Alfonso Corti and the discovery of the hearing organ: the man, his life, his works.

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Abstract
Alfonso Corti was 28 years old when he wrote the first draft of his most famous work (*Recherches sur l'organe de l'ouïe des mammifères*) while in Paris in 1850, probably at the Sorbonne. His work was published in June of the following year. The human and scientific story of this young medical student is fascinating. He left Pavia, the city of his youth and where he had begun his medical studies, and went to complete them in Vienna, where he graduated. He then continued his studies in several European cities – in Bern, Paris, London, Utrecht, and Würzburg – before completely cutting all his ties with the scientific world to which he had been so dedicated when he was just 32 years of age. The name of Corti quickly became known throughout the world, and synonymous with the organ of hearing, thanks to Joseph Hyrtl and Albert Kölliker, who had been his teachers and mentors. Almost nothing was known about Alfonso Corti as a scholar, however, until the publication of biographical articles by Gottfried Brückner (1913) and Josef Schaffer (1914), and especially the monograph by Bruno Pincherle published in 1932. With this paper [1], coinciding with the bicentenary of Corti's birth, we wanted to explore this man's human and scientific history.

Key words: Alfonso Corti, cochlea, inner ear

The organ of Corti is the key structure of the ear and of auditory function, the formation at which a physical phenomenon, the sound wave, gives rise to a biological signal, the action potential of the acoustic nerve.

But why 'organ of Corti'? Where does the eponym come from? Who was Corti?

Alfonso Corti in Pavia

Marquis Alfonso Corti of Santo Stefano Belbo, descendant of a noble and wealthy Lombardy-Piedmontese family, was born in Gambarana, now in the province of Pavia but then part of the Kingdom of Sardinia, on 15 June 1822. He was the son of Marquis Gaspare Giuseppe Corti of Santo Stefano Belbo and Beatrice of the Marquises Malaspina di Carbonara, the first of three brothers (Alfonso, Luigi, and Carlo) and two sisters (Emilia and Costanza). His brother Luigi (box 1), who graduated in mathematics and then entered diplomacy, became ambassador, plenipotentiary and finally foreign minister under the Cairoli government in 1878. After high school, Alfonso enrolled in 1841 in the Faculty of Medicine at the University of Pavia and 'gave himself up to medical studies only because of a particular predilection for human and comparative anatomy'. Under the guidance of Bartolomeo Panizza (box 2), professor of anatomy, and Mauro Rusconi (box 3), free researcher, both students of the great anatomist Antonio Scarpa (box 4), Corti learnt the techniques of anatomical dissection that

[1] This paper is mainly based on the volume: Alfonso Corti. The discovery of the hearing organ, (English edition) and Alfonso Corti. La scoperta dell'organo dell'udito (Italian edition), by A Martini, P Mazzarello, E Mira and A Mudry, Padova University Press, Padova, 2022.

would serve him for the construction of wax anatomical models and for the realisation of his medical degree thesis. From Rusconi, he was also initiated into the principles of microscopic anatomy, a discipline that was emerging in those years thanks to the introduction of the compound achromatic microscope.

Alfonso Corti in Vienna

The young Corti was fascinated by histological research and, in order to devote himself more and more to this academic field, after four years, in 1845, he left Pavia and, via Milan, Pisa, where he bought what was to become his beloved microscope, and Trieste, enrolled in the Faculty of Medicine at the University of Vienna, the capital and seat of the most important university in the Habsburg Empire. As he struggled to improve his stunted German, he was taken on as an internal student by professor Josef Hyrtl (box 5), chair of Anatomy and director of the Anatomical Institute. In the following months, Corti worked frantically on dissections and the preparation of anatomical preparations, and on 6 August 1847, he graduated in Medicine with a thesis entitled *'De systemate vasorum psammosauri grisei'*, dealing with the vascular system of a variety of lizard, the monitor lizard (*Varanus griseus*). This first scientific work does not contain any discoveries of value, although it goes beyond the usual level of medical theses and proves Corti's virtuosity, already displayed in Pavia, in anatomical preparations. Having earned Hyrtl's esteem and almost admiration for his personality and commitment, Corti won a position as an unpaid assistant - *prosector* - at the Institute of Anatomy on 2 December 1847. In his application, Corti confesses that "in order to fully satisfy his predilection for anatomy and consecrate his life to it, he overcame all the obstacles that stood in his way, overcame living with his family and abandoned his homeland" and that, by coming to Vienna, he "lost the chance of obtaining a post in Pavia, as he had been privately promised". The beginning of the new year sees Corti already at work. But 1848 is throughout Europe the year of the springtime of the peoples: the Habsburg empire encompasses a multitude of nationalities that start a series of revolutionary uprisings aimed at obtaining autonomy and independence. In Vienna, riots broke out on 13 March and dragged on with alternating phases until the end of the year, leading among other things to the damage to the Institute of Anatomy and the interruption of all its activities (box 6). Corti, equally disgusted by the revolution and repression, unable to continue his beloved research in microscopic anatomy and moved by patriotic sentiments, left Vienna, moved to Turin and, from November 1848, served in the Piedmontese army during the First War of Italian Independence.

Around Europe

With the return of peace in the spring of 1849, Corti embarked