results of the expedition are covered in an article by a historian and published in the “Readings of the Nestor Chronicler Historical Society”. The aim of the study was to determinate the area spreading of crypts on the territory of the mountain. Another point, where excavation had taken place, situated on a coast of the Sea of Azov (cape Zuk). Unearthed into cultural layer coins and other artefacts had led Kulakovskiy to believe that from 1st to 4th cent. here was a settlement. He also made the assumption that in the time of emperor Zenon it could be the antique city of Khersones (Kulakovskiy, 1895).

In 1895, Yu. A. Kulakovskiy opened a new crypt in the proximity of the previously opened crypt, discovered in 1890. The new finding was located on the north slope of Mithridates mountain on Hospital Street. On the walls of the niches of the crypt chamber of 1895 the researcher found the text of Psalm 90 – “Holy God” prayer written in red and brown paint and crosses, by the nature of the inscription was determined the date – 491 year. The newfound painted crypt had a great historical significance, like a monument of Christianity on the Bosphorus in the 5th century.

Analyzing the experience of the previous crypt researched at the Panticapaeum – Bospor necropolis, Yu. A. Kulakovskiy sharply criticized the analogies of open monuments with Roman Christian catacombs cited by A. B. Ashik and noted the illegality of his statement “on the primacy of the opening of structures of this kind on the Bosporus,” pointed out uncertainty about the location of open catacombs (Kulakovskiy, 1896).

For the first time in the history of Bosporus archeology, a researcher conducted excavations of the most valuable early Christian crypts. Yu. A. Kulakovskiy studied a significant part of the necropolis, discovered unique funerary sites, some of them are known their wall pictures, besides, he created important and significant for further study of the necropolis of publications and researches.

Conclusion

Thus, having researched Kulakovskiy's life and career, was determined that the most fruitful period of his academic activity was related to his work at the Nestor Chronicler Historical Society. For many years he has been a worthy representative of the Society at the All-Russian Archeological Congresses. Yu. A. Kulakovskiy actively participated in solving important organizational issues, he was definitely among its most respected activists, as evidenced by his election to the position of President of the Society. The results of his scientific research were regularly published on the pages of “Readings in the Nestor Chronicler Historical Society”. Arguably to assume that he initiated the new direction of research in the field of late antique archeology of the Crimea in the Nestor Chronicler Historical Society. The researches of Yu. A. Kulakovskiy allowed to starting the systematic excavations of the ancient Panticapeus, thanks to his efforts it was possible to preserve unique archeological materials, which became the subject of a close study of modern scientists.

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Внесок Ю. А. Кулаковського в розвиток античної археології в Історичному товаристві Нестора Літописця

Анотація. В історії української археології є чимало імен видатних дослідників, які присвятили своє життя вивченню нашої давнини. Серед них – Юліан Андрійович Кулаковський, відомий вітчизняний історик та археолог. Багато років свого життя він присвятив науковій та педагогічній діяльності в

Київському університеті св. Володимира, де працював на історико-філологічному факультеті. Після переїзду до Києва Ю. А. Кулаковський починає цікавитись пізньоантичною ранньохристиянською археологією Криму. У 1883 році Ю. А. Кулаковський приєднується до Історичного товариства Нестора-літописця. З цього часу його життя та кар'єра були тісно пов'язані з цим науковим об'єднанням. Багато років він представляв Товариство Нестора-Літописця на Всеросійських археологічних з'їздах. У 1905 році за надзвичайні заслуги Ю. А. Кулаковський був прийнятий до Почесних членів Товариства, а з 1907 по 1911 роки виконував обов'язки його Голови. Головування Кулаковського було одним із найпродуктивніших періодів діяльності Товариства, проводилися зустрічі та публічні лекції, під час яких читались наукові доповіді. Захоплення Ю. А. Кулаковського археологією почалося після переїзду до Києва, історик почав цікавитись слабо вивченими аспектами археології та епіграфіки Північного Причорномор'я та історією Боспорського царства. Протягом багатьох років він був активним учасником археологічних досліджень на околицях м. Керч, біля гори Митридат. Результатам цих досліджень присвячений цикл доповідей, опублікованих на сторінках «Читань Історичного товариства Нестора-літописця». Можна вважати, що саме він започаткував напрямок досліджень в галузі пізньоантичної археології Криму у Товаристві. Вперше в історії боспорської археології дослідник не тільки провів розкопки найцінніших ранньохристиянських похоронних пам'ятників, але й ним була досліджена значна частина некрополя, відкриті унікальні похоронні пам'ятники, частина яких відома своїми настінними зображеннями. Завдяки зусиллям вченого вдалося вирішити важливі питання кордонів давнього некрополя, хронології та культурною приналежності давнього населення Криму. Дослідження Ю. А. Кулаковського дозволили почати систематичні розкопки стародавнього Пантікапея, що дозволили зберегти унікальні археологічні матеріали, які стали згодом предметом пильного вивчення сучасних вчених.

