

GIOVANNI BERLUCCHI

## EMILIO VERATTI AND THE RING OF THE CZARINA

**ABSTRACT.** — Camillo Golgi, recipient of the Nobel award for Medicine or Physiology in 1906, trained many students destined to acquire international fame in the biological and medical sciences. Emilio Veratti, who was for many years Golgi's right arm in the laboratory, did not seem to be able to perform scientifically as well as many of his co-disciples. He was noted for his witty and proud character, as well as for his intellectual cleverness and skill with histological techniques. Yet his scientific productivity and academic career suffered from his excessive self-critical attitude and the division of his research interests among too many fields. Through a series of coincidences, he eventually came to occupy Golgi's chair at 58 years of age, twelve years after Golgi's retirement. International recognition of his research work occurred much later, in the 1950s and 1960s, when those who investigated the fine structure and functional significance of the sarcoplasmic reticulum of muscle fibers rediscovered a splendid paper that he had published more than fifty years previously. This study, based on a modification by Veratti of Golgi's black reaction, was judged by international experts to be by far the best contribution of light microscopy to the understanding of the structure of the sarcoplasmic reticulum. The octogenarian Veratti reacted to these belated and unexpected celebrations of his work with typical modesty, self-effacement and even skepticism.

**KEY WORDS:** Veratti; Golgi; Sarcoplasmic reticulum; Epistemology of the Golgi school.

**RIASSUNTO.** — *Emilio Veratti e l'anello della zarina.* Camillo Golgi, vincitore del premio Nobel per la Medicina nel 1906, ebbe molti allievi destinati ad acquisire fama internazionale nelle scienze mediche e biologiche. Emilio Veratti, che per molti anni fu il braccio destro di Golgi nella direzione del laboratorio, non fu generalmente considerato dello stesso livello scientifico di molti suoi condiscipoli. Si faceva notare per il suo carattere arguto e orgoglioso, per il suo acuto intelletto e per la sua abilità tecnica di istologo, ma la sua produttività scientifica e la sua carriera accademica furono svantaggiate da un eccessivo atteggiamento autocritico e da una divisione dei suoi interessi fra troppi e disparati argomenti di ricerca. Per una serie di coincidenze egli giunse ad occupare la cattedra di Golgi a 58 anni di età, dodici anni dopo che Golgi l'aveva lasciata. L'attività di ricerca di Veratti ricevette un riconoscimento internazionale solo molto tempo dopo, quando, negli anni '50 e '60, coloro che studiavano la fine struttura e il significato funzionale del reticolo sarcoplasmatico delle fibre muscolari scopersero uno splendido lavoro che egli aveva pubblicato più di mezzo secolo prima. Questo studio, basato su una modificazione personale della reazione nera di Golgi da parte di Veratti, fu ed è tuttora giudicato da esperti internazionali come il miglior contributo della microscopia ottica alla conoscenza del reticolo sarcoplasmatico. L'ultraottantenne Veratti reagì a queste tardive e inattese celebrazioni del suo lavoro con tipica modestia, riserbo e anche un certo scetticismo.

Since I am neither an expert of muscle physiology nor a historian of science, I feel that I must explicate my reasons for accepting Professor Margreth's kind invitation to speak at this Golgi day at the Accademia dei Lincei, celebrating the centennial of the publication of Emilio Veratti's paper on the sarcoplasmic reticulum. Nearly fifty years ago I enrolled in the Medical School of the University of Pavia, at a time when legend still surrounded the scientific adventure that had brought the Nobel prize in Medicine to Camillo Golgi and had made the names of several of his coworkers appear as eponyms of important discoveries in treatises of biology and medicine.

