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Italian nominees for the Nobel Prize in physiology or medicine 1901-1950: Scholars, Research trends, Hotspots.

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Abstract. As the Nobel Prize is considered to be the most prestigious award in the world, it is not surprising that already much has been written about it. Whilst the majority of studies have focused on the laureates, this article sheds light on the much larger group of nominees for the Nobel Prize in physiology or medicine in Italy during the first half of the 20th Century. Drawing on information from the Nobel archives and secondary literature this article reconstructs some structures behind the nominations including popular research topics, cities and nominators. We found candidates to pool in few cities and identified infectious diseases as a prevalent research topic among the nominees during the examined time period. Having found the vast majority of nominations to originate in Italy with nominator and nominee often holding positions in the same university, this study also discusses factors that might have influenced the choice of the nominators without necessarily being related to the work of the nominee itself.

Key words: Nobel Prize, excellence in medicine, Italy, Camillo Golgi, Carlo Forlanini, Aldo Castellani

Introduction

Considered the most prestigious award in the world, the Nobel Prize has since its first award ceremony in 1901 been of immense interest to scientists and laymen around the globe. Whilst countless articles have dealt with the award in general and the laureates in particular, few studies focus on the history of the prize in single countries, most notably Harriet Zuckerman's book on Nobel laureates in the United States and Elisabeth Crawford's publications on nomination networks in some European countries (1-3). Zuckerman and Crawford underlined that the topic young scholars conduct research on as well as the university they are working at greatly influence their Nobel Prize chances.

Furthermore, Zuckerman identified Californian universities as the places where most Nobel laureates have positions and characterized the laureates as eager to establish and maintain scientific networks, a "noblesse oblige in co-authorships in collaborative publications" (4).

This article aims at outlining the history of the Nobel Prize in physiology or medicine in Italy and presents researchers nominated for the award during the first half of the 20th century. Although scholars have disseminated the work and reputation of single laureates such as Salvador Luria (1912-1991), Renato Dulbecco (1914-2012) and Rita Levi-Montalcini (1909-2012) (the trio met while working at Giuseppe Levi's (1872-1965) laboratory in Turin) (5), an overview of nominees is still lacking (Tab. 1).

The Nobel Prize in physiology or medicine has to date (December 2021) been awarded to six Italian scholars, adding to the three previously mentioned Camillo Golgi (1843-1926), Daniel Bovet (1907-1992), originally from Switzerland, and Mario Capecchi (1937-) (see table 1). This number can be

Table 1. Italian Nobel laureates in physiology or medicine.

1906	Camillo Golgi	Work on the structure of the nervous system
1957	(Daniel Bovet)	Discovery of drugs blocking the actions of specific neurotransmitters
1969	Salvador Luria	Discoveries on the replication mechanism and the genetic structure of viruses
1975	Renato Dulbecco	Work on oncoviruses
1986	Rita Levi- Montalcini	Discovery of nerve growth factor (NGF)
2007	Mario Capecchi	Discovery of a method to create knockout mice

compared to the 32 British and 19 German scientists (6), who have been awarded the Nobel medal in the same prize category. In contrast to most of the studies focusing on the Nobel Prize laureates, this article sheds light on the much larger group of nominees. It aims at reconstructing Italian hubs featuring a relatively high number of Nobel Prize nominees, popular research topics and trends over time. Not just concentrating on the scholars themselves we will cast a light on the nominators as well.

Methods

We systematically searched the Nobel database (nobelprize.org) (7) for the prize category physiology or medicine, listing all Italian scholars, nominators, cities as well as reasons given to evaluate trends and to identify the most important scholars and universities in this context. In order to explain the conclusions drawn from the analysis of the material from the Nobel database, we also consulted material from the Nobel archive, including Nobel Prize shortlists (i.e. scholars who were brought up for a special investigation by the Nobel Committee) and the nominations as well as secondary literature.