Ключові слова: Ю. А. Кулаковський; Історичне Товариство Нестора Літописця; історія археології; Крим

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Вклад Ю. А. Кулаковского в развитие античной археологии в Историческом обществе Нестора Летописца

Аннотация. В истории украинской археологии есть немало имен выдающихся исследователей, которые посвятили свою жизнь изучению нашей старины. Среди них – Юлиан Андреевич Кулаковский, известный отечественный историк и археолог. Много лет своей жизни он посвятил

научной и педагогической деятельности в Киевском университете св. Владимира, где работал на историко-филологическом факультете. После переезда в Киев Ю. А. Кулаковский начинает интересоваться позднеантичной и раннехристианской археологией Крыма. В 1883 году Ю. А. Кулаковский присоединяется к Историческому обществу Нестора-летописца. С этого времени его жизнь и карьера были тесно связаны с этим научным объединением. Много лет он представлял Общество Нестора-Летописца на Всероссийских археологических съездах. В 1905 году за чрезвычайные заслуги Ю. А. Кулаковский был принят в Почетные члены Общества, а с 1907 по 1911 годы исполнял обязанности его Председателя. Председательство Кулаковского было одним из самых продуктивных периодов деятельности Общества, проводились встречи и публичные лекции, во время которых читались научные доклады. Увлечение Ю. А. Кулаковского археологией началось после переезда в Киев, историк начал интересоваться слабо изученными аспектами археологии и эпиграфики Северного Причерноморья и историей Боспорского царства. В течение многих лет он был активным участником археологических исследований в окрестностях г. Керчь, возле горы Митридат. Результатам этих исследований посвящен цикл докладов, опубликованных на страницах «Чтений Исторического общества Нестора-летописца». Можно считать, что именно он основал направление исследований в области позднеантичной археологии Крыма в Обществе. Впервые в истории боспорской археологии исследователь не только провел раскопки ценнейших раннехристианских погребальных памятников, но также, была исследована значительная часть некрополя, открыты уникальные погребальные памятники, часть которых известна своими настенными изображениями. Благодаря усилиям ученого удалось решить важные вопросы границ древнего некрополя, хронологии и культурной принадлежности древнего населения Крыма. Исследования Ю. А. Кулаковского позволили начать систематические раскопки древнего Пантикапея, и позволили сохранить уникальные археологические материалы, которые стали впоследствии предметом пристального изучения современных ученых.

Ключевые слова: Ю. А. Кулаковский; Историческое Общество Нестора Летописца; история археологии; Крым

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Army Forces and epidemic diseases: A travel through the XIXth century International Sanitary Conferences

Abstract. *This article involves a critical examination of XIXth century military interventions, as the basic cause of the international contagion. Challenges arising and choices made in a critical reading of the International Sanitary Conferences (ISC) proceedings, reveal case histories and early statistical techniques at use with epidemiological purposes. These episodes in the history of the diseases suggest that relevant military information was circulated among health professionals through the ISCs. Although the evolution of the epidemic process during the latter half of the XIXth century made the Conferences fail to cure the diseases that the Western medicine own expansion engendered. By discussing the ways that prophylactic measures and international interventions were used by medical scientists and diplomats alike, from the detailed records of troop mortality to such ubiquitous terms as "contagion" and "quarantine", the article seriously reflect on what happened when the action taken by military forces was a mass phenomenon. As evidenced from the study of the proceedings when comparing different populations, in the pathologies associated with the mass-transport era the rationale of interaction outlined the challenges involved in the train transport of troops. Also, the existence of an environmental risk factor can answer the question on the action taken by military forces as a mass phenomenon with huge impacts on hospitals, harbors and prisons. Materials intended for these international epidemics studies and commissions were prepared by experimented military and civil medical doctors who believed that evidence and common sense proved epidemic diseases capable of being prevented, treated, and controlled by a military approach. This essay demonstrates that Army forces' capability to take control over their host governing apparatus, emphasizes the importance of their aim to follow and accompany the control of the disease in the imperialist competition for land. It grows out of its specific historical context, which due to its origin could become uniform and international, but constituted the principal obstacle on the road to an international health office.*