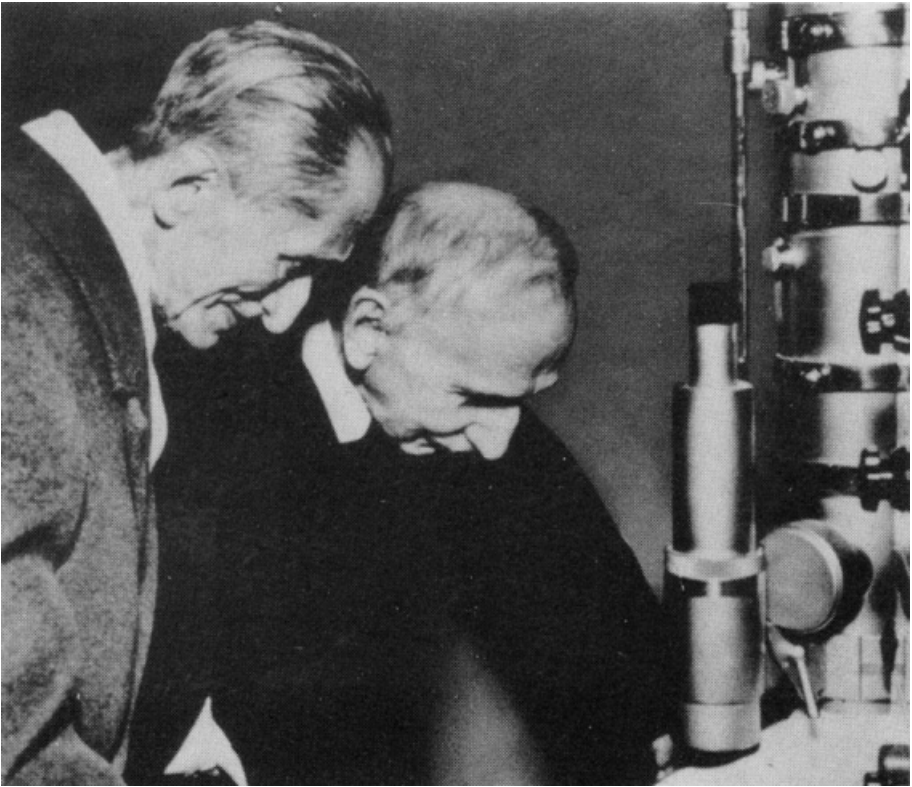


Fig. 1. – Emilio Veratti (right) and Antonio Pensa in front of the first electron microscope installed in the Institute of Human Anatomy of the University of Pavia, circa 1960 (from Pensa, 1991).

At that time Antonio Pensa and Emilio Veratti, two direct coworkers of Golgi, were still alive, both about 80 years of age (fig. 1). I don't remember ever seeing Veratti, who after leaving his position of Professor of General Pathology had retired to his native house in Varese, where he died in 1967 at 95 years of age. In contrast, Pensa was very much around (he died at 96 in 1970), since he had kept an official National Research Council position in the Institute of Human Anatomy that he had previously directed for several years. I knew him well (he gave me the whole Histology examination and part of the Anatomy examination), and during the six years of my undergraduate work at the Anatomy Institute I had frequent contacts with him. His recollections of times past made me develop almost an anthropologist's curiosity for the human factor behind a scientific effort that had restored to my alma mater the international prestige it had enjoyed in the 18<sup>th</sup> century, when it boasted among its professors two extraordinary geniuses such as Alessandro Volta and Lazzaro Spallanzani. The name of Emilio Veratti was known to my fellow students and myself mostly because he was the author of two textbooks that we had to study for our examinations of Microbiology and General Pathology. Yet there were interesting stories about him as a very unusual man whose academic career had not been equal to his remarkable intellect. The impact of his

work on the present-day developments about the sarcoplasmic reticulum will be given a scientific treatment from various perspectives by the other speakers in this meeting. As for myself, I will try to throw some light on a few peculiar aspects of his scientific life that I have learned throughout the years from a variety of sources – conversations with relatives, friends and colleagues who share my Pavian roots, writings of Veratti's and his contemporaries, Pensa's autobiography, and the publications of those modern investigators who look at Veratti as one of the initiators of the history of the sarcoplasmic reticulum. In addition, Giuseppe G. Pietra, Professor of Pathology at the University of Pennsylvania and grandson of Veratti, has kindly made available to Professor Mazzarello and myself copies of letters exchanged between Veratti and American colleagues at the time of the rediscovery of his sarcoplasmic reticulum paper.

*A man of character.*

A portrait of the man Veratti is provided in several written accounts by his contemporaries and friends. Pensa called him «the witty dissident» because he liked to argue about almost everything and to play the part of the devil's advocate with sophisticated irony, great sense of humor and considerable dialectic power (Pensa, 1991). As a scientist he apparently was a workaholic, but his published scientific output did not match the time and effort he put into research because he was hypercritical of his own work even more than that of others. According to the neurologist Medea (1966), who worked with Veratti as a student in Golgi's laboratory, the master often spurred Veratti to write up results that he felt were quite ripe for publication, but Veratti usually resisted because he had thought of some further indispensable control experiment. Throughout his life Veratti showed no sympathy for those scientists who jumped to conclusions without taking the respite necessary for assessing the validity of the facts underlying their hypotheses and theories. At 81 years of age, writing on the occasion of the fiftieth anniversary of the discovery of Negri's bodies in the brains of animals and humans with rabies, he reiterated the concept:

*«Faced by a phenomenon whose significance we do not understand, we should not satisfy ourselves with hypothetical explanations, but humbly confess our helplessness and wait for those advances in our knowledge, even perhaps in far and unexpected fields, that may afford us the elements for a sounder judgement»* (Veratti, 1953).

