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COLD DRUGS. CIRCULATION, PRODUCTION AND
INTELLIGENCE OF ANTIBIOTICS IN POST-WWII YEARS

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SUMMARY

The paper details how the earliest antibiotics were subject to a strict control during the earliest phase of the Cold War. Because of antibiotics strategic and economic value, Anglo-American Governments restricted circulation of scientists, techno-scientific know-how and technology related to penicillin production, as well as closely controlling the circulation of the drugs in the Communist countries. These efforts are documented by archival documents, testifying how drugs were actual instruments of propaganda and political strategies, affecting pharmaceutical development both in the Western and the Eastern bloc.

Introduction

During the Second World War, a medical revolution started. In 1943, large-scale production of penicillin was achieved in the USA thanks to the cooperation of public research institutes, private pharmaceutical company, and the Armed Forces. The British scientists that actually made penicillin – by discovering how to extract it from the juice produced by the mold – turned to USA after realizing it was impossible to achieve it in the UK. Howard Florey and Norman Heatley (members of the Oxford team that isolated penicillin) in June 1941 flew

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to USA, where the superior know-how and the integration of public research and private industry allowed the breakthrough. After the earliest medical proofs of the penicillin potential, its strategic value became apparent, so that US authorities quickly decided to sponsor a huge program to turn penicillin in an easy-to-use drug, dramatically improving the production efficiency, and making the whole business commercially viable for companies¹. As an unintended side effect, the drug even saved Hitler's life in 1944². In the years between 1942 and 1944 the news of the drug quickly spread outside UK and US and reached all the countries involved in the war, aided by heavy political publicity. Howard Florey complained already in 1943 that the issue was "wrapped up with propaganda of a personal, institutional, Governmental and international nature...the Russians think penicillin is an American discovery"³. Florey was also aware of penicillin potential beyond therapeutics. In 1944 he wrote "Another political and economic factor is that as the Americans have much more penicillin than we have they may ... gain political kudos and have economic advantages!"⁴ (Report, 1944, part II, p.32).

In this paper, I will show how antibiotics research and production were a concern on both sides of the Iron Curtain, and how the circulation of the drugs and of the manufacturing know-how were subject to a strict control in the earliest phases of the Cold War. Following how these molecules – at one time the product of advanced research, a powerful medical instrument, a commodity, a warfare tool, and a cultural and political symbol – were monitored will gather insights on the effects of the global political climate on the development of pharmaceutical research and business, and will detail the various contrivances adopted in order to secure Anglo-American hegemony in the field, and how this hegemony was challenged. Furthermore this research, though based only on a partial recognition of extant archival material, will enlighten some aspects of the Cold War itself, showing how diverse in their scope and aims were the different actors involved.

Across Borders: Ernst Chain and penicillin in USSR and Italy

While in the USA antibiotics research was already heading towards full-scale industrial production, in Soviet Union scientists were still struggling to master the basic science of antibiotics. However, important results were already achieved in 1942, when Zinaida Vissarionovna Ermoleva and Tamara I. Balezina obtained the first Soviet penicillin⁵, and Georgii Frantsevich Gause's team isolated Gramicidin S from the newly found variety *Bacillus brevis* var. Gause-Brazhnikova. Ermoleva was nonetheless central in the whole Soviet penicillin affair, being the head of the earliest effort for penicillin mass production in USSR, at the specifically created *All-Union Scientific-Research Institute for Antibiotics*, in Moscow. The earliest history of these two antibiotics in USSR reflects a climate of cooperation between the Allies. Gramicidin S was sent to UK in 1942 to be studied, and some penicillin was brought to USSR by the Surgical mission sent in the autumn of 1943⁶. Furthermore, Howard Florey – with a British colleague and two US scientific delegates - made his way to USSR in January 1944, on a visit to several medical and scientific Soviet establishments. During this trip, he visited Ermoleva's lab, and they shared crucial information about penicillin production and research, in a time when publications in the field were already embargoed. Furthermore, Florey brought with him penicillin tablets, allowing for treatments and experiments. In this context, Florey was also shown the Soviet penicillin (obtained by *P. crustosum*) and its therapeutic activity. Yet, Ermoleva's method for obtaining penicillin, using a meat-broth, was deemed by Florey to be "useless for large scale production"⁷. Also, during the visit, selected patients were treated with British and American penicillin, to be compared with Soviet-produced antibiotic. Yet, cases treated with Soviet penicillin were never shown in earnest to the Allied delegates, leaving room for doubts in Florey's mind.