Keywords: *communicable diseases; military medicine; international cooperation; cholera; quarantine; XIXth century*

Introduction

For much of the XIXth century (second half), the International Sanitary Conferences (ISC) was the chief route through which news of the propagation of communicable disease by the armies or by bodies of troops in movement was channelled to medical administrators and researchers on cholera, yellow fever, and plague (Harrison, 2006) (Huber, 2006). A principle of internationalism through science argued in this instance in terms of the desirability of loyalty in military affairs, depending on a particular social problem: the community outbreaks of infectious diseases (Ringén, 1979) (Capshew & Rader, 1992). Hence the question is posed if, granted ISC "health reform" aims, it is possible to detect the presence of specific military intervention issues in their Proceedings as in fact the best way of securing them? (Howard-Jones, 1975). From 1851 and until the end of that century these Conferences tried to build an international consensus to prevent the incursion of cholera from Asia, to develop a special relationship between science and diplomacy, and to support at the heart of the polemic the preventive confinement, the quarantine (Rosen, 1993) (Stern & Markel, 2004).

While epidemiology is a discipline dealing with the evolution of knowledge (MacKillop & Sheard, 2019) (Coste, 2019), it would not be unjust to identify attitudes expressed at the ISCs on military regulations and troops' transport as "epidemiologic agents", because the military has kept a detailed record of troop mortality. The description of these historical contexts in which this evolution has taken place (Rosenberg, 1992), give details about the military work and thought in the International Health Conferences between 1851 and 1897. In that sense, the military population serves as a control group, to observe the cause of the disease (Morabia, 2004). Then, it considers contagion as the spread of a crisis from its origins by any means (Siegfried, 1960). And military campaign (Evans, 1988) was one of the main forms of mass migration in the 19th century, if it does mean the fast displacement of many thousands of people in large consolidated groups over long distances. The goal at this level of the analysis is on the identification of the exact cause of interaction with military populations (eg, military advantages in steering quarantine agreements). Along with these Conferences, there was an extensive narrative of information and secret that addresses the military experience during epidemic times (Curtin, 1998), the results of which are showed in this research.

This article is about the causes of the infectious diseases involved in military interventions, as can be read in the printed proceedings of the International Sanitary Conferences in the second half of the 19th century.

Research methods

Attitudes expressed at the International Sanitary Conferences (1851–1897) towards military intervention to prevent the spread of communicable diseases, makes the use of their proceedings like a 'handbook' an extremely pertinent method here. This suggestive procedure classifies the development of diseases by reframing their historical contexts. Accordingly, the explanatory levels of disease reflect its ability to transfer from the military to the civilian population through a variety of channels. The point of view of the history of the diseases and the epidemics, typically narrative and centred in the activities, emerged as one way to gain insight from the prophylactic system of the military quarantines and to what extent a military commander obligated its own forces to danger. Case histories of both disease incidence and distribution of medical services are well documented in the ISC's proceedings, and some examples of military hospitals, military prisons and onboard warships are central issues of concern. These methods for efficient classification and retrieval of medical information across the ISC's proceedings, held that the sanitationist ideas from the last part of the century can be read to the extent that the military medicine was the backbone of the imperial economy. Its central techniques (early statistical data on soldiers, including mandatory notification of diseases) represented the evolution of epidemiologic thought by selecting the military participants as the study population of historical interest.

Results and discussion

To appreciate how many military topics on the agenda of the International Sanitary Conferences (ISC) have been covered in the course of the nineteenth century, a good many new and important results that used to be hidden have been obtained.

At great length, in the birth of the epidemiology of the 19th century (Louis Pasteur, Robert Koch) it was already risen a work program to identify the underlying determinants of human diseases on the base of mass population movements. Because via the movements of large masses of human beings a strong bridge for the infectious diseases spread is consolidated (Siegfried, 1960). And it was especially interesting to note that in the original formulation of the ISCs, the military campaign (Evans, 1988) was one of the main forms of mass migration in the 19th century. The disease was able to transfer from the military to the civilian population through a variety of channels: the occupation of villages and towns, the cantonment of units of the fighting forces, the demobilized troops returning home after the cessation of active hostilities.