According to Pensa (1991), Veratti's research also suffered from his tendency to switch between too many topics of interest in such broad fields as normal histology, pathology, bacteriology, and even sanitation of the sewers of Pavia. Veratti's strong self-critical attitude was combined with an equally strong sense of personal pride, which manifested itself very early in his career in his decision to move from the University of Pavia to that of Bologna for getting his medical degree. Golgi's scientific successes and prestige, combined perhaps with his mild tendency to academic despotism, had attracted to him the envy and the hostility of a few colleagues of the Medical Faculty (Mazzarello, 1999). When students of Golgi had to defend their thesis for obtaining a medical degree, it was virtually impossible for the examining committee to arrive at the unanimous vote necessary for a *cum laude* decision, because such decision was

regularly opposed by at least one anti-Golgi committee member. As a result, in spite of the fact that the best students competed for preparing their thesis under the supervision of the great master, Golgi's students usually resigned themselves to graduate with the highest grades but without honors. This happened, for example, to Pensa, notwithstanding he had been a very good student (Pensa, 1991). But Veratti, whose curricular performance had also been well above average, was too proud to subject himself to such an injustice. A year before graduating he transferred to the University of Bologna, where he prepared a thesis on some aspects of the histology of the cerebral cortex under the supervision of a former student of Golgi, Romeo Fusari, Professor of Microscopic Anatomy. Veratti's move was successful because it made it possible for him to graduate with the highest grades and honors, and also to receive a prize for the best thesis produced in that year at the University of Bologna (fig. 2). Yet Golgi and his science were so dear to his heart that after his graduation in 1896 he promptly returned to Pavia to take up an assistant professor position at Golgi's Institute (Veratti, 1930).

#### *Ups and downs in Veratti's academic career.*

Golgi's scientific prestige allowed him to obtain positions for his collaborators not only in his own disciplines (General Pathology and Histology), but also in Anatomy and Neurology. Soon after Veratti's return from Bologna, Golgi offered him the possibility to become an assistant of Luigi Sala, Professor of Human Anatomy. Veratti, always the resolute man, declined the offer because he wanted to continue to work in Golgi's laboratory, hence the position in Anatomy went to Pensa (Pensa, 1991). Veratti's decision was to be academically rewarded, a few years later, as a consequence of an unexpected tragic event. In 1903 Giovanni Marengi, Golgi's right arm in the laboratory, died suddenly of meningitis. His post went to the 31-year old Veratti, who took his new responsibility most seriously. The organizational skill and technical competence with which he ran Golgi's laboratory were given a very important public recognition a few years later. Giovanni Battista Grassi, who had also been a student of Golgi, had acquired world fame for his discovery of the pathogenetic link between Anopheles mosquitoes and malaria. In 1911, Grassi, then Professor of Zoology of the University of Rome, wrote in a survey of the recent advances of Italian biology that as far as microscopic techniques were concerned, Golgi's laboratory had achieved a higher status than that of even the best German laboratories, and that not a small part of that achievement was to be credited to Veratti, who devoted his life to such an arduous mission (Grassi, 1911).

Veratti appeared to be a wizard with all histological techniques (fig. 3). After Golgi's discovery of the internal reticular apparatus, confirmed and extended to cells outside the nervous system by Pensa and Veratti himself (Mazzarello and Bentivoglio, 1998; Bentivoglio, 1999), it had become clear that the black reaction, if appropriately modified, could also stain intracellular components. In what was going to become the best work of his life, Veratti applied his own modification of the black reaction to muscle fibers, obtaining a superb visualization of a new type of reticulum, the sarcoplasmic



Fig. 2. – Emilio Veratti at the time of his graduation in Medicine  
(courtesy of Mrs. Merzagora Pietra, Milan).

reticulum (Veratti, 1902). That his career was very much on the rise was acknowledged by Golgi himself when in 1906 he asked Veratti to accompany him and Mrs. Golgi to Stockholm in order to witness the triumphal crowning of his scientific career by the award of the Nobel prize in Medicine or Physiology (Mazzarello, 1999). The dedication on a photograph that Golgi donated to Veratti in 1907 reads: «To Dr. Veratti, with



Fig. 3. – Emilio Veratti king of the lab (courtesy of Professor Pietra, University of Pennsylvania).

fatherly affection and in memory of the journey to Stockholm» (1). On this evidence, one could look at Veratti as Golgi's predestined scientific heir and future successor.

Yet Veratti's very promising career was not going to develop in a smooth fashion. His publication record did not grow as one could have expected from his widely recognized scientific standing, because of both his excessive self-critical attitude and his reluctance to focus his research efforts on a reasonably limited selection from the multitude of his interests. In addition, he refused to co-author the publications of students that he had

(1) I thank Mrs. Marialuisa Merzagora Pietra, granddaughter of Emilio Veratti, for providing a copy of the Golgi photograph with a dedication to Veratti. Mrs. Merzagora also kindly provided the photographs reproduced in figures 2 and 6.

directed and supervised with much generosity, competence and dedication, because he thought that those who had done the work should get the recognition. Many years later he took public international pride in this austere view of authorship, as is evident from his letter reproduced in fig. 4. On top of all this, at the outbreak of the first world war he was given the responsibility to manage some large hospital wards that had been set up in the University Colleges of Pavia for treating war casualties. He performed this task with admirable dedication and great medical skills, but also at the expense of his research (2).