The cooperation between Allies lasted for a couple more years. Within the context of this cooperation, UNRRA deployed a great

effort to increase penicillin production outside US and UK, providing equipment for deep fermentation to a handful of countries in Eastern Europe: Yugoslavia, Ukraine, Poland, Czechoslovakia, and Belarus. To this group, Italy was added. More research pending, we can speculate that the introduction of Italy among the UNRRA club was due to political motives: while the other countries were firmly attached to USSR block, Italy's future was somewhat unpredictable. Communist-led Resistance movement played a major part in freeing the country from Fascist regime, and the Communist Party (PCI) had considerable power in the most industrialized areas of Northern Italy. In the first elections after WWII, in 1946, Communist and Socialist Parties gained almost 40% of the votes, as compared to the Christian Democrats' 35%. Until the general elections held on April, 18th, 1948, the country seemed on the verge of a Communist takeover: hence a huge effort by the US in order to secure Italy on the West side. The history of the Italian penicillin factory has already been told⁸. Yet, it's worth a brief recap. Indeed, the Italian plant only began its production in 1952, six years after the UNRRA donation, because the Italian Institute for Public Health (where the plant was built) thwarted UNRRA gift into something grander, coupling the penicillin factory with a large biochemical research centre. The head of the new laboratory was no less than Ernst Boris Chain, Nobel prize in 1945 for his research on the chemistry of the penicillin molecule (he shared the prize with Alexander Fleming and Howard Florey)⁹. This raised some worries in US: a leading scientist moving to Italy meant that the Country may become an international player in antibiotics research, a challenge to American supremacy in the field. As a matter of fact, Italy stretched US friendship to the limit, obtaining economical help while maintaining a large autonomy. Italian antibiotics research, both pure and applied, rose to international pre-eminence, and national pharmaceutical industry enjoyed (also thanks to the absence of patenting) a golden age during which the Italian drug manufacturers

were able to compete worldwide. Securing the help of a top scientist the like of Ernst Chain, was pivotal in order to achieve international importance. In the midst of the Cold War, it may have sounded as a threat to US hegemony, both politically and commercially. The Cold War attitude, with the necessity to help Italy (and keeping the country on the Western side), had thus a backlash on US, that largely assisted the country without being able to exercise in full their liberal political and economic influence. As a matter of fact, Italy gained a lot from the Cold War without giving up – at least in the case of pharmaceutical research and business – its own autonomy.

Furthermore, as already noted, this happened in a larger context where antibiotics were considered to be of strategic importance, as a commodity as well as for military purpose. UK and US governments, well into the 1950s, controlled the export of the very drugs and of the technology related to antibiotics production toward Communist countries. The initial post-WWII East-West cooperation faded, and already in 1947 Soviet emissaries met with several refusals when attempting at buying penicillin-related licenses and machineries from the Anglo-Americans¹⁰.

Again, we find Ernst Chain entangled in an international intrigue. He was probably the most capable student in the field of biochemical industrial fermentation, and acted as a consultant to several firms, including the Swedish Astra and the British Beecham, as well as to many governments. He often visited, with his wife, Czechoslovakia in order to help with the UNRRA-donated penicillin plant, and in the spring of 1948 he was directly contacted by USSR representatives in order to secure his help for setting up a state-of-the-art fermentation facility. Chain gladly accepted¹¹, and three Russian biochemists (N.M. Borodin, V.I. Zeifman, and G.A. Cherniavskii) spent a few weeks in Oxford – before Chain left UK to Italy. Chain eventually produced a 100-pages long report about penicillin industrial technology, entirely paid (including stationery and clerical expenses) by

the Technopromimport, one of the industrial associations controlled by Vneshtorg (the USSR Ministry of Foreign Trade) that managed machinery and technology import in the Soviet Union. The report, transmitted to the Russians in the late summer of 1948 was a thorough and up-to-date compendium of penicillin production by submerged fermentation. As explicitly stated, the scope of the memorandum was “1) to give an account of equipment and methods used in existing American and European penicillin factories 2) to make detailed suggestions for the construction of a penicillin plant in the U.S.S.R. [...] 3) to supply practical working instructions for all phases of the process”. The report even included information from the firms for which Chain was acting as a consultant, such as Astra.

