

Journal Pre-proof

Typhus works of Rudolf Weigl, PhD, Ludwik Fleck, MD, and Eugeniusz Lazowski, MD, against the Nazis

Agnieszka Polak PhD , Katarzyna Pawlikowska – Lagód PhD , Anna Zagaja PhD , Andrzej Grzybowski MD, PhD

PII: S0738-081X(22)00031-1
DOI: <https://doi.org/10.1016/j.clindermatol.2022.02.016>
Reference: CID 7732



To appear in: *Clinics in Dermatology*

Please cite this article as: Agnieszka Polak PhD , Katarzyna Pawlikowska – Lagód PhD , Anna Zagaja PhD , Andrzej Grzybowski MD, PhD , Typhus works of Rudolf Weigl, PhD, Ludwik Fleck, MD, and Eugeniusz Lazowski, MD, against the Nazis, *Clinics in Dermatology* (2022), doi: <https://doi.org/10.1016/j.clindermatol.2022.02.016>

This is a PDF file of an article that has undergone enhancements after acceptance, such as the addition of a cover page and metadata, and formatting for readability, but it is not yet the definitive version of record. This version will undergo additional copyediting, typesetting and review before it is published in its final form, but we are providing this version to give early visibility of the article. Please note that, during the production process, errors may be discovered which could affect the content, and all legal disclaimers that apply to the journal pertain.

Caretaker of the Skin**Edited by Andrzej Grzybowski, MD, PhD****Typhus works of Rudolf Weigl, PhD, Ludwik Fleck, MD, and Eugeniusz Łazowski, MD, against the Nazis**

Agnieszka Polak, PhD^{1,*}, Katarzyna Pawlikowska – Łagód, PhD¹, Anna Zagaja, PhD¹, Andrzej Grzybowski, MD, PhD^{2,3}

¹Chair and Department of Humanities and Social Medicine Medical University of Lublin

²Department of Ophthalmology, University of Warmia and Mazury, Zolnierska 18, 10-561 Olsztyn

³Institute for Research in Ophthalmology, Poznan, Poland

*Corresponding author: Chair and Department of Humanities and Social Medicine, Medical University of Lublin, ul. Chodźki 7, 20 – 093 Lublin, Poland. agnieszka.polak@umlub.pl

Abstract

Typhus has been present in Central Europe and Russia since the 19th century; however it was not until 1918 that it became an epidemic problem in Poland. Poverty, general devastation, unsanitary living conditions, and the extensive spread of the disease forced the Polish government to organize effective measures to improve the population's health. One of such measures was establishing a typhus research center in Lviv. The center was led by Rudolf Weigl, who in the 1930s succeeded in elaborating a clinically effective vaccine. In September 1939, when the Germans invaded Poland, the problem of typhus returned, primarily due to the ghettos where the Nazis confined Jews in poor, crowded, and unsanitary conditions. Later, in 1941 when Nazis tried to invade the U.S.S.R. (where typhus was endemic), the typhus vaccine, the work of Weigl and Fleck (also an employee of the Lviv institute), was in high demand. The Germans feared typhus because of its persistence and speed of spread. The Nazi typhus phobia was also used by some Polish doctors who took advantage of this disease to protect their patients from being deported or located in camps. An example of such a doctor was Eugeniusz Łazowski, who even organized a "false pandemic" to save the local population.

Key words:

Rudolf Weigl, Ludwik Fleck, Eugeniusz Łazowski, typhus, typhus vaccine

The German experience from World War I

The situation of Central European territories touched by the First World War was challenging. Poverty, general devastation, unsanitary living conditions, and epidemics, mainly typhus, played an essential role in creating a typhus phobia among the Germans. This fear resulted in the development of the concept of medical geography (geomedicine), which attributed the existence of certain diseases to race and which later became part of Nazism's philosophy of national welfare, safety, and solidarity. It was also used to create propaganda presenting some groups of people like rats, vermin, and subhumans (Untermenschen). Because of the typhus phobia, the Nazis used the knowledge and experience of Polish scholars such as Rudolf Weigl and Ludwik Fleck and equipped them with tools, conditions, and relative freedom for further research. The Germans' fear of typhus that spread in the Wehrmacht was so immense that during the occupation, Polish doctors, including Eugeniusz Łazowski, used this phobia to organize a resistance movement.