From the circulation of scientific information perspective, the main result of these International Sanitary Conferences was to provide a forum among medical administrators and researchers on cholera and other communicable diseases. Together with the International Health Councils in Alexandria (from 1835), Constantinople

(1839), Teheran (1865) and Hong-Kong (1894), this forum echoed how much the European armies suffered enormously from the plague in Egypt (International Sanitary Conference, 1885), cholera in India (International Sanitary Conference, 1874), yellow fever in the Caribbean (International Sanitary Conference, 1881). The material in the present work proves that epidemiology and military intervention is in the same dynamic while in the expansionary phase of the imperialism during the second half of the 19th century. But in spite of the fact that the propagation of disease by the armies or by bodies of troops in movement was well known, it was not subject to control, being the military intervention a determining factor as a cause for international contagion.

In the case of French imperialism, the historical analysis invites us to distinguish between the first period from the Crimean War (1853–1856) to the expedition to Mexico (1867), to the expeditions to China-Conchinchina (1857) and to Syria (1860–1861). A second period, in which control over Africa was established, could extend from the Tunisia protectorate in 1881 to the creation of the military territory of Tchad in 1900. The administration of the British colonies, after the Crimean War, attained control over India in 1858; and the second Opium War (1856–1860) ensured the Crown with the main part of the international commerce from the south of China harbors. After the French-Prussian war, British occupation of Egypt finalized in 1882, and that leads to the takeover of Sudan in 1896-98 and to the South-Africa War in 1899–1902. United States established a little empire in the Caribbean at the end of the century over Puerto-Rico and temporarily over Cuba, as it counted among its weapons with an efficient control of mosquito. The Russian-Turkish War of 1877–1878 and the Sino-Japanese War of 1894–1895 also are important in the proceedings.

Society had a right concerning the fidelity of its citizens facing both epidemiological and military problems, a coincidence fostering statistical research on the Army, given the origins, administration and impact of communicable diseases. In fact, in the history of the registration of the causes of death, it was in the 50's of the 19th century when with the collaboration between John Snow (1813–1858) and William Farr (1807–1883), population thinking and comparison of exposures between groups were interrelated as the two fundamental elements of epidemiology. It was possible to work with mortality tables, by comparing the results obtained from the troops in the Metropolis and outside the Metropolis. Showing clearly that the French colonial experience (from 1830) and the British one (from 1815) were good test cases where medical research could work with comparison groups. Military populations, troops in which mortality were three times higher in Africa and two times higher in India than in Metropolis, probably perceived that the risk in a military campaign was always estimated in higher mortality rates when compared with those remaining in the barracks (frequently between three and ten times higher). As could be seen by using the annual reports from the *Army Medical Department* (from 1816) and the medical statistics of the Colonial and Metropolitan Army from *Ministère de la Guerre* (the War Ministry in Spain published from 1884 a Summary of the health

statistics from the Spanish Army (*Resumen de la estadística sanitaria del ejército español*), relevant in the case of the U.S.-Spain war in 1898).

In the second half of the 19th century, the three great blocks constructing epidemiological theory were: local factors (naturals or locals), individual predisposition and contagion. These elements proved to be multiple and mutually permeable (Hamlin, 1992), especially in the case of the colonies. Because predictions concerning military populations affirmed the existence of universal causes needed to characterize the illness. However, the practice of population control based on military de-centered the application of public-health aspects as referred in laws and international conventions. Thus, for example, during the third quarter of 19th century, Conferences reported that in the British Army on West Africa soil the infectious disease spectrum decimated the military population with a mortality rate between 600 per thousand and 111 per thousand, being 32.13 per thousand the average mortality of the European officers in the last quarter of the century and in the same area (Curtin, 1998). On the contrary, at the time of the Vienna Conference (1874) French troops demonstrated a comparative mortality higher between those staying in metropolis than in Africa concerning cholera, following the statistics of causes of death in the military cantonments in France and Algeria. From the medical point of view, disease and Empire were claiming that there were few colonial wars in which more men died in action than of sickness.