The material was produced (and copied to microfilms) in agreement with the three Soviet emissaries. Soon after the memorandum was sent to the Soviet representative in UK, one of the three Russian – Nikolai Borodin – announced his defection to the Western block. Chain’s help for penicillin production was indeed an early symptom of Cold War, as it was needed because Anglo-American companies refused to obtain penicillin plant and know-how from other – official – sources. After the attempt to acquire the technology in USA, in early 1948 contacts were on with two British antibiotic producers, The Distillers Company and Glaxo. We have evidences regarding the latter company having an advanced negotiation about the provision of a full manufacturing plant, with operating instructions and a three-weeks training for five Russian technicians in the British factory. The scientific consultant of Biological Research Advisory Board of the Advisory Council on Scientific Research and Technical Development, part of the UK Ministry of Supply, though, underlined that since Glaxo was not sending any personnel to USSR, it would have been difficult for the Soviets to master the process in short time. In fact, “successful manufacture of penicillin requires a great deal of detailed “know-how” and practical experience”. As a consequence,

the Russians “were most unlikely to obtain a sufficient amount of this information from the handbook of operating instructions or from their period of three weeks at the Glaxo factory”¹². The deal was eventually stopped by UK government mostly because the country “should have a definite lead over Russia in both fields” of antibiotic manufacture and of pathogen production for biological warfare¹³.

The embargo on Podbielniak extractors

As said, USSR and other Eastern Europe countries were already producing penicillin, either by the slow and inefficient surface culture method or using the UNRRA-donated plants (according to Ernst Chain, already ‘technically antiquated’ at the end of 1946¹⁴). American and British firms were instead using a cheaper method, with higher yields and a higher degree of purity of the final product. Although the actual machinery was not available for export in Eastern Europe, as the Soviets learned, the scientific know-how was available through helpful scientists. But while the Danish company Løvens managed to obtain the assistance of American biochemists (from the University of Wisconsin, Madison) and became one of the global competitor in the antibiotics market¹⁵, USSR had to look elsewhere, and Chain was the best resource on the market, as probably no one else could master all the phases of the production process, and offer scientific advice together with innovative research. Chain was thus in the position of supplying the know-how and practical experience lacked by the Russians. In his *Memorandum*, Chain details the production processes used in Anglo-American factories, pointing at the use of a special tool, the Podbielniak extractor, as pivotal for using less solvent and yielding a purer product (with a considerable economy). The extractor was invented and produced in the USA in Chicago since the 1930s, and its use in antibiotics production was patented in 1946 (patent nr.US2509010 A)¹⁶. In 1949 the Podbielniak extractor was included under the Export Control Act, in the general

list restricting the circulation of antibiotic production technology towards Communist countries. Deep fermentation penicillin plants in Eastern Europe – for example, the UNRRA production facilities – did not use Podbielniak extractors. The embargo on such a crucial product sparked a controversy in late 1949, since Podbielniak company wanted to access to the global market, overcoming the restriction posed by the Cold War politics. A colloquium took place in late December 1949, with Podbielniak trying to convince British authorities, with the help of American representatives, to lift the embargo. Yet, UK Foreign Office resisted, and with the backing of the Ministry of Defence insisted that the technology would improve Soviet defensive capacity and that it may be of “extreme importance from the point of view of bacteriological warfare”. British authorities felt “of the utmost importance to do nothing which would facilitate or accelerate their researches”. They therefore stood firmly against removing the Podbielniak extractor from the prohibited list. After the meeting with Podbielniak members, an appointee from the US embassy was summoned, and the Foreign Office representative expressed the bitter disappointment in having to discuss the matter with “private individuals and in particular with the manufacturers themselves”. The control on “the export of penicillin apparatus had been kept a close secret”, and as such the Foreign Office appointee G.B. Duke strongly complained for having “to discuss it with other than American officials”.¹⁷ In the archival records, we find that the British authorities were convinced that American behaviour was inconsistent, since they claimed that US Defense department was equally concerned about the export of antibiotic manufacture technology to Eastern Europe, but that the US Trade department was trying to help Podbielniak in securing the whole European (including Soviet countries) market. On the British side, however, it seems that the biological warfare argument – that is, penicillin production machinery and know-how could be used for offensive purpose – was

not steadily supported. As a matter of fact, in the Glaxo-USSR affair the Biological Research Board stated on May 4th, 1948 that “the existence of penicillin manufacturing capacity and experience in the manufacture of anti-biotics (*sic*) will not contribute substantially to Russia’s efficiency to withstand attack by B.W. agents; nor it will contribute greatly to her ability to produce such agents”¹⁸. In 1950, though, there is a reference to a June 1948 report by the same board, according to which the risk “lies in the fact that the acquisition of this technique might enable U.S.S.R. to learn more quickly than she otherwise would how to manufacture B.W. agents on a large scale”¹⁹. Furthermore, “staff at Porton” was consulted²⁰, and they stated “that developments over the past 18 months have in no way invalidated the views of the Biological Research Advisory Board”; actually, “they also pointed out that there is one agent in particular which will be manufactured by a process very similar to penicillin, and for the production of this agent these extractors would be of direct value.”²¹ The American Intelligence also reported that in Czechoslovakia – where Chain was a frequent visitor for consultancy about the penicillin factory in Roztoky, near Prague – in 1949 “efforts were made to procure US-type centrifugal extractors through the United Nations Health Organization at Geneva [...]. It is believed, delivery of this equipment was stopped by the US Government because it could be used in the mass production of biological warfare agents. Attempts were then made by Czechoslovakia to obtain these separators from Sweden”²².