Rudolf Weigl (1883-1957)

Rudolf Weigl [Fig.1.] was born in Moravia. His parents had Austrian-Czech roots. After his father's death, Weigl's mother remarried, and it was his stepfather, Józef Trojnar, who taught Rudolf the Polish language. The family settled in Galicia, in Jasło, and then in Stryj, wherein 1903, Weigl passed his matura examination. What is it? Weigl entered the Faculty of Medicine at the University of Lviv and completed his studies in 1907. After graduation, he became an assistant to Professor Józef Nusbaum-Hilarowicz (1890-1941), zoologist, evolutionist, and founder of the Lviv school of natural science. In 1913, he defended his doctorate and habilitated in zoology, comparative anatomy, and histology. In the following years, he studied cell structure and cytophysiology and the comparative anatomy of lower vertebrates. He developed medical bacteriology, which was closely related to the diagnosis and pathology of infectious diseases. At that time, this research direction dominated medicine [1,2].

Rudolf Weigl was called to the Austrian Army on August 4, 1914, as a parasitologist. By order of the Minister of War, he researched typhus in both refugee and prison of war camps [3, 4]. Between 1915-1921, he worked at the Military Medicine Center in Przemyśl, first for

Austria, then after 1918 for the Polish government [4]. After the war, he continued his research in independent Poland. The Polish government established the Institute for Research on typhus in Przemyśl to continue his work. He isolated and described an unknown species of *rickettsia*, *Rickettsia Rocha-Lima*, which Weigl proved harmless to humans, even though he was unable to discover its biologic mechanisms [5]. In 1920, he published his research on *rickettsia prowazekii*, where he proved that the microorganism grows inside the epithelial cells of the louse's intestine [6].

Weigl returned to Lviv, where he continued his research on typhus at the Lviv Institute for Study Typhus and Virology. There he investigated the mechanisms of infection and proved that both *Rickettsia Rocha-Lima*, and *rickettsia prowazekii* pathogens, develop by multiplying inside the epithelial cells of the louse intestine. [7]. Based on biologic criteria, he demonstrated a laboratory method for differentiating between both types of *rickettsia* [8, 9]. In the meantime, he was working on an effective method of preventing typhus infection. He developed an original method of obtaining a vaccine. Rickettsiae do not grow on artificial media, but like other viruses, they multiply only within living cells. Weigl was breeding clothing lice, infecting them with pathogenic *rickettsiae*, and after dissecting the intestines of sick insects, he obtained material for vaccination [10]. He developed a method of artificially infecting this insect via the rectal route where rickettsiae multiplied in the intestinal epithelium [11, 12]. The intermediate host and vector turned out to be the clothing lice.

A vaccine was prepared from properly cleaned intestines (which was innovative in the Weigel school). The difficulty lay in maintaining a stable source of microorganisms for research and keeping live typhus agents in artificial cultures. Because it was considered impossible to infect insects other than by feeding them on the blood of sick persons, Weigl came up with the idea of inserting lice into the rectum of the flees. He also researched bedbugs, lice, cockroaches, and flies.

By 1930, Weigl had gained worldwide recognition after vaccinating people against louse-borne typhus in the Belgian Catholic Missions in China and Africa. Weigl's vaccine allowed for Manchuria and North Africa [1]. For his discovery, in 1939, he was awarded the highest distinction from the Pope and the Belgian Government and granted membership in many scientific societies. He was nominated for the Noble Prize. He was invited to Geneva, where he presented the methods for fighting typhus fever [12].

