



Caretaker of the Skin

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

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Abstract Typhus has been present in Central Europe and Russia since the 19th century, but 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 such measure was the establishment of 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 Soviet Union (where typhus was endemic), the typhus vaccine—the work of Weigl and Ludwik Fleck (also an employee of the Lviv institute)—was in high demand. The Germans feared typhus due to 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.

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The German experience in 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 wel-

fare, 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.

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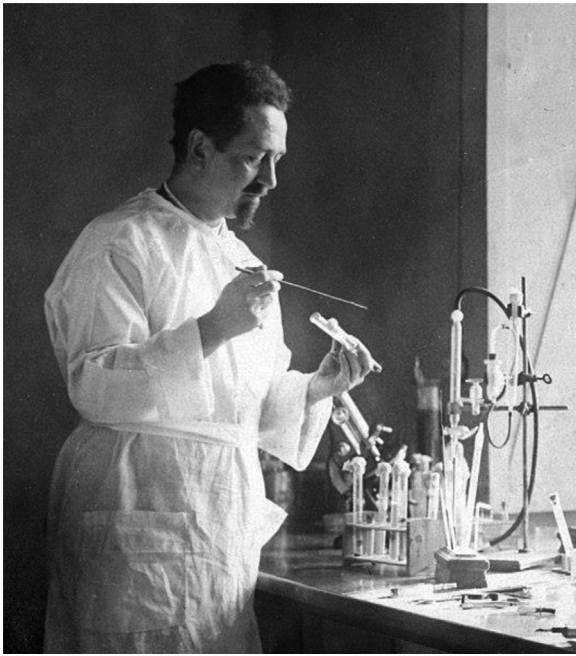


Fig. 1 Rudolf Weigl (1883-1957) (unknown author). Reproduced from the public domain.

Rudolf Weigl (1883-1957)

Rudolf Weigl (Figure 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 Weigl the Polish language. The family settled in Galicia, in Jasło, and then in Stryj, wherein 1903, Weigl passed his matura examination. 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}

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 and 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-rima*, 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 louse.

A vaccine was prepared from properly cleaned intestines (which was innovative in the Weigl 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.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(p103)} 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



Fig. 2 A unique historic image of how the "lice feeding" actually took place (unknown author). Reproduced from the public domain.

sometimes Romani people into ghettos, where unsanitary conditions flourished. Epidemic typhus spread rapidly. In 1941, after the Nazi invasion of the Soviet Union, 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 Weigl and 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 (Figure 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 (Figure 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



Fig. 3 Ludwik Fleck (1896-1961). Reproduced with permission from the archives of the Auschwitz-Birkenau State Museum (ref. D-AuI-5/9).

World War I, he began working with 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 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. From 1923 to 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 until 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 Schutzstaffel (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 pro-



Fig. 4 Eugeniusz Łazowski (1913–2006). Reproduced with permission from the Regional Museum in Stalowa Wola.

duction 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

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}

Eugeniusz Łazowski (1913–2006)

Eugeniusz Łazowski (Figure 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 Łazowski returned to Warsaw. In January 1940, 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. 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 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 his memoir:

The fact that Stasiak 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 impera-

tive 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(p85)}

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, Łazowski recalled:

Stasiak 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.^{29(p106)}

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 was the story of the false epidemic described in his biography *Private War: Memoirs of Doctor-Soldier 1933-1944*, which was published in 1991.

Conclusions

The history of epidemic typhus is strongly entangled with the events of World War II. Nazi ideology focused on the idea of 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 collaborated with Eugeniusz Łazowski to organize diversion movements during the occupation of Poland by the Nazis

from 1939 to 1944. Weigl and 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. Łazowski used the Nazis' obsession in helping people to survive by the "discovery of a weapon which did not harm or kill but which was nevertheless effective in defending the local population from German atrocities."³⁰(px)

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