But the most effective threat to the progression of Veratti's career came from the rise of a new star in the firmament of Golgi's laboratory, an ascent in which Veratti himself had played a far from insignificant role. Aldo Perroncito was the son of a Professor of Veterinary Parasitology of the University of Torino and of Erminia Aletti, niece of the great biologist Giulio Bizzozero and sister of Golgi's wife, Lina Aletti. The Golgis had no children of their own and Mrs. Golgi loved her nephew Aldo Perroncito as a son. Aldo, who studied Medicine in Pavia, understandably chose the laboratory of his uncle to prepare his thesis, and like all the students in that laboratory, he learned the techniques of the craft primarily from Veratti. Being quite bright and hard working, he started to leave his mark upon science already with his thesis work, which afforded the first demonstration that regeneration of cut peripheral nerve fibers proceeds from the proximal stump of the axon. Even Cajal, who had an intense aversion to conceding any kind of priority to competitors in his fields of research, admitted that Perroncito had beaten him in the description of the early changes occurring in nerve axons after transection (Cajal, 1991). Unlike Veratti, Perroncito was quick in producing several publications in normal and pathological histology, and in a short time he made a name for himself as a first rate investigator. As a result, in 1914 he was appointed acting

(2) I have often heard from relatives, friends and acquaintances from Pavia that Veratti's career was handicapped by his reputation as an opponent of the fascist government, but I don't know of any direct evidence that can support this suggestion. My supposition is that he despised the boorishness and crass vulgarity of the fascist style, which apparently he was inclined to quip about in the classroom, more than he disliked the antidemocratic and reactionary character of the fascist ideology. Ironically, Veratti joined the Medical Faculty of Pavia as a full professor on the same day as Angelo Nicolato, Professor of Ophthalmology and a notorious fascist leader of the Province of Pavia (Pensa, 1991). After the war Veratti and Medea were part of an epuration committee of the Istituto Lombardo di Scienze e Lettere which was to sentence the fascist and antisemitic activities of Padre Gemelli, the founder and rector of the Catholic University of Milan. Edoardo Gemelli had been a member of Golgi's laboratory at the same time as Veratti, Pensa and Medea. As a medical student and young medical doctor he had divided his energies between work in the laboratory and the preaching of the Marxist credo to the peasants of the Pavia countryside. Suddenly and quite unexpectedly he responded to the calling of God by leaving the laboratory to be ordained as a Franciscan friar with the name of fra' Agostino. He became a major figure of the Catholic culture in Italy. He also initiated a school of experimental psychology at his University (Cosmacini, 1985). Amongst Veratti's students, one whose academic career was interrupted because of his antifascist activities was the bacteriologist Carlo Callerio. In the 1960s Callerio gave his generous patronage to the foundation of the Medical Faculty of the University of Trieste. He named the electron microscope laboratory of that Faculty after Emilio Veratti (information about Carlo Callerio and the Callerio Foundation in Trieste can be found at <http://www.callerio.org/History.htm>).



AN AUTOBIOGRAPHICAL NOTE FROM  
EMILIO VERATTI

"I MUST CONFESS that I do not have a complete curriculum vitae; therefore, I can give you only a short summary of my career which was not particularly rich in success.

"I was graduated in Medicine at Bologna in 1896, and soon afterwards became Assistant in Camillo Golgi's Laboratory [University of Pavia] where I had been a student several years previously. I remained there until 1919. During this time, I acquired the *Libera Docenza* [equivalent of German *Privat Dozent*] in histology and later in general pathology, and was put in charge of the teaching of microbiology at the Medical School. When Professor Golgi retired and was succeeded by Professor Aldo Perroncito, I left the post of Assistant and found hospitality in the Medical Clinic which, at that time, was directed by Professor Zoia. I organized there a very modest laboratory where I was able to work with a team of eager young investigators. Finally, in 1930, after Professor Perroncito's untimely death, I obtained the Chair of General Pathology which I held until I retired in 1942.

"I published a Textbook of General Pathology which went into six editions, a Manual of Bacteriology which went into three, (an unusual editorial success for books of this kind in our country), and a monograph on "Inflammation" in the Textbook of Pathological Anatomy edited by Pio Foà. I also published about 70 original papers on various subjects in normal and pathological histology, general pathology and microbiology.

"In addition to my own publications, I initiated and directed more than 100 works by my students which, of course, were published under the names of those who actually carried out the work, according to a custom which no longer seems fashionable."

Translated from his letter  
of July 8, 1960

Fig. 4. – Veratti's photograph and letter published in the *Journal of Biophysical and Biochemical Cytology*, 1961.

Professor of General Pathology at the University of Cagliari. In 1918 Golgi retired and Veratti was appointed by the Medical Faculty to replace him as acting professor, but it was clear that this was going to be a temporary assignment. In the meantime Perroncito





Fig. 5. – Veratti (sitting, second from right) and Pensa (sitting, second from left) in a group photograph of Golgi's collaborators and students circa 1900. A very young Aldo Perroncito, who was then being trained by Veratti, is standing on the extreme right. The bearded man sitting on Golgi's right is the Russian Serge Soukhanoff, who was visiting Golgi's laboratory at the time (from Mazzarello, 1999).

had been made a full professor in Cagliari, and in 1920 the Medical Faculty of Pavia designated him as the official successor to Golgi. Veratti had a very high opinion of Perroncito and had followed his former trainee's career with an almost avuncular satisfaction. He was incapable of holding a grudge against either Perroncito or Golgi, but as a very proud man he could not accept to work under someone who was ten years his junior and had been an undergraduate student when he was Golgi's second-in-command (fig. 5). In 1921 he therefore resigned from his position in Golgi's Institute and became the director of a modest bacteriology laboratory in the Medical Clinic of the University of Pavia (Pensa, 1991).