The Weigl vaccine was the only one to be confirmed by clinical trials. In 1939, Weigl was

invited to Occupied Ethiopia by Fascist Italians to work in Giacomo Mariani's laboratory. Louse-borne typhus was endemic among the local population. The government separated the local population and wanted to use Weigl's vaccine to protect Italians from typhus. Weigl's son wrote about this departure: "He was an opponent of fascism - on the other hand, the proposal was very tempting ... It allowed conducting scientific research and acquiring new strains of rickettsiae" [1]. For political and diplomatic reasons, the trip to Ethiopia was controversial. At that time, Western scientists were boycotting Nazi policy and were reluctant to cooperate with German and Italian scientists.

In September 1939, Poland was invaded and occupied by two powers: Nazi Germany and the Soviet Union. The Nazi regime set up ghettos to segregate and confine Jews and sometimes Romani people into ghettos, where unsanitary conditions flourished. Epidemic typhus spread rapidly. In 1941, after the Nazi invasion of the U.S.S.R., there was an outbreak of epidemic typhus, aggravated by the cramped conditions. [13]. The Germans then placed the camps under quarantine, fearing that typhus would spread throughout the German Army. For these reasons, the Oberkommando der Wehrmacht permitted the work of both Rudolf Weigl and Ludwik Fleck.

Between 1941 and 1944, the technology of obtaining the vaccine on a larger scale was developed in the Lviv laboratory run by Weigl thanks to Zbigniew Stuchły, who designed the machine for serial infection, which allowed more rapid vaccine production [2]. This mass production permitted Weigl to save many Polish scientists, laboratory technicians, and artists. Some worked at the institute itself; others were employed as the so-called louse-feeders, which provided an opportunity to socialize and created favorable conditions for conveying messages within the resistance movement [1]. Infected flees were placed in cages and blood-fed for five consecutive days [Fig. 2].

The Nazis placed the Lviv Institute under official protection. For this reason, its employees held the Institute für Fleckfieber und Virusforschung ID, which allowed them special privileges and safeties. What is more, Weigl was held in such high esteem as a scientist that his refusal to succumb to German thought and sign the Reichsdeutsch declaration did not negatively influence the continuation of his research.

Ludwik Fleck (1896-1961)

Ludwik Fleck [Fig.3.] was a Polish microbiologist and philosopher of science [14]. He, too, played a vital role in the research on typhus and cooperated with Weigl for many years. Fleck was born in 1896 in Lviv to a family of Polish Jews [15]. In 1914, Fleck graduated from the Polish Gymnasium in Lviv and then matriculated at the Faculty of Medicine of the Jan Kazimierz University in Lviv in 1922. As a student, during World War I, he began working with Rudolf Weigl in the laboratory in Przemyśl (1920-1921). He was commissioned as a medical officer in the Austro-Hungarian Medical Corps to fight typhus [1]. Together with Rudolf Weigl, they worked on typhus in Russian war prisoner camps in Bohemia and western Galicia, in the region of Lviv, Przemyśl, and Tarnów. After the war, he returned to Lviv. Based on the results obtained in Weigl's laboratory, Fleck wrote his doctoral dissertation, which he defended in 1922 in Lviv, obtaining the Doctor of Medical Science title.

After receiving the title, Fleck started working as an assistant at the Department of General Biology, Faculty of Medicine of Jan Kazimierz University [16]. From 1921 to 1923, he worked in Weigl's laboratory. There he developed a method of typhus diagnosis, performing a subcutaneous injection of a suspension of typhus antigens [17]. In 1923, Fleck lost his job at the university due to redundancies. Thanks to the support of a friend of the dermatologist, Jan Lenarowicz, he started working as a bacteriologist at the city hospital in the Department of Dermatological and Venereal Diseases. In 1923-1927, he worked as the Head of the Bacteriological and Chemical Laboratory of the Internal Ward of the General Hospital in Lviv. After 1927 he set up a private laboratory where he continued his research. He still cooperated with Weigl and used the materials and instructions of the Lviv scholar [18]. In 1927 he spent a year working at the serotherapeutic institute in Vienna. Based on infectious samples he received from the institute, he conducted several tests and applied a new method using X-19 *Proteus rickettsial* suspensions for agglutination - the Weil-Felix test [19, 20].