Results

According to the Nobel Prize database, a total of 253 nominations was submitted for medical scientists working in Italy between 1901 and 1950 (7). This number seems rather low when compared to (admittedly larger) countries like the United States, France or Germany with more than 1000 nominations for medical scientists per country during the same time period (8) and puts Italy on before countries like Switzerland or Canada. Even though almost all of the nominations for Italian researchers in the first few years were submitted by foreign nominators, a vast majority (207) of the 253 nominations (82%) originated from Italian nominators. After 1910, Italian scholars received hardly any nominations from scientists from other countries. In 71 cases (28%) nominator and nominee were colleagues at the same university.

When looking at the nominees chosen abroad consensus can often be seen within the universities. In 16 cases scholars were nominated by three or more nominators originating from the same city in the same year. The popularity of those scholars was, however, rarely limited to just one university when taking prior and subsequent years into account. For instance, Giuseppe Sanarelli (1864-1940) of Rome accumulated a total of 26 nominations between 1935 and 1937 (3 of them by Pavia scholars in 1935, 4 of them by Turin scientists in 1936 and 13 additional nominations by Roman nominators in 1937). All of the nominations used the same work as justification. In 1935 he was nominated for his "work on enteropathies, caused by microbes (typhus, cholera)", in 1936 and 1937 the motivation was his "work on the haematogenous nature of certain infectious enteropathies, ultrafiltration and ultravirus, immunity against tuberculosis".

A similar pattern can be observed when looking at Ugo Cerletti (1877-1963). Out of the 24 nominations submitted in his favor until 1950 11 were filed by Roman scholars in 1948, 4 by Florence university scientists in 1947 and 3 by Bologna scholars in 1950.

As both Sanarelli and Cerletti are among the most-nominated in Italy during the period 1901-1950 and with Cerletti even being shortlisted by the Nobel

Prize committee in 1943, this phenomenon indicates the popularity of these candidates and their research.

The highest share among foreign nominations for Italian scholars is held by Germany (13 nominations). A possible explanation for Germany being in first place could be found in the connection some of the scholars had to German universities. For instance, Battista Grassi (1854-1925) had spent time working in Heidelberg (9) whilst Angelo Celli (1857-1914) had studied in Berlin. Nobel laureate Camillo Golgi, nominated by 6 German scientists, had been a member of German academy Leopoldina since 1890 (10) as well as of the Göttingen Academy of Sciences (1892) (11) implying that his work had been acknowledged in Germany years before he was awarded the Nobel Prize. In addition, Golgi has been described as a close friend to one of his nominators, Albert von Kölliker (1817-1905) (12).

Categorizing motivations stated when nominating a scientist for the Nobel Prize, most of the work showcased was ascribed to basic research. Especially in the first years after the turn of the century research on the function of organs, the structure of tissues and on physiology proved to be popular consistent with the technical resources and methods available at that time. Popular scholars working in these areas were Giulio Vassale (1862-1913), who investigated the function on endocrinous glands, and, Camillo Golgi who, together with Santiago Ramón y Cajal (1852-1934) was awarded the Nobel Prize in 1906 "in recognition of their work on the structure of the nervous system", emphasizing the significant role discoveries regarding the microscopic anatomy of tissues had at the time. In subsequent years work based on this new knowledge acquired by studying the structure and basic function of organs gained popularity with scholars like Quinto Calabro (1905-1987), nominated for his work on the transmission of nervous impulses and Filippo Bottazzi (1867-1941) conducting research on the function of sarcoplasm. Still, clinical research played a significant role with scholars such as Ugo Cerletti and Carlo Forlanini (1847-1918) (see below for details) being nominated for their work on specific treatments for different diseases. Ugo Cerletti, sometimes together with his colleague Lucio Bini (1908-1964), was put forward multiple times for the development of electroconvulsive therapy for patients suffering from mental illness (13). In both, clinical as well as basic research, research related to infectious diseases (predominantly malaria and tuberculosis) was deemed popular in a Nobel context during the first half of the 20th century. Probably the most prominent Italian scholar conducting research on tuberculosis was the already mentioned Carlo Forlanini, nominated for his development of artificial pneumothorax as a cure for tuberculosis. His approach was to puncture the pleural cavity with a large needle in order to have the lung collapse. As Forlanini was able to demonstrate that this method did indeed help to improve the situation of some patients and taking the disappointment about the failure of tuberculin as a cure for tuberculosis into consideration, he was considered a strong candidate by the Nobel Committee, also appearing on their shortlist. Nevertheless, Forlanini's discovery was not undisputed, as many claimed it to be very risky. This debate proved to be an obstacle, leading to the Nobel Committee finally judging against him. (14).