Golgi was clearly pleased to have Perroncito as his successor. The Accademia dei Lincei, the most important and rather exclusive cultural institution of Italy, elected Perroncito as corresponding member in 1923 and national member in 1925, clearly with the support of Golgi, a prominent figure in the Academy, to which, incidentally, Veratti was never admitted. Perroncito was expected to remain in charge of Golgi's Institute for some thirty years, but fate decided otherwise. He had contracted tuberculosis while serving as a medical officer during the war, and a relapse of the disease ended his life in 1929. At that point Veratti applied successfully for a full professor position in General Pathology, and in 1930, at 58 years of age, he came to occupy Golgi's chair four years after the death of his teacher (fig. 6).



Fig. 6. – Professor Veratti wearing the academic robes of the University of Pavia, *Alma Ticinensis Universitas* (courtesy of Mrs. Merzagora Pietra, Milan).

### *The ring of the czarina.*

Veratti's career as full professor of General Pathology and director of Golgi's Institute was marked by a search for excellence in teaching, as well as by self-effacement and an even exaggerated modesty as regards his own research. I recently looked at the 6th edition of his Textbook of General Pathology (Veratti, 1950) and the 3rd edition of his Manual of Practical Bacteriology (Veratti and Bianchi, 1953), which I had to study for my examinations and are still in my possession. The name Veratti does not appear in the analytical index of the General Pathology Textbook, even though

the text contains original data, ideas and illustrations from Veratti's research work, especially on inflammation. By contrast, there are in that index several references to members of the Golgi's school in addition to Golgi himself, such as Negri, Monti, Pensa, Perroncito, Locatelli. Veratti's name is mentioned in the analytical index of the Bacteriology Manual, but that is most probably due to Luigi Bianchi, a pupil of Veratti and Professor of Microbiology, who revised and co-authored that edition of the Manual.

Veratti's understating attitude in his self-evaluation as a scientist is best epitomized by the theme that he chose for his farewell lecture to the medical students when he reached the age of compulsory retirement in 1942. Paolo Pinelli, now Professor Emeritus of Neurology at the University of Milan, attended the lecture as a third-year medical student at Pavia and was greatly impressed by it. I am grateful to him for telling me the story repeatedly over the years in great detail, supported by confirmations from other independent sources. Veratti surprised the students by sparing them the usual exposition of scientific material and by recounting instead the parable which has suggested the title for my talk. During a grand ball at the czar's court, the czarina suddenly realized that she had lost a precious ring while dancing. The czar then divided the huge ballroom into a number of sectors equal to the number of gentlemen in attendance, and gave each gentleman the responsibility to look carefully for the ring in the sector specifically assigned to him. Obviously only one gentleman eventually found the ring, but the czar's reward rightly went to all participants, because the success of the search was due not only to the lucky searcher, but also to those who had thoroughly done their job in excluding the presence of the ring in their respective sectors.

With this parable Veratti wanted to convey the moral message that doing serious science is rewarding by itself even in absence of dramatic accomplishments, but at the same time he also meant to expose the audience to a recapitulation as well as to a justification of his own scientific life. Although he could not boast any major discovery, he felt proud and content that like those gentlemen who had not found the ring, he had contributed to the scientific search for truth with the unspectacular but sound results of his competent and conscientious exploration of several areas of biology and medicine. According to an additional, rather mischievous and unproven suggestion, Veratti's parable may perhaps have contained a hidden reproach to Golgi (the czar) for making him work on relatively unfertile themes of investigation compared to those which had brought more visible successes to other members of the laboratory.

*But Veratti did find a ring!*

If Veratti believed that he had made no striking scientific discovery, the judgement of posterity on his work did not match his belief. H. Stanley Bennett of the University of Washington at Seattle, a pioneer of electron microscopy, rediscovered his paper on the sarcoplasmic reticulum (Veratti, 1902) in the 1950s and proclaimed it to be the most comprehensive treatment of this reticulum based on light microscopic investigations (Mazzarello, 2002). Inspection of the beautiful drawings in Veratti's paper led Bennett to call attention to the relevance of some of Veratti's histological findings for the understanding of the then fresh physiological findings of Huxley and Taylor (1955)