From 1928 to 1935, he was the Head of the Bacteriological and Chemical Laboratory of the Skin and Venereal Division of the Social Insurance Company. In 1935, however, he lost this job and made a living, working in his private laboratory, which prospered as he was already a valued specialist [21]. The laboratory operated till 1939. At that time, Weigl's research inspired Fleck's work on rickettsia. They both tested the microorganism.

Both investigated whether it was possible to culture the microorganism in a vessel. Weigl's research did not bring positive results in this regard. What is more, he questioned the stability of the bacterial species and the possibility of bacterial mutation research. Fleck shared his

view. At that time, genetic identification of microorganisms was in its infancy, and bacteria research was based on assumptions and observations. One criterion was external appearance; however, it was impossible to determine why the microorganisms took fluctuating forms [22]. In the mid-1920s, Fleck began to develop a philosophy of scientific discovery inspired by research on *rickettsiae* [23, 24]. Problems related to the study of this microorganism confirmed his view that scientific truths depend on the context and social expectations and are culturally conditioned [7]. The experience of Weigl and Fleck's cooperation will lay the foundation of what will make Fleck one of the leading philosophers of medicine and science in the future. In 1935, Fleck published "Genesis and Development of Scientific Fact," He emphasized that science depends on specific techniques, methods, and available instruments.

In 1939, Lviv was incorporated into the Ukrainian Soviet Republic, and Fleck was appointed head of the municipal hygiene and bacteriology laboratory. Two years later, Germans occupied Lviv and executed Polish scientists on the Wuleckie Hills on July 4, 1941 [25]. Fleck and his wife were saved from the massacre of Lwów professors because Weigl enrolled him employee of the Lviv Institute of Research of Typhus and Virology. In August 1941, Fleck was resettled to the Lviv ghetto. A team of Jewish laboratory workers developed and produced a vaccine against typhus from the urine of the sick. Fleck researched the phenomenon of urinary excretion of typhus *rickettsiae* [1]. From the Lviv ghetto, Fleck's team was moved to the premises of the "Laokoon" factory. He was then tasked with producing a typhus vaccine for German soldiers. From the "Laokoon" factory, Fleck and his family were imprisoned in K.L. Auschwitz-Birkenau. During his stay in K.L. Auschwitz-Birkenau, Fleck conducted bacteriological tests in the camp laboratory [26].

In 1944, at the request of the chief SS physician in K.L. Buchenwald, Dr. Erwin Ding, Fleck was transferred to the concentration camp in Buchenwald near Weimar - in Thuringia, in the heart of the Reich. There he obtained the category of a Jewish political prisoner. From his imprisonment, Fleck's duties included work on the production of typhus vaccines at the Blok 50, which was subordinate to the Waffen-SS Institute of Hygiene in Berlin [27]. Together with researchers and doctors of various nationalities, they produced a vaccine against typhus [28]. Fleck argued that despite Erwin Ding's prior preparation of a typhus vaccine, Ding was far from being an expert. Fleck and other ex-prisoners believed that Ding's inability to understand the details of typhus vaccine production allowed for large-scale sabotage. The prisoners fabricated a large amount of worthless vaccine, which was sent to the German

Army, and a small amount of an effective vaccine was sent for clinical trials and distributed to prisoners inside the camp. Fleck claimed that he was the initiator of the sabotage action [29].