The shortlists of the Nobel committee confirm the trends observed: All Italian scholars shortlisted between 1901 and 1914 studied infectious diseases. Even though fewer nominations in favor of scientists conducting research in malariology or concerning tuberculosis were submitted by the mid- 1920s, infectious diseases remained a prevalent topic only seeing the focus shift towards another common disease, cholera, with a total of 26 nominations regarding work on infectious enteropathies such as cholera submitted in the 1930s. Whereas cholera was widespread in all of Europe in the 19th century, Italy was still struck by cholera in the 20th century with the disease claiming its last victims in southern Italy in a 1974 outbreak (15).

Italian 'Nobel Hotspots': Rome and Pavia

The seven most often nominated candidates all conducted research either in Rome or in Pavia (Tab. 2). The two cities accumulated the highest numbers of nominations submitted during the first half of the 20th century. 33 out of 253 nominations were submitted by Roman scientists in this period placing Rome at the top of all Italian universities for both nominations received as well as nominations submitted. All

Table 2. Most often nominated scholars for the Nobel Prize in physiology or medicine 1901-1950, who did *not* receive the prize and who were nominated while working in Italy.

Number of Nominations	Name	City	Motivation
26	Ugo Cerletti	Rome	Application and developement of electroconvulsive therapy
26	Giuseppe Sanarelli	Rome	Work on cholera and other infectious diseases
21	Battista Grassi	Rome	Various discoveries in malariology
20	Carlo Forlanini	Pavia	Application and developement of curative pneumothorax
17 [not taking into account the 40 nominations he received before 1950, while working outside of Italy]	Aldo Castellani	Naples, Rome	Various, especially in the field of tropical medicine
14	Guido Baccelli	Rome	Treatment of infectious disease by intravenous injection
11	Vincenzo Diamare	Rome	Work on the isles of Langerhans

33 nominations submitted by Roman scholars were in favor of researchers of the same city putting Rome in first place in this category as well. Pavia took second place with 28 nominations handed in out of which 13 were in favor of candidates of the same city.

Out of 13 Rome scholars nominated from 1901 to 1950, eight were put forward for malaria research while working at Rome university. These scientists account for 69 of the 109 nominations submitted for Roman scholars in this period, 22 of them stating research on malaria as their main argument. One explanation could be found in the city's historic connection with the disease (16). Being surrounded by the marshy grounds of the *Roman Campagna* malaria has been present in Rome presumably since its founding.

When deducting the nominations connected to malariology from the total of nominations submitted for Roman scientists, there are only 40 nominations remaining with only 5 out of 13 nominees not having conducted work on the field of malariology. In terms of scholars nominated from 1901 to 1950 Rome would then only be in 3rd place among Italian universities instead of occupying 1st place, on a par with the universities of Bologna and Turin.