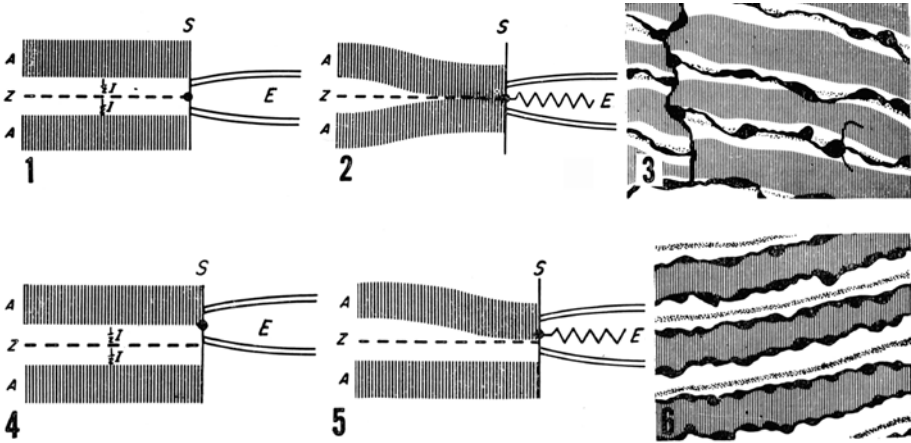


Fig. 7. – Bennett's figure showing the correspondence between Veratti's histological findings and Huxley's physiological findings (from Bennett, 1960).

and Huxley (1957). These authors had determined the location of «sensitive spots» on the sarcolemma of striate muscle fibers by producing localized contractions in a sarcomere with subthreshold depolarizing currents. The sensitive spot was found at the level of the Z band in frog muscle fibers, and at the A-I junction in crab muscle fibers. We now know that the localized contraction effect is due to an electrotonic spread of the stimulating current along the transverse tubules, the spatial relations of which to the sarcomeres are different in frog, crab and lizard muscle fibers. In a review published in 1960, containing many reproductions of the original illustrations of Veratti's paper, Bennett presented side-to-side drawings to show the striking correspondence between the sensitive spots localized with electrical stimulation and the transversal strands impregnated by the black reaction in Veratti's preparations (Bennett, 1960; see fig. 7). Veratti's transversal strands that appeared to reach the fiber's outer surface were therefore to be interpreted as transversal or T tubules rather than parts of what we know as the sarcoplasmic reticulum proper<sup>(3)</sup>. In Veratti's preparations, partial impregnation of the sarcoplasmic reticulum proper probably produced the longitudinal striations (Mazzarello, 2002).

Veratti himself (1902) had drawn attention to the different spatial relations between the transversal reticular striations and the striations of the muscle columns in different animal species, although he had expressed the belief that such interspecies differences might be artifacts of the impregnation method. In addition, Bennett supplied an English

<sup>(3)</sup> I learned about the Bennett's review in the early 1960s from my teacher, Giuseppe Moruzzi, head of the Institute of Physiology of the University of Pisa, where I had moved soon after graduating in Pavia. I believe that Professor Moruzzi was the first in Italy to discuss in the physiology classroom the functional significance of Veratti's histological findings, which he called «le striae del Veratti». He included in his treatise of Physiology a modified version of Bennett's figure with the side-to-side representation of Huxley and Taylor's sensitive spots and Veratti's reticulum (Moruzzi, 1975).

translation of Veratti's paper to be included in the supplement of the August 1961 issue of the *Journal of Biophysical and Biochemical Cytology* devoted to the sarcoplasmic reticulum, thus at last making the paper available to the international scientific community (Veratti, 1961).

The way in which Veratti became aware of the appreciation of his old paper by American investigators has been nicely recounted by Sir Andrew Huxley: «*In most striated muscle fibres, electron micrographs show an elaborate system of tubules and vesicles in the spaces between the fibrils. These have to do with the process of turning on the contractile material which forms the fibrils themselves. Their structure and function have been worked out from 1953 onwards, but forgotten papers from the turn of the century, mostly based on the Golgi method, contained much first-rate information about them . . . A beautiful paper by E. Veratti (1902) was rediscovered by Professor H.S. Bennett, and an English translation of it is published as a theme of a Supplement to the Journal of Biophysical and Biochemical Cytology together with a collection of articles on these structures. About 1959 my friend and colleague Lee Peachey wrote to the University of Pavia, where Veratti had worked, asking if a reprint of the original paper were available, and was surprised to receive a courteous reply of Veratti himself, enclosing two reprints, one of which Peachey gave to me*» (Huxley, 1977).

In 1960 Keith Porter, the Editor of the above mentioned Supplement of the *Journal of Biophysical and Biochemical Cytology*, contacted Veratti in order to obtain authorization for publishing the English translation of his paper. The results of that contact are described by Porter in his preface to the Supplement: «*The papers selected for this first supplement deal with a reticular component of striated muscle fibers that has received varying amounts of attention over the last century but which, within the last fifty years, has been generally forgotten until rediscovered by electron microscopy. The current studies of this system, of which a few are reported here, attest to its importance in muscle fibers and cells in general. Dr. Veratti's is one of the most significant papers on the subject ever published. Fortunately the author is still living, and has provided the brief autobiography published on page vii. We are naturally proud to be able, within the lifetime of this investigator, to give one of his best papers that recognition it well deserves, especially since he has commented in correspondence that very few people noticed it when it was originally published. In acknowledging the contributions of several people to the publication of the supplement we are pleased first of all to thank Dr. Veratti for his photograph, his biography, and his interest. He has lent a certain liveliness to the project*» (Porter, 1961).