The results of these violent measures characterized the start of tropical medicine as an instrument of the empire (Watts, 1997), although they were an effort that failed to counter the diffusion of the diseases under the general rubric of contagion transmitted by fleas, by mosquitoes or by personal contact (Lederberg, 2000). Which is what eventually led to panic, undermining trade and challenging the social order in a number of specific historical episodes whose reverberation on a large scale facilitates a new perspective on military intervention in the turnover from the 19th to 20th centuries (Peckham, 2013). This fact together with the evidence resulting from the production of an international cooperation system, happened in a time of increasing tensions that at last collapsed with the outbreak of the Crimean War (1854–1855). And this was the military moment at this time, although the second Conference (1859) remained unmoved by the dramatic consequences, with what the Paris spirit did not emerge again until 1866, the opening year of another great epidemic. But even this time the international forum won't hear the echoes of an influential struggle, the battle of Solferino. Inside this context, the paralysis of military health services, injured service men that were not evacuated, was a starting point appealing to the humanitarian conscience, the signal to the modification of military mentality and to the development of Red Cross. The military personalities, the specialists in military medicine, or the politicians with military responsibilities, started to see the benefits of the regulations and procedures internationally accorded, with regard to the evacuation and care of those injured.

After the Franco-Prussian war (1870–1871) and the German crash in 1873, the 1874 Vienna Conference (the first after the 1869 Suez Canal's opening) saw the victory of the anti-quarantinist policy, so promoting medical inspection (Ogawa, 2000). Though generally these Conferences were conducted each seven or eight years, on this occasion it was convened just four years after the previous one, because the 1882 unilateral rupture in favor of Great Britain of the dual control of the Egyptian debt provoked that France, its formed partner in Egypt, to insist on strict quarantine on ships in the Suez Canal. Nevertheless, as soon as the united Germany emerged and the Triple Alliance with Italy and Austria was formed, the new colonial power in East Africa endorsed the British position on Suez (Harrison, 2006). In the Conferences held in Venice (1892) and Dresden (1893), against the background of the 1890–1893 depression in Hamburg, the value of the English system (or neo-quarantinist) was acknowledged, and its techniques were adopted as a base for international preventive action (Hardy, 1993). Again discussions on the winter of 1892–1893 cholera epidemics, that originated in the military hospital in Altona (Hamburg) in Germany, concerned the 1894 Conference and, in 1897 the impacts of pest coming from the first Sino-Japanese war made the attendees work at the sessions of the Tenth conference.

Thus, rivalries among the imperialisms in competition, were determining that disease control focus on information (Bynum, 1993). Considerable controversy was generated within the last third of the 19th century: were the military actions (resulting from the preventive measures) appropriate to valuate the validity of contagion as an explanation at the scientific level? or, the taking of control of the apparatus of government by the military forces resulted a specific attribute of the spread of the epidemic? In any case, at least inside the federated structure of the British colonization, the practical effects of this scientific knowledge application would not be felt until the last dates of the century (Briggs, 1961). Ogawa records the fact that in the British army there was very little evidence of a response to the new epidemics, despite the Empire included two main cholera sites, Egypt and India (Ogawa, 2000). Although the health of the European troops in the Egyptian garrison was among the worst in the Empire, the disease was considered endemic and could not attract the international political attention and, as a product of secret, was only rarely subject of open commentary inside the official documents of the British command (Curtin, 1998).

Otherwise, even if one of the belligerent armies was doing all it can to avoid the spread of diseases, its efforts were seriously determined by the existence or not of an equally diligent enemy army medical corps. Because even if a health care staff was successfully protecting their own troops, it was nevertheless sure that an epidemic outbreak would appear between the civil inhabitants in the country where the war was being fought. Barracks and Lazarettos had to be built, the available military medical doctors should be those aware of the hygienic research methodology, and an adequate number of nurses should be ready for service immediately after the early signs of the infectious disease. But for the military authorities (which scarcely were able to

comply with all the mandates that the weight of war placed on them), it was not an easy task to deal with the large-scale prevention of the outbreaks of diseases as a consequence of war.

In the quarantinist field, the armies were slowly considering to replace the traditional precautions with those of disinfection and inspection. In this sense the socio-political evolution of military thoughts on contagion associated with epidemic diseases can be tracked through three institutions: the military hospital, the military prison and the military harbor. To the geography of contagionism and its associated quarantinist attitudes, the determination of the causes of death on the basis of the medical records at the army hospitals were providing valuable data.

Other challenge posed by public dissatisfaction, military prisons often involved new outbreaks of infection. Obviously, those communities where a military correctional facility was established were faced with a very difficult problem, because if infected men were jailed in those prisons the detention centers were promptly identified as focuses of infection. For instance, during the Franco-Prussian war the number of French prisoners who contracted smallpox and succumbed to the disease in the overcrowded prisons in eastern Germany was respectively 34.5 per thousand and 17 per hundred (the highest level of overcrowding was attained in Stettin, where 21.000 detainees were concentrated) (Prinzing, 1916).