Whilst 69 nominations were submitted in favor of scholars, who worked on malariology, only 22 of those nominations state work on malaria as their main motivation. This implies that the members of the Roman school of malariology did not limit their research to malaria itself but were also very active in other fields contributing to Rome being in first place in terms of scholars nominated as well as nominations submitted. One scientist, who relocated to Rome in order to join the school of malariology was Battista Grassi (1854-1925), a physician and zoologist originally from the university of Pavia. (17). During his stay, he published several articles and was among the most nominated Roman scholars highly regarded for his work in malariology even claiming to have identified Anopheles as the vector of the disease (17). In 1902, the Nobel Prize was awarded to Sir Ronald Ross (1957-1932) (GB) "for his work on malaria, by which he has shown how it enters the organism and thereby has laid the foundation for successful research on this disease and methods of combating it" (official prize motivation) instead, who claimed to have made this discovery before and even launched a defamatory campaign against Grassi and his colleagues (17). Another renowned Roman scholar in a Nobel Prize context was Guido Baccelli (1830-1916). Even though also involved in the research on malaria, he conducted work and published on diverse topics, including the treatment of aortic aneurysm, cancer of the spleen, cardiology and public health (18). Surprisingly, all of his 14 nominations cite his work on the treatment of disease by intravenous injection as motivation.

A different picture emerges when looking at Pavia, the university ranking second in terms of nominations received for its scholars. All of the 51 nominations Pavian researchers managed to obtain were submitted in favor of the two scholars already mentioned, Golgi and Forlanini. Even though the medical faculty of Pavia is among the most highly regarded in Italy until this

day (19), discoveries seen as worthy to be considered for the Nobel Prize seem to have only been made by Golgi and Forlanini during the first half of the 20th century (20).

Next to Pavia and Rome, another Italian 'Nobel hub' was Naples with a total of eight scholars subject of 42 nominations. Among the candidates were Leonardo Bianchi (1848-1927), nominated for his work on the physiology and pathology of the brain and Aldo Castellani (1874-1971), who were both on the Nobel Prize committee's shortlist at some point. Castellani spent a few years of his international career in Naples and was nominated eight times in that period. Another protagonist at Naples university was Anton Dohrn (1840-1909), a German scientist who founded the Zoological Station of Naples in order to study the marine fauna. His institute quickly developed into a popular venue for gifted scientists hosting several subsequent Nobel Prize nominees such as Battista Grassi and laureates forming an international contact zone (21). Some visitors referred to their stay at Naples "as a key moment in their scientific life" (22).

For the outstanding contribution Dohrn made to science by founding this institute, he was even nominated for the Nobel Prize by the fellow zoologist Julius Kazzander in 1907. Many other relevant scientists have also spent time at the Zoological Station, including Vincenzo Diamare (1871-1966), subject of 11 nominations in the 1901-1950 period. Among his most important work is his research on the Isles of Langerhans, which he was also nominated for.

However, when characterizing those universities, it has to be taken into account that researchers tended to travel a lot working in several Italian and international cities. Consequently, the universities stated in the nominations do not necessarily reflect the places where the nominees made the discoveries they were nominated for.

A scholar, who was particularly fond of traveling was Aldo Castellani. Whilst Naples and Rome were stated as places of his activity in the nominations he also spent time working in Germany, United Kingdom, Uganda, the United States and Ceylon making it difficult to allocate Castellani's work to single universities or even countries (23).

The case for Aldo Castellani

Aldo Castellani (1874-1971) deserves a closer look since he was by far the most often nominated Italian scientist in the considered period: 57 nominations before 1950, 17 of which while working in Italy (plus 4 after 1950), whilst the second most often nominated Italian scholar, Ugo Cerletti, only received 24 (and at least another dozen after 1950).

Despite Castellani's worldwide range of action, of his pre-1950 nominators 42 were Italians (for a total of 45 nominations) and only 4 were from England, the United States and Portugal (for a total of 13 nominations).

Two Nobel Prize laureates nominated Castellani: Camillo Golgi (1906) nominated him twice, in 1920 and 1921, for a wide range of works "on the etiology of sleeping-sickness and framboesia, absorption of agglutinins, mortal bronchitis and vaccinations"; Ronald Ross (1902 laureate) nominated Castellani four times, between 1929 and 1932, for his "work on sleeping-sickness", but always together with pathologist and microbiologist David Bruce (1855-1931), since a long lasting controversy had been going on as to the respective roles of the two scientists in the elucidation of the aetiology of that tropical disease (24).