Veratti's photograph and letter cited by Porter are reproduced in fig. 4. In spite of their conciseness, Veratti's correspondence with Porter and his letter provide a veritable representation of the man's pride, dignity and austerity, as well as of his underrating of his work and his aversion to the limelight. His only apparent concession to vanity was his choice of a photograph presumably taken at about the time of his study on the sarcoplasmic reticulum, a genuine «portrait of the author as a young man» (Locatelli, 1967). From documents provided by Professor Pietra, Veratti's grandson, it turns out, however, that Veratti hated that photograph. He sent it because the Americans wanted a photograph from the time he had published the sarcoplasmic reticulum paper, and that was the only one he had.

*The scientific decline of the Golgi school.*

The basic epistemological attitude of the Golgi's school was characterized by an extreme form of physicalism whereby scientific truths could only be reached or approached by discovering entities having actual material existence. Structures, rather than functions, were regarded as the ontological monopoly of true science. Accordingly, an obsessive preoccupation of Golgi and his followers was to decide whether what they saw under the microscope was a real thing or an artifact of fixation or of other histological manipulations. They thought that in the absence of tangible evidence afforded by the microscope, biological mechanisms, functions and processes were abstractions about which science could only offer far-fetched speculations or at best indirect hypotheses instead of definitive knowledge. One of Golgi's claims was that the chief task of anatomy was to answer the most pressing questions asked by physiology (Golgi, 1885). Apart from the fact that very rarely, if ever, did he condescend to listen to the questions of physiologists, by that claim Golgi meant that only the analysis of material structures can lead to a complete understanding of the oddities of biological reality (Berlucchi, 1999). The historical failure of Golgi's descendants to maintain a high standing on the international scientific scene can be ascribed to their allegiance to their master's view of the light microscope as the ultimate and supreme means of investigation. The question is, how can the mere observation of a static structure explain its function? Even the hypercritical Veratti did not deviate from the slanted way of thinking of the Golgi school, and his best paper makes it clear that he thought that any attempt to attribute a function to a complicated structure such as his reticulum was a futile exercise.

Cajal met the young Veratti at the 1903 International Congress of Medicine in Madrid and wrote in his autobiography: «Dr. E. Veratti, a young man of great talent, pupil and assistant of Golgi, showed himself in various papers and discussions an enthusiastic defender of his teacher's ideas and methods» (Cajal, 1991).

Twenty-three years later Veratti wrote an obituary of Golgi in which his unabated loyalty to the master went so far as to try and defend the indefensible diffuse nerve net theory against the neuron theory (Veratti, 1926). His arguments ranged from the denial of the existence of any serious evidence on the propagation of the «nervous wave», to the assertion that the neuron theory was solely a gimmick used by physiologists and neurologists for simplifying the description of complex relations and functions. In so arguing, Veratti was guilty of neglecting all the giants of the 19<sup>th</sup> century electrophysiology (Matteucci, Du-Bois Reymond, Helmholtz, Hermann, Bernstein, etc.), the great conceptual and technical developments of neurophysiology in the early 20<sup>th</sup> century due to Sherrington, Lucas and Adrian, not to speak of the neurohistology of Cajal and his followers. In addition, he completely lost his critical power when he suggested that selective and isolated interactions can occur in a system of diffuse nerve connections in the same way as an electric current can take momentary different pathways through a colloidal solution. This shows how even a very critical mind could be clouded not only by a per se laudable affection for Golgi, but also by a scientific perspective narrowed and distorted by an odd epistemology.

In 1983 Lee Peachey wrote in the preface to the volume on skeletal muscle of the *Handbook of Physiology*: «I think Veratti, were he alive today, would have enjoyed immensely seeing the networks he so elegantly described in muscle cells as we now see them in the high-voltage electron microscope» (Peachey, 1983). Be that as it may, I am afraid that Veratti would have remained as skeptical about the functions currently attributed to the sarcoplasmic reticulum as he was reported to be when in the 1950s and 1960s he was told about the initial developments in the understanding of the role of the sarcoplasmic reticulum in muscle contraction. He may have relished the demonstration by the electron microscope that his networks were no histological artifacts, though there is some evidence that he thought that «his» sarcoplasmic reticulum was a different thing from the structure unveiled by the new histological investigations<sup>(4)</sup>. And with regard to the links between structure and function, he would have probably stuck to the belief firmly expressed in one of the final sentences of his best paper: «There are no data on which to base any hypothesis on the functional significance of the reticular apparatus of muscle fibers».