On the other side, Podbielniak representatives made their case in front of the British authorities pointing out that their machine was not new at all and was totally replaceable by using other extraction processes. They even stretched to state that the advertising they made was somewhat “over-ambitious” and made their machine appear more innovative than it actually was. A peculiar example of a company downplaying its own product...

The subject was also discussed in the same days at the OEEC (Organisation for European Economic Cooperation) talks in Paris, with the US representatives trying to push for the security downgrading of the Podbielniak extractor. After the complaints by the UK ministries (the Ministry of Supply, the Ministry of Defense, the Board of Trade, and the Ministry of Health, as well as the Foreign Office, jointly managed the affair)²³ US stepped down their position, only obtaining a downgrading of the Podbielniak instrument from “top secret” to “secret”. A few months later, it was the US that defended the embargo on Podbielniak, when the World Health Organization (WHO) expert committee on antibiotics called for a free flow of know-how and technology between the East and the West. In this case, the WHO committee – headed by Chain – explicitly pointed at “the difficulty of procuring essential equipment, such as the Podbielniak extractors for penicillin production”, which was causing “serious harm [...] to the prestige of the WHO through its inability to help various governments to obtain this essential equipment.”²⁴ In the final resolution of the first meeting, the Committee made the point even stronger: “Podbielniak extractors are absolutely essential for the economic production of penicillin”. As such, “the World Health Organization should do everything possible to assist Member States to procure these essential items”²⁵. The Podbielniak affair was considered to be the most pressing subject by the Committee, to be discussed before everything else in the very first meeting. The resolution of the Committee was considered – according to a confidential message by the British ambassador in Washington, sir Oliver Franks – by the US State Department as “the prelude to a full scale attempt to secure passage of a resolution at the forthcoming meeting of the World Health Assembly calling for the removal of the restrictions on the export of this equipment to Eastern Europe”²⁶. US delegates were thus instructed to oppose proposals on lifting the ban, by using two arguments: Podbielniak extractor’s “potential stra-

tegic value”, and that “in any case this particular equipment is by no means necessary for the manufacture of Penicillin”²⁷. However, UK would have preferred a different strategy, grounding their opposition on patent and economic issues, leaving out the fact that a strategic control on antibiotics was exerted. It was the second time in few months that UK authorities tried to avoid any publicity in this respect. Though it was clear which side they were on in the Cold War, nobody wanted the UK to be the only “bad cop” pressing for the embargo. Obviously, penicillin was not the same as other commodities – strategic or not. It carried such a symbolic value that denying it to entire countries would have been unanimously deemed inhumane, even with the harsh reality of biological warfare looming in. Yet, control was tightly implemented, not only through the careful management of export, but also with a thorough intelligence work that covered every aspect of penicillin and other antibiotics: research, production and circulation. For example, two top secret reports were produced in late 1949 - “Some further information on the production and supplies of penicillin in U.S.S.R.” and “Some information on the supplies of streptomycin in the USSR”²⁸ – based on telegrams intercepted on the internal network of the Soviet Ministry of Communication. An analogous strategy was implemented by the USA, with the Central Intelligence Agency closely monitoring the development of antibiotics in USSR and her allies. The intelligence reports collected by CIA provide a wealth of details regarding penicillin production in the Soviet Bloc, highlighting general shortage of penicillin (at least according to Western Europe standards) well into the 1950s (“the Soviet Bloc...falls 37,000 BU short”²⁹), the low quality of Soviet antibiotics, and the attempt at blocking the export of these substances towards Communist countries. In the most comprehensive document about antibiotics circulation and production, CIA officers take pride of showing that “US exports of antibiotics to the Soviet Bloc dwindled from a substantial \$12.388.000 in 1950 to a mere \$4,000

in 1952. There was no US exports directly to China in 1951, 1952, and 1953³⁰. Yet, the US export crunch had been almost totally covered by export from other Western countries, peaking to \$12,990,000 in 1953³¹ - most of the trade was towards China, going through the British territory of Hong Kong. Furthermore, though European satellites were improving production, the import was crucial to meet the demands of the Soviet Bloc, and the satellite countries “shipped most of their own production of antibiotics to the USSR”³². Shortage of penicillin led Soviets researchers to look for solutions, for example experimenting with “recuperation and regeneration” of penicillin and streptomycin, and studying the efficacy of diluted penicillin on prisoners³³. This scarcity-driven ‘innovation’ went hand in hand with obsolete practices: Czech hospitals still used arsenicals to treat syphilis as late as 1952, because the whole production of penicillin of the two national factories was dispatched to USSR³⁴.