From Paris, where the attendees to the 1851 first International Sanitary Conference formulated the first international sanitary convention, the world of the military harbors was directed towards considering the territorial sovereignty on an international basis (International Sanitary Conference, 1852). The fatal disease epidemic could be transported by water tanks like those aboard ships, the risks of disease were multiplied and Auguste Marroin, chief surgeon of the French fleet, described them in his medical history of the Crimean War (Marroin, 1861).

In such a way the communicable disease was an important obstacle to the Naval Supremacy on the basis of the disagreement between France and Great Britain, that affected Europe and the Middle East. A basic disagreement concerning precautions in Suez Canal, as ideologically motivated by commerce and anti-colonialism and that was present in 1892 in Venice, in 1893 in Dresden and in 1894 in Paris. Confronted with the international control of epidemics, the negotiators also raised the use of the epidemiological information coming from the military medical doctors assigned to the fluvial quarantine regimes, when cholera reappeared in Europe in spring 1892. As an example, to patrol the Elbe river each of the 10 stations counted with 2 military medical doctors, who between September 2 and November 29 examined 57.000 ships, disinfected 33.000, and visited 200.000 persons, between whom they identified 108 with symptoms of cholera (International Sanitary Conferences, 1893). The military intervention also considered the relevance of control in the Persian Gulf, and during the last Conference in the century the Ottoman government used a warship aimed at ensuring adequate surveillance of the Strait of Ormuz in facing the 1896 plague epidemic (International Sanitary Conference, 1897).

On the basis of military interventionism, the social management of the epidemics tended to make broadly comparable population groups, taking the view that their territorial sovereignty was considered from a war perspective. It was, of course, a drastic action, because of the suspension of the individual duties for public benefit. But also sanitary cordons bounded by the frontiers could become popular, by demonstrating the efforts of the government and because it only affected the travelers. Other versions of preventive measures approached in the proceedings also offer subtle examples on interaction in public health under the basis of military interventionism (International Sanitary Conference, 1881).

One of the marvelous science's conquest of nature occurred under the basis of international interventionism, the Cuban medical doctor Carlos Finlay found and affirmed the role of mosquitoes in the transmission of yellow fever; and North American co-workers certified that it was so, at the risk of their lives (Siegfried, 1960).

Conclusions

In the second half of the XIX century, the development of epidemiologic thinking can be found in the proceedings of the International Sanitary Conferences (ISCs), by focusing on the characteristics of the Army Forces. At the heart of their prophylactic measures the military intervention is already out in the open as witnessed by the discussions on military personnel as a large group of men who carried infectious organisms. The common diseases affecting the state of health of the military forces played an important part to establish a statistical information system, by developing an imperial medicine as a central agency of knowledge in the interest of the acquisition of territory by war. Within the quarantinist field, a military point of view to assess the impact of communicable diseases drew heavily on contagionism, prompting cordons and quarantines to stop the circulation of carriers. In so far as any historical information that can be considered in the proceedings covers a long time-span, significant interactions are revealed between the causative agent of the epidemic and the risk factors associated with the military assigned to implement sanitary cordons. The scientific evidence demonstrated that the restrictions aroused by the intervention of the colonial power's army put its emphasis on the comparison between population groups in support of the operational perspective of war. Much consideration on isolating strategies has come of this intensified discussions. That knowledge was provided on the base of the proceedings issued after each ordinary session of the ISC meetings, where the interaction is considered as a preemptive move against disease conducive to the adoption of key strategic decisions, like the need for more direct international intervention. Most military officers did express their profound concern related to the connections between the sanitary guarantees enjoyed by the quarantined population and the information sources available on them as an appreciation for medical care. Priority was therefore given to keep decisions secret mainly due to the fact that the military approach to managing the population in terms of confidentiality help to ensure the unity of action and responsibility specific

to the military command. In historical perspective, the ISCs were a context of the interaction between the disease, the military population, and the causal agent, which had its roots in the political traditions with which the prevention, treatment, and control of epidemic diseases have evolved at this time.