Ludwik Fleck is primarily known as a philosopher of science, but he played an important role in shaping the Polish school of immunology and was also one of the Polish researchers whose knowledge was used by the Nazis to create a vaccine against epidemic typhus. [1,26].
he

Eugeniusz Łazowski (1913-2006)

Eugeniusz Łazowski [Fig.4.] was a doctor and a soldier of the Polish underground Home Army. He studied medicine at the University of Warsaw as a Cadet in the Polish Army Medical Cadet School. During Nazi aggression against Poland in September 1939, he participated in fights with the Germans and later with the Soviets.

As a lieutenant, he was mobilized and assigned to an ambulance train and sent to a hospital in Brześć near Bug. He was arrested by the Soviets but managed to escape. In November 1939, he traveled by medical transport to Stalowa Wola, where his fiancée was staying. After the wedding, Maria and Eugeniusz Łazowski returned to Warsaw. In January 1940, Eugeniusz Łazowski obtained his medical diploma. In 1941, he returned to Stalowa Wola and started a medical practice in Rozwadów as part of the activities of the Polish Red Cross organized by Princess Anna Lubomirska. It was one of the delegations established in December 1939 in occupied Poland to organize, among others, humanitarian aid. Eugeniusz Łazowski provided medical care for the inhabitants of Rozwadów and Zdybniów until May 18, 1944. These two towns were under Nazi occupation and became part of the General Governorate for the Occupied Polish Region (also known as General Government). He also actively supported the local resistance movement organized medical aid for partisans; exposed in the spring of 1944, he was forced to flee. In 1945, he started working at the Clinic of the Medical Academy and the Institute of Mother and Child in Warsaw. In 1958, as a Rockefeller Foundation scholarship holder, he went with his family to the United States, where he started working at the University of Illinois, obtaining a professorship in pediatrics [30].

Łazowski, together with Stanisław Matulewicz [Fig.5.] used the German typhus phobia to organize a diversion in Rozwadów. It was Matulewicz who organized a laboratory in the back room of a rented wooden cottage where he conducted his typhus research. It was a time when living conditions were deteriorating significantly in the General Government.

There was poverty. People from the cities fled to the countryside in search of food, while the countryside inhabitants went to the cities to sell their crops. Such movements favored the spread of lice. The Germans were aware that the outbreak of the typhus epidemic was becoming a real threat. Typhus also reached Rozwadów, where Łazowski and Matulewicz noted confirmed cases of typhus. During the occupation, Polish doctors sent blood samples to German laboratories, where the existence of typhus was confirmed by the test developed by Arthur Felix and Edward Weil. The Germans used this test (Weil-Felix) as a standard for diagnosing typhus [31].

During research in the laboratory, Matulewicz discovered that the Weil-Felix test would show a false-positive result for typhus if the patient were injected with a previously dead *Proteus* bacterium. Moreover, as Łazowski explained, typhus diagnosis could not be confirmed within a few weeks, but several days as Łazowski describes in *Private war. Memoirs of a soldier-doctor 1933-1944* "The fact that Stasiek could perform the Weil-Felix test in his laboratory was very significant. It meant that we could get a typhus diagnosis within a few hours and not have to wait for 6 to 10 days for the results from laboratories in Tarnobrzeg or Lublin. It also meant that we could hide patients with the disease when it was imperative that the identity of an infected person had to be kept from the German Authorities. It was even more important for Jewish patients, because a Jew with typhus was shot immediately [30]".

The first person injected intramuscularly with *Proteus* bacteria was a 35-year-old Polish farmer, who was on leave, previously deported to Germany for the so-called forced labor. The Pole turned to Matulewicz for help. He was given an injection and taught to simulate typhus symptoms. The only real symptoms were headache and general breakdown. After the Weil-Felix test, the result was positive for typhus, which was confirmed in a German laboratory. After this success, Łazowski convinced Matulewicz that this procedure could be used on a larger scale to organize a diversion that would allow the inhabitants to be saved from being deported to Germany. Together with Matulewicz, they caused a false typhus epidemic by immunizing people with the deadly *Proteus* O.X. 19 strain. To increase the credibility of the typhus epidemic in their villages, Łazowski and Matulewicz administered the preparation mainly in winter, thanks to which the reports of the authorities reflected the natural epidemiological pattern of typhus. The patients were also kept ignorant. In his biography, E. Łazowski recalled: "Stasiek and I decided that during the Winter of 1942/43 we would "immunize" more people with the *Proteus* bacteria and expand the false

typhus epidemic in the area. We had become more experienced and better equipped. We both felt that our action was one of many different methods of fighting the enemy.