However, the embargo on antibiotics also hit Western countries, such as Italy. In 1950, when the restrictions on circulation of antibiotics were strictly enforced because of the Korea war, Italy suffered a shortage of penicillin and streptomycin. Curiously enough, no penicillin was manufactured in Italy until late 1950, despite UNRRA’s gift³⁵. The first working factory was the Leo Penicillina’s plant in Rome, based on the manufacturing process developed by the Danish company Løvens and inaugurated by Alexander Fleming in September, 1950³⁶. The shortage of antibiotics supplies was overcome by the direct intervention of the Government, struggling to open special diplomatic channels to obtain import licenses, and in the second half of 1951 the problem was in fact solved. Yet, with regards to Communist countries, the embargo was maintained for a few more years. In UK, for example, the ban was lifted in late 1953, after the armistice in Korea, removing quantitative control over the export to China.³⁷ UK also pressured US to lift the embargo, and the matter was discussed in the final months of 1953³⁸. At a mee-

ting of the US National Security Council in November 1953, the Foreign Operations Administration's president Harold Stassen introduced the subject and the Secretary of the Navy Robert B. Anderson pointed at the fact that "the Chinese were desperately anxious to obtain" antibiotics, while allied countries "were anxious to sell". According to Anderson, loosening the trade policy on antibiotics may have induced US "allies to restrict more effectively their trade with Communist China on items of genuine strategic importance."³⁹ That is, antibiotics was not considered anymore of military and strategic importance. At the same time, pressure was growing in favour of antibiotics free circulation grounded in humanitarian reason, and the US Department of State was concerned about this. Eventually, restrictions on antibiotics trade towards China were abrogated in December 1953. Obvious economic reasons stood behind this decision, too. During the Korean war, US Government indirectly funded (by tax reduction) the expansion of several antibiotics plants, issuing "certificates of necessity"⁴⁰ to several companies. This was based on the fact that penicillin "again became an important wartime item"⁴¹ with the outbreak of Korean war. In order to meet civilian demand on antibiotics while supplying Armed Forces, production was scaled up, resulting with a surplus capacity when operations in Korea ended. Export could be thus an effective way to deal with overproduction.

Conclusion

The Cold War was thus a powerful force in shaping the circulation of drugs, and especially antibiotics, in terms of science, industrial know how, and the actual product. The symbolic value of antibiotics – as life-saving drugs, widely acclaimed – made them a perfect object for propaganda and political agenda, intertwining military, economic and political issues. While strategic importance was attached to the "wonder drugs" from the point of view of warfare (both conventio-

nal and biological), these drugs also showed the superiority of Free World science and technology, as well as the Western higher and healthier living standards⁴². Yet, economic reason pushed for free trade, even towards the enemy, in opposition to other concerns. In some cases, though, the economic liberalism preached and practiced and by U.S.A. conflicted with local necessities, so that non-liberal practices were enforced – in one form or another. As shown elsewhere⁴³ and only shortly expressed above, in Italy antibiotics circulation was limited by Governmental actions: protectionism favouring the underdeveloped local antibiotics production was put in place in the late 1940s and early 1950s, with the result of a temporary shortage of drugs during the Anglo-American embargo. This led in turn to the development of a flourishing pharmaceutical industry in subsequent decades. Similarly, patents on drugs were not applied in Italy until the early 1980s, despite a strong lobbying (begun in the early 1960s) from bigger Italian and foreign industries: several industrial governments fiercely resisted for the benefit of a pharmaceutical compound made of small-scale companies not research- and innovation-based, also facing a strong advocacy by the Italian Communist Party in favor of the nationalization of pharmaceutical production⁴⁴. American attempt at cultural penetration in the country, initially accompanied by the circulation of techno-scientific know-how and commodities, was only partially successful. The same happened in other countries, where the different political “world view” expressed by the various governments, and the relative relation with the “Free World” and the “Soviet Bloc” led the therapeutic cultures along different paths. As a result, we may state that pharmaceutical policy was affected by the global of East-West warfare, and the general Cold War frame influenced – whether positively or negatively – the development of pharmaceutical research, industry and culture. This was even more true for the antibiotic breakthrough, notwithstanding its medical, humanitarian and symbolic value. Medical science and

profession were deeply affected by the Cold War-related practices, all over the world, and pharmaceutical industry globally was shaped also by the East-West conflict. To quote one obvious example, Soviet pharmaceutical industry, in the absence of a thorough exchange with Western countries, showed a marked reliance on botanicals, though this and other deficits in pharmaceuticals were also caused by more general inefficiencies in governmental policies and enterprise management.⁴⁵