Italian support to Castellani came in successive waves from different universities, apparently through well-orchestrated actions. In 1914, seven scientists from the University of Siena nominated him for "the discovery of the cause of sleeping-sickness, framboesia and other tropical diseases", even if three of them used slightly different formulations. Later, in 1931, eleven professors from the University of Padua supported Castellani's nominations for his "work on different fungal diseases, bacteriological methods, vaccines, the demonstration of new microbes, description of new diseases, some clinical symptoms and therapeutic results". In 1934, a joint nomination came by eight scientists of the University of Parma for his "work on sleeping-sickness, framboesia, elephantiasis and medical mycology". Smaller support groups or even isolated nominations came in time from different universities such as Pavia, Milan, Palermo and Catania. Only in the last part of the considered period four nominations came also from the University of Rome, where

Castellani held the chair of Tropical medicine since 1931 (25).

Among the motivations, his youth contribution to the discovery of the cause of sleeping sickness (1902-1903) is by far the most often submitted, but over time a number of his contributions to laboratory methods, tropical medicine and medical mycology were also mentioned. It is worth noting that only Nobel laureate Camillo Golgi, and some years later the group from Padua, highlighted Castellani's pioneering work in the history of vaccination, a role that is only recently being rediscovered (26).

Eventually, Castellani, even if shortlisted in 1905, 1907 and 1908 never received the Prize. Among the possible reasons, the already mentioned long-lasting controversy about the elucidation of sleeping sickness, and also the fact that – as some of Castellani's critics loved to point out – his unremitting and multidimensional scientific work sometimes sacrificed quality over quantity.

Discussion and conclusions

This overview of Italian Nobel hotspots, research trends and nominators leads to the question of whether the scientific achievement of the nominees was the sole motive for nomination and the roles of social ties between e.g. nominator and nominee. This chimes with a recent discussion in Italy about the alleged Italian citation cartels among Italian scientists and whether Italian scholars try to "boost metric score" and impact with various strategies (27). With this claim finding its way into *Nature* (28) other scientists published data showing that the share of self-citations in Italy was in fact rather low (2%) and attributed the climb of Italian scientists in International impact ratings to "the overall state of health of the Italian research system"(29) and to increased productivity (30).

A similar discussion could be stimulated about the large number of scholars nominating scientists they knew personally. This seems not only to be the case for Italian scholars. The high share of Nobel nominations within the country and within universities was recently characterized as *Nationalistic homophily*, meaning that nominators tend to propose "fellow academics from the same country"(31).

This overview has confirmed Harriet Zuckerman's observation that most Nobel candidates pool in few cities. Extensive collaboration could also be seen among Italian nominees with many working together in groups such as the Roman school of malariology.

International collaboration, however, does not seem to have played a major role in the context of Nobel Prize nominations for Italian scholars leading to few Italians being nominated by foreigners. Also during the period of the fascist regime, Italians continued to be nominated in the 1922-1945 primarily by their fellow countrymen. This stands in stark contrast to Germany, where Hitler and his party banned Germans from nominating and accepting a Nobel Prize, which also had a direct effect on the nomination pattern (32).

On a more general basis, we argue that the nominations submitted for Italian scientists reflect the research landscape in the first half of the 20th century in Italy, allowing insights into popular research trends and the pinpointing of scientists and cities which were considered outstanding at that time. Even when taking into account that a high number of nominations does not necessarily mean the respective scholar will be considered prizeworthy, (33) previous research has shown, that a significant share of Nobel Laureates had been nominated over and over again by multiple scientists before finally receiving the prize (34).

Further research shall analyze the Nobel nominations of individual scholars covering their personal surroundings and the reasons that led to them not being awarded the Nobel Prize. Apart from providing an insight into the personal history of single candidates, portraying some of these individuals provide valuable information about the Italian 'Nobel population' and networks in medicine.

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