A false epidemic would help throw off German plans". This practice continued for two years. The Germans of Rozwadów and the surrounding villages considered the area plagued [30].

Unfortunately, at some point, the Nazi collaborators noticed that there were no typhus patients in the village. At the end of 1943, a team of doctors was sent to verify the situation. Knowing about this, Łazowski organized a group of men (who were previously given Proteus O.X.) who pretended to be seriously ill. A team of doctors took blood samples from them, which came positive for typhus. As a result, the trick of Łazowski and Matulewicz was not discovered [29, 30]. Only many years later did the story of the false epidemic in his biography "Private War: memoirs of Doctor-Soldier 1933-1944" published in 1991 was described.

Conclusions

The history of epidemic typhus is strongly entangled with the events of World War II. Nazi ideology focused on the idea that Germany's "racial purity" and Nazi propaganda argued that Jews spread disease, especially typhus. Rudolf Weigl used the Nazis' fear of this disease spread in Wehrmacht and Eugeniusz Łazowski to organize diversion movements during the occupation of Poland by the Nazis in 1939-1944. Rudolf Weigl and Ludwik Fleck were working during the occupation on a vaccine trying to help people in the tyranny of the German occupation of Poland. They found their basis in research on rickettsiae conducted since the First World War. Eugeniusz Łazowski used the Nasist's obsession in helping people to survive by "discovery of a weapon which did not harm or kill but which was nevertheless effective in defending the local population from German atrocities" [30].

Figure legend:

Fig. 1. Rudolf Weigl (1883-1957). Unknown author. Source: https://www.szukajwarchiwach.gov.pl/en/jednostka/-/jednostka/5982107/obiekty/309679#opis_obiektu. Public domain.



Fig. 2. A unique historical image of how the "lice feeding" actually took place. Unknown author. Source: https://en.wikipedia.org/wiki/File:Wszy_klatki.JPG. Public domain.

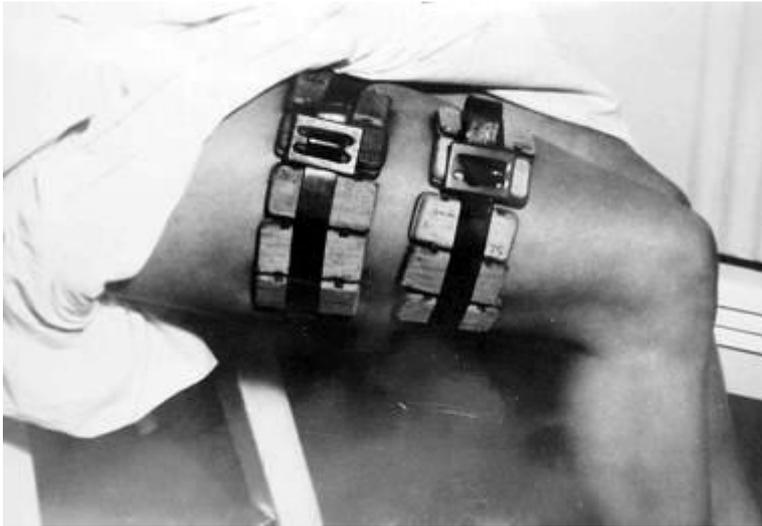


Fig. 3. Ludwik Fleck (1896-1961). Source: Archives of the Auschwitz-Birkenau State Museum (ref. D-AuI-5/9) Book of the X-ray station, Item 9 Ludwik Fleck, diagnosis of Peribronchitis emphysema.