Even the circulation of scientists within the Western world was influenced by the Cold War attitude. A notorious case is the US denying access to the country to Ernst Chain in 1950 - 1951, even if the Nobel prize was travelling under the auspices of W.H.O. The refusal is consistent with the above described US concerns about circulation of antibiotics and related technology: since Chain had been a key consultant to the Soviets, a frequent visitor to Czechoslovakia, and an advocate for the free circulation of Podbielniak extractors, it is not difficult to see the reason of US authorities' behaviour⁴⁶.

In the following years, the attitude between East and West changed: mutual cooperation in several scientific field was set up, with specific programs and a series of US missions to USSR. While in the earliest years of the Cold War a complete breach in communication was deemed necessary, after mid-1950s the US Dept. of State felt that a two-way exchange could be useful in order to monitor the developments of Soviet medical sciences, and to influence its evolution⁴⁷. However, the earliest years of the Cold War actually showed a much stronger opposition between the two blocks, though some interexchange did exist – Chain, again, is a crucial example, being open to cooperation with whoever was willing use his skills, no ideological strings attached. But we may also realize the existence of such minute actors as the therapeutic molecules: penicillin, for example, whose centrality actually turned the product of the mould into a real active subject within the Cold War and international di-

plomacy. Penicillin (and its antibiotic fellows), in the West as well in the East, were actively monitored, followed, intercepted, tested, dissected, and interrogated almost as an important spy, at one time being the witness, the victim and perpetrator of a crime. The wonder drug was part of propaganda on both sides, and its medical value called for humanitarian initiatives (as well as for commercial endeavours) but its related technology was part of the biological warfare nightmare: which side was penicillin on?

We must also acknowledge a tension between different forces pushing for different behaviours, so that the far-reaching Cold War framework must be blurred at its edges, and its consequences for the development of science and technology shall be observed at multiple levels, bringing in scientific concepts, people, technologies and local vs. global dynamics. “East vs. West” only accounts for a part, though large, of the history.

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1. For a comprehensive history of penicillin, see: HOBBY G. L., *Penicillin : Meeting the Challenge*. New Haven, Yale University Press, 1985; BUD R., *Penicillin: Triumph and Tragedy*. Oxford, Oxford University Press, 2007.
2. WAINWRIGHT M., *Hitler's Penicillin*. *Perspect Biol Med* 2004; 47(2): 189-98.
3. Letter to Carling, 6 sept. 1943, Royal Society Archives (RSA), HF/1/3/13/1/2.
4. FLOREY, *Report on scientific mission to Moscow 1944*, RSA, HF/1/3/13/3, part II, p.32. The quote is from part II of Florey's report, significantly marked "Not to be transmitted to America".
5. While Ermoleva is largely credited for the discovery, other sources point at Balezina for the actual breakthrough in identifying the mould *P. crustosum* for the production of the antibiotic. BALEZINA T. I., ISTORII K., POLUCHENIIA Z.V., *Ermol'evoi Penitsillina*. [On the History of Penicillin Preparation by Z.V. Ermol'eva]. *Antibiotiki i Khimioterapiia* 1998; 43(5): 7-9. CONROYM. S., *Medicines for the Soviet Masses During World War Ll*. Lanham, MD, University Press of America, 2008.
6. PENFIELD W., *The British-American-Canadian Surgical Mission to the U.S.S.R.* *Can Med Assoc J* 1943; 49(6): 455-61.
7. FLOREY, 1944, see n.4, p.25.
8. CAPOCCI, M. "A Chain Is Gonna Come". *Building a Penicillin Production Plant in Post-War Italy*. *Dynamis* 2011; 31(2): 343-62; COZZOLI D., and CAPOCCI M., *Making Biomedicine in Twentieth-Century Italy: Domenico Marotta (1886-1974) and the Italian Higher Institute of Health*. *British journal for the history of science* 2011; 44(163 Pt 4): 549-74.
9. A German born Jewish, emigrated in Great Britain in 1933, and British citizen since 1938, he was the key scientist within the Oxford penicillin team. About his life and career, see the quite hagiographic biography by CLARK R. W., *The Life of Ernst Chain. Penicillin and Beyond*. New York, St. Martin's Press, 1985. And the more science oriented ABRAHAM E., *Ernst Boris Chain. 19 June 1906-12 August 1979*. *Biographical Memoirs of Fellows of the Royal Society* 1983; 29: 43-91.
10. BORODIN N. M. L., *One Man in His Time*. London, Constable, 1955. An American intelligence report states that in July 1946 "the Amtorg Trading Corporation communicated with the Merck Company, New York City, expressing an interest in purchasing a penicillin plant to be erected in the Soviet Union", in order to "purchase the 'know how' relating to the large-scale manufacture of penicillin". Federal Bureau of Investigation (FBI), *Soviet Intelligence Targets in the United States 1946-1953*, September 1954.