## REFERENCES

- BENNETT H.S., 1960. *The structure of striated muscle as seen by the electron microscope*. In: G.H. BOURNE (ed.), *The structure and function of muscle*. Academic Press, New York–London: 137-181.
- BENTIVOGLIO M., 1999. *The discovery of the Golgi apparatus*. *J. Hist. Neurosci.*, 8: 202-208.
- BERLUCCHI G., 1999. *Some aspects of the history of the law of dynamic polarization of the neuron. From William James to Sherrington, from Cajal and van Gehuchten to Golgi*. *J. Hist. Neurosci.*, 8: 191-201.
- CAJAL S.R., 1991. *Recollections of my life*. The MIT Press, Cambridge, Mass.
- COSMACINI G., 1985. *Gemelli. Il Machiavelli di Dio*. Rizzoli, Milano.
- GOLGI C., 1885. *Sulla fina anatomia degli organi centrali del sistema nervoso*. Calderini, Reggio Emilia.
- GRASSI G.B., 1911. *I progressi della biologia e delle sue applicazioni pratiche conseguiti in Italia nell'ultimo cinquantennio*. In: *Cinquanta anni di storia italiana*. Pubbl. R. Acc. Lincei, vol. 3, parte 1. Hoepli, Milano: 151-156.
- HUXLEY A.F., 1957. *Local activation of striated muscle from the frog and the crab*. *J. Physiol.*, 135: 17P-18P.
- HUXLEY A.F., 1977. *Looking back on muscle*. In: A.L. HODGKIN (ed.), *The pursuit of nature. Informal essays on the history of physiology*. Cambridge University Press, Cambridge: 23-64.
- HUXLEY A.F., TAYLOR R.E., 1955. *Activation of a single sarcomere*. *J. Physiol.*, 130: 49P-50P.
- LOCATELLI P., 1967. *Emilio Veratti*. *Rend. Ist. Lombardo Sci. Lett.*, 101: 1-7.
- MAZZARELLO P., 1999. *The hidden structure: A scientific biography of Camillo Golgi*. Oxford University Press, Oxford (originally published as: *La struttura nascosta*. Cisalpino, Bologna 1996. Translated from the Italian and edited by H. A. Buchtel and A. Badiani).
- MAZZARELLO P., 2002. *La scoperta del reticolo sarcoplasmatico*. *Rend. Fis. Acc. Lincei*, s. 9, v. 13: 273-288.
- MAZZARELLO P., BENTIVOGLIO M., 1998. *The centenarian Golgi apparatus*. *Nature*, 392: 543-544.
- MEDEA E., 1966. *Come, quando, dove li ho conosciuti. Profili di grandi medici*. Edizioni Minerva Medica, Torino.
- MORUZZI G., 1975. *Fisiologia della vita di relazione*. UTET, Torino.
- PEACHEY L.D., 1983. *Preface*. In: L.D. PEACHEY (ed.), *Handbook of Physiology, Section N. 10: Skeletal muscle*. American Physiological Society, Bethesda, Maryland: V-IX.
- PENSA A., 1991. *Ricordi di vita universitaria (1892-1970)* (a cura di Bruno Zanobio). Cisalpino, Istituto Editoriale Universitario, Milano, 326 pp.

<sup>(4)</sup> Professor Mazzarello has obtained from Professor Pietra, grandson of Emilio Veratti, copies of the correspondence between Veratti and Giuseppe Millonig, a former member of the Institute of Anatomy in Pavia who worked in Porter's laboratory and contacted Veratti on his behalf. I thank Professors Pietra and Mazzarello for providing me with this important material.

- PORTER K.R., 1961. *Preface*. J. Biophys. Biochem. Cytol., 10 (4) suppl.: V-VI.
- VERATTI E., 1902. *Ricerche sulla fine struttura della fibra muscolare striata*. Mem. R. Ist. Lombardo, Cl. Sc. Mat. Nat., 19: 87-133.
- VERATTI E., 1926. *Camillo Golgi e la sua opera scientifica*. Boll. Ist. Sieroter. Milan., 5: 1-14.
- VERATTI E., 1930. *Curriculum vitae*. Tipografia Cooperativa, Pavia.
- VERATTI E., 1950. *Patologia Generale*. 6<sup>a</sup> edizione, Vallardi, Milano.
- VERATTI E., 1953. *L'interpretazione dei corpi del Negri cinquant'anni dopo la scoperta*. Boll. Soc. Med.-Chir. Pavia, 67: 1-13.
- VERATTI E., 1961. *Investigations on the fine structure of the striated muscle fiber*. J. Biophys. Biochem. Cytol., 10 (4) suppl.: 3-59 (Translated from the Italian by C. Bruni, H.S. Bennett and D. de Koven).
- VERATTI E., BIANCHI L., 1953. *Manuale di Batteriologia Pratica*. 3<sup>a</sup> edizione, Vallardi, Milano.
- 

Dipartimento di Scienze Neurologiche e della Visione  
Sezione di Fisiologia Umana  
Università degli Studi di Verona  
Strada Le Grazie, 8 - 37134 VERONA  
giovanni.berlucchi@univr.it