Fig. 4. Eugeniusz Łazowski (1913-2006). Source: Regional Museum in Stalowa Wola.



References:

1. Allen, A.: *The Fantastic Laboratory of Dr. Weigl: How the Brave Scientists Battled Typhus and Sabotaged the Nazis*. New York: London. Paperback.
2. Kryński, S: Rudolf Weigl (1883-1957) *Med. Dośw. Mikrobiol.* 1967; 19: 233-239.
3. Goodall, EW.: Typhus fever in Poland 1916-1919. *Section of Epidemiology and State Medicine.* 1920; 13: 261-276.
4. Szybalski, W.: The genius of Rudolf Stefan Weigl (1883-1957), a Lvovian microbe hunter and breeder In Memoriam. *International Weigl Conference (Microorganisms in Pathogenesis and their Drug Resistance - Programme and Abstracts; R. Stoika et al., Eds.)*. 2003; 11 – 14.
5. Weigl, R.: Untersuchungen und Experimente an Fleckfieberläusen, Die Technik der Rickettsia-Forschung. *Beitrag zur Klinische Infektionskrankheiten.* 1919; 8: 353.
6. Weigl, R.: Dalsze badania nad Rickettsią prowazeki (Further research on Rickettsia prowazeki). *Przegląd Epidemiologiczny.* 1920; 1(4): 365-375.
7. Grylewski, R.: *Biologia lekarska (Medical biology)*. *Dzieje medycyny w Polsce.* PZWL. Warszawa. 2015; 303-308.

8. Weigl, R.: Further studies on rickettsia rochalimae, *Journal of Tropical Medicine and Hygiene* 1924; 27: 14-15.
9. Hauhamadi, L, Fournier PE, Fang, R, et al.: An Experimental Model of Human Body Louse Infection with Rickettsia prowazekii. *Journal of Infectious Diseases* 2002; 186(11): 1639-1646.
10. Weigl, R.: O istocie i postaci zarazka duru osutkowego (About the essence and form of the germ of typhoid fever). *Medycyna Doświadczalna i Społeczna* 1927; 7: 1-2.
11. Wincewicz, A, Sulkowska, M, Sulkowski, S.: Rudolph Weigl (1883-1957) -a scientist in Poland in wartime plus ratio quam vis. *J Med Biogr.* 2007;15(2): 111-5. doi: 10.1258/j.jmb.2007.06-19.
12. Sahajdakowski, M, Hnatusz, S.: Profesor Rudolf Weigl, Życie poświęcone nauce i ludzkości. Referat wygłoszony na międzynarodowej konferencji naukowej mikrobiologów dedykowanej prof. Rudolfowi Weiglowi w 120 rocznicę jego urodzin, która odbyła się na Uniwersytecie Lwowskim w dniach 11-14.IX.2003 r. (Professor Rudolf Weigl, A life dedicated to science and humanity. Paper presented at the international scientific conference of microbiologists dedicated to prof. Rudolf Weigel on the 120th anniversary of his birth, which was held at the University of Lviv on 11-14.IX.2003.)
13. Megargee, Geoffrey P., *The United States Holocaust Memorial Museum Encyclopedia of Camps and Ghettos, 1933-1945, Volume II: Ghettos in German-Occupied Eastern Europe*, INDIANA UNIV PR, 2012; 287.
14. Brorson, S.: The seeds and the worms: Ludwik Fleck and the early history of germ theories. *Perspect Biol Med.* 2006; 49(1): 64-76. doi: 10.1353/pbm.2006.0004.
15. Sak, J, Pawlikowski, J.: Medicine and Thought-Styles: On the 50th Anniversary of the Death of Ludwik Fleck (1896-1961). *The Israel Medical Association journal.* 2012; 14(4): 214-8.
16. Fleck, F.: O odczynie egzantynowym (About the exanthinic reaction) *Wiadomości Lekarskie.* 1930; 3(10-11): 392- 409.
17. Płonka – Syroka, B.: Ludwik Fleck (1896 – 1961), mikrobiolog, prekursor nowoczesnej metodologii historii medycyny (Ludwik Fleck (1896-1961), microbiologist, precursor of modern methodology in the history of medicine). *Medycyna Nowożytna.* 1994; 1(1): 47 – 82.