The source for this quote was a “Soviet defector”, whose name has been omitted in the released document (the report has been de-classified in 2008): probably the defector was Borodin himself.

11. A sum of 35.000 GBP was asked in exchange of his work, with the clause that his name could not be used by the Soviets without his explicit consent, as stated in a letter to Borodin N.M., 27 January 1948, Wellcome Archives (WA), PP/EBC, C.4.
12. “Technical aspects of the sale of penicillin plant to Russia – Note by Dr. Wilkins F.J.”. Annex to A.O. 9825/BRB.54 – “Ministry of Supply – Advisory Council of Scientific Research and Technical Development – Biological Research Board – Proposed sale of penicillin plant to Russia – Note by Secretary. Received 13th May, 1948.” By J.F.S. Stone. UK National Archives (NA), WO 195/9821.
13. *Id.*
14. CHAIN E. B., *My Activities at the Istituto Superiore di Sanità*. WA, PP/EBC, C.13, p. 1.
15. COZZOLI D., *Penicillin and the European Response to Post-War American Hegemony: The Case of Leo-Penicillin*. *History and Technology* 2014; 30(1-2): 83-103.
16. On the Podbielniak extractor, see also ŁOTYSZ S. A., “*lasting memorial to UNRRA? Implementation of the penicillin plant program in Poland, 1946-49*”. *ICON: Journal of the International Committee for the History of Technology* 2014; 20, *in press*.
17. Letter from DUKE G.B. to ELLNER T.W., Ministry of Defence, 10th January 1950, NA, FO 371/87185.
18. *Technical aspects of the sale of penicillin plant to Russia*, see note 12
19. Letter from LAMB W. TO GRESSWELL MR., Ref. 37/B.W./4/31, January 1950, NA, FO 371/87185
20. Porton Down was a secret laboratory of the UK Ministry of Defense, where most of the biological and chemical warfare research took place. See Robert Bud’s paper in this issue.
21. *Ibid.*
22. Central Intelligence Agency (CIA), *The Antibiotics Industry in the Soviet Bloc*, CIA/RR PR-80, 15 November 1954, CIA-RDP79-01093A000700020008-2, p.22.
23. British authorities also called attention on the fact that such decisions were to be made in multilateral contexts. According to Eric Alfred Berthoud, by insisting on exporting the extractors to Eastern European countries the U.S. “would be endangering the whole of the East-West trade policy agreed with

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- so much difficulty between O.E.E.C. countries”. (Letter from Berthoud to Philip Broad, 14th February 1950, NA, FO 371/87185. Broad worked in the Foreign Office, in charge of the European Recovery Dept.). As a representative of the Ministry of Supply – Engineering Industries Division, put it, if unilateral or bi-lateral action should be taken in this regard, “the whole fabric of the Paris talks would be endangered”, since everybody would know that commercial pressure could override security and political issues, and eventually U.K.-U.S. mutual trust would be undermined (Truscott to Cresswell, February 10th, 1950. NA, FO 371/87185).
24. Expert Committee on Antibiotics, Report on the First Session, Geneva 11-15 April 1950. World Health Organization Technical Report Series, 26, pp.4-5.
 25. *Ibidem*, p.5.
 26. Letter from Franks to Foreign Office, May 3rd, 1950, NA, FO 371/88813.
 27. *Ibidem*.
 28. NA, HW 75/152.
 29. The Antibiotics Industry in the Soviet Bloc, CIA/RR PR-80, 15 November 1954, CIA-RDP79-01093A000700020008-2, p.14. BU stands for “billion units”.
 30. *Ibidem*, p.9.
 31. *Ibidem*, p.11. It’s worth noting that British and German exports almost tripled from 1952 to 1953, rising from \$1,366,000 to \$3,470,000 and from \$772,000 to \$1,915,000, respectively.
 32. *Ibidem*, p.9.
 33. According to a CIA source, prisoners were sent to hospitals in Vologda, Leningrad and Moscow for experiments: “In the initial stages several patients died, but the problem had apparently been solved by the end of 1950. (CIA information report, *Soviet experiments with penicillin*, 11 feb 1952, CIA-RDP82-00457R009700390006-1). Two publications are listed in Pubmed for the use of penicillin dissolved in campolon - a liver extract from marine mammals (whales and dolphins) containing folic acid and vitamin B12 - dating to 1950-1951, by Soviet authors. ARUTIUNOV V. I., *Lechenie Gonorreii I Sifilisa Penitsillinom, Rastvorennym V Kampolone*. [Therapy of Gonorrhoea and Syphilis with Penicillin Dissolved in Campolon]. Vestnik venerologii i dermatologii 1950; 5: 52-4; PECHERSKII B. F., IARUSTOVSKAIA L. E., GOFMAN E. M., et al. *Lechenie Gonorreii Rastvorom Penitsillina V Kampolone*. [Treatment of Gonorrhoea with Penicillin in Campolon Solution]. Vestnik venerologii i dermatologii 1951; 6: 31-5.