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Енріке Вульф

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Військові сили та епідемічні захворювання: Екскурс через міжнародні санітарні конференції XIX сторіччя

Анотація. Ця стаття присвячена критичному аналізу військових втручань XIX століття, як основної причини розповсюдження інфекцій на міжнародному рівні. Виникаючі проблеми та рішення, одержані в результаті критичного аналізу матеріалів Міжнародних санітарних конференцій (МСК), розкривають історію розвитку хвороб і методи ранньої статистики, які використовувались в епідеміологічних цілях. Ці епізоди в історії хвороб показують, що відповідна військова інформація поширювалася серед медичних працівників через МСК. Хоча еволюція епідемічного процесу в другій половині XIX століття не дозволила конференціям повністю вилікувати хвороби, але вони стимулювали розвиток західної медицини. Обговорюючи способи використання профілактичних заходів і міжнародних втручань як вченими-медиками, так і дипломатами, починаючи з докладних звітів про смертність військ і закінчуючи такими повсюдно використовуваними термінами, як «зараження» і «карантин», в статті критично аналізуються результати дій зроблених військовими силами як масове явище. Як свідчить дослідження процесу, при порівнянні різних груп населення, в патологіях, пов'язаних з епохою масових перевезень, обґрунтування взаємодії виявило проблеми, пов'язані з залізничним перевезенням військ. Крім того, наявність фактора ризику для навколишнього середовища може відповісти на питання про дії, що вживаються збройними силами, як про масове явище, яке має великий вплив на лікарні, гавані і в'язниці. Матеріали, призначені для цих міжнародних досліджень і комісій по епідеміям, були підготовлені досвідченими військовими

і цивільними лікарями, які вважали, що докази і здоровий глузд виявили епідемічні захворювання, яким можна запобігти, лікувати і контролювати за підходом військових. Це есе демонструє, що армійські сили були здатні контролювати свій керуючий апарат, підкреслює важливість їх прагнення слідувати і супроводжувати боротьбу з хворобою при імперіалістичній конкуренції за землю. Цей підхід впливає зі свого специфічного історичного контексту, який в силу свого походження міг би стати єдиним і міжнародним, але був головною перешкодою на шляху до створення міжнародного бюро охорони здоров'я.

Ключові слова: заразні захворювання; військова медицина; міжнародне співробітництво; холера; карантин; ХІХ століття

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Военные силы и эпидемические заболевания: Экскурс посредством международных санитарных конференций ХІХ века

Аннотация. Эта статья посвящена критическому анализу военных вмешательств ХІХ века, как основной причины распространения инфекций на международном уровне. Возникающие проблемы и решения, полученные в результате критического анализа материалов Международных санитарных конференций (МСК), и раскрывают истории развития болезней и методы ранней статистики использовавшихся в эпидемиологических целях. Эти эпизоды в истории болезней показывают, что соответствующая военная информация распространялась среди медицинских работников через МСК. Хотя эволюция эпидемического процесса во второй половине ХІХ века не позволила конференциям полностью излечить болезни, но они стимулировали развитие западной медицины. Обсуждая способы использования профилактических мер и международных вмешательств как учеными-медиками, так и дипломатами, начиная с подробных отчетов о смертности войск и заканчивая такими повсеместно используемыми терминами, как «заражение» и «карантин», в статье критически анализируются результаты действий предпринятых военными силами как массовое явление. Как свидетельствует исследование процесса, при сравнении различных групп населения, в патологиях, связанных с эпохой массовых перевозок, обоснование взаимодействия выявило проблемы, связанные с железнодорожной перевозкой войск. Кроме того, наличие фактора риска для окружающей среды может ответить на вопрос о действиях, предпринимаемых вооруженными силами, как о массовом явлении, которое оказывает огромное влияние на больницы, гавани и тюрьмы. Материалы, предназначенные для этих международных исследований и комиссий по эпидемиям, были подготовлены опытными

военными и гражданскими врачами, которые полагали, что доказательства и здравый смысл выявили эпидемические заболевания, которые можно предотвратить, лечить и контролировать с подходом военных. Это эссе демонстрирует, что армейские силы были способны контролировать свой управляющий аппарат, подчеркивает важность их стремления следовать и сопровождать борьбу с болезнью при империалистической конкуренции за землю. Этот подход вытекает из своего специфического исторического контекста, который в силу своего происхождения мог бы стать единым и международным, но являлся главным препятствием на пути к созданию международного бюро здравоохранения.

Ключевые слова: передающиеся заболевания; военная медицина; международное сотрудничество; холера; карантин; XIX век

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