18. Fleck, L, Krukowski, O.: Oddziaływanie skóry w durzę plamistym na odmieńca X19 i prątki pokrewne (The effect of the spotted skin on the changeling X19 and related mycobacteria). *Med. dośw. spot.* 1923; 1(2): 98.
19. Fleck, L.: Versuche über eine lokale Hautreaktion mit Proteus X19 Extrakten. *Zeitschrift für Immunitätsforschung und Experimentelle Therapie.* 1931; 72: 282-300.
20. Grzybowski, A.: Ludwik Fleck as a medical scientist, microbiologists, and immunologists, in *The Global and the Local, The History of Science and the Cultural Integration of Europe. Proceedings of the 2nd I.C.E.S.H.S. (Cracov, Poland, September 6- 9, 2006).* Ed. By. Kokowski, M. 1-2.
21. Grzybowski, A.: Ludwik Fleck's studies in microbiology. *Wurzburg Medizinhist Mitt* 2007: 110-119. Weigl, R.: Über das Wesen und die Form des Fleckfiebererregers. *Bulletin International de l'Academie Polonaise des Sciences et des Lettres.* 1930; 6-21.
22. Weigl, R.: Die Methoden der aktiven Fleckfieber - Immunisierung, *Bulletin International de l'Academie Polonaise des Sciences et des Lettres* 1930; 25-59.
23. Grzybowski, A.: Ludwik Fleck (1896-1962) and his contribution to dermatology. *Clin Dermatol.* 2012; 30(6): 663-7. doi: 10.1016/j.clindermatol.2012.04.001. PMID: 23236653.
24. Cohen, RS, Schnelle T.: *Cognition and Fact. Materials on Ludwik Fleck Boston Studies in the Philosophy of Science.*
25. Grzybowski, A, Ciesielska, M.: Lesser-known aspects of Ludwik Fleck's (1896-1961) heroic life during World War II. *J Med Biogr.* 2016; 24(3): 402-8. doi: 10.1177/0967772014532893.
26. Opis pracy i akcji sabotażu więźniów-badaczy zawiera rozdział *Die Fleckfieberversuche in Buchenwald* [Eksperymenty nad tyfusem plamistym w Buchenwaldzie] w książce Eugena Kogona: *Der SS-Staat* (For a description of the work and sabotage action of prisoners-researchers, see the chapter *Die Fleckfieberversuche in Buchenwald* [Experiments on typhus in Buchenwald] in Eugen Kogon's book *Der SS-Staat.*) *Das System der deutschen Konzentrationslager.* München. 1998; 191–196.
27. Baldamus, W.: Ludwik Fleck i rozwój socjologii nauki (Fleck and the Development of the Sociology of Science). *Human Figurations. Eseje dla Aufsätze für Norbert Elias.* Gleichman, PR, Goudsblum, J, Korte, H. (red.) Amsterdam: *Amsterdams Sociologisch Tijdschrift.* 1977; 135-156.

28. Löwy, I.: Fleck w Buchenwald. *Ethics in Progress*. 2020; 11(1): 4 – 19.
29. Łazowski, ES.: Private war: Memoirs of a doctor soldier 1933-1944 (Prywatna Wojna). The University of Illinois at Chicago. Library. Special Collections Department. 1991; 1 – 265.
30. Berger, M, Ghadimi, K.: Necessary Heroes and Ethos, from Fighting Nazis to COVID-19. *Anesthesiology*. 2020; 133(6): 1307-1310. doi: 10.1097/ALN.0000000000003488.

Journal Pre-proof