34. *Penicillin factories at Radnice and at Roztoky*, 20 August 1952, CIA RDP82-00457R013500190005-1.
35. The other UNRRA-donated factories in Eastern Europe were all up and running, by 1949 at max. In Italy, notwithstanding Chain (or because of that), the Government-operated factory started production in 1952, see CAPOCCI M., see note 8.
36. CAPOCCI M., see note 8; COZZOLI D., see note 15. At the time, Leo claimed the factory to be the largest in Europe.
37. Removing control over export to China also meant relaxing trade policy towards the Soviet Bloc, albeit indirectly.
38. The Secretary of State John Foster Dulles wrote in a Secret communication in October 1953: "UK proposed in next ten days to raise question in Paris re continuation existing controls on antibiotics to Communist China. In this connection UK Reps asserted considerable domestic pressure for relaxation such controls, maintenance of which they regarded as dangerous from propaganda viewpoint and as imperilling their ability cooperate on strategic controls in general." (*The Secretary of State to the Embassy in the United Kingdom*, Washington, October 7, 1953, in *Foreign Relations Of The United States, 1952-1954*, Washington, United States Government Printing Office, 1983. Vol. I, Part 2, Doc. 53, p.1020).
39. *Memorandum of Discussion at the 169th Meeting of the National Security Council, Washington, November 5, 1953* in *Foreign Relations Of The United States, 1952-1954*, note 30, Vol. XIV, Part 1, Doc. 147, p.272.
40. US Federal Trade commission, *Economic report on antibiotics manufacture*, Washington, United States Government Printing Office, June 1958, p.57.
41. *Ibidem*.
42. As documented by Tobell, pharmaceutical industry eagerly picked up Cold war rhetoric - presenting itself "as a critical national asset in the global war again communism" (p.433) in order to defend its own interests within U.S. public sphere. TOBELL D. A., *Who's Winning the Human Race?"Cold War as Pharmaceutical Political Strategy*. *Journal of the history of medicine and allied sciences* 2009; 64(4): 429-73. During the Kefauver investigation (1959-1962) into drugs pricing practices in US, pharmaceutical companies prided themselves in championing freedom against the "socialist" threat posed by government involvement in drug business.
43. CAPOCCI M., see note 8; CAPOCCI M., *L'industria Farmaceutica*. Il Contributo Italiano Alla Storia Del Pensiero - Tecnica. Rome, Istituto dell'Enciclopedia Italiana, 2013, pp.417-26.
44. CAPOCCI M., see note 43.

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45. CONROY M. S., *The Soviet Pharmaceutical Industry and Dispensing, 1945-1953*. *Europe-Asia Studies* 2004; 56(7): 963-91.
46. In August 1950, an Italian newspaper (*Il Momento*, 8.8.50) ran an article pointing at Chain as a “new Fuchs case”, referring to Klaus Fuchs, the physicist convicted a few months before for passing nuclear secrets to USSR.
47. GELTZER A., *In a Distorted Mirror the Cold War and Us-Soviet Biomedical Cooperation and (Mis)Understanding, 1956-1977*. *Journal of Cold War Studies* 2012; 14(3): 39-63. Clearly, the Sputnik showed that Soviet science could be extremely effective, and this fact proved a surprise to most of the Western observers. However, it was after Stalin’s death in 1953 that USSR showed a new attitude, increasing cooperation with international boards, such as the W.H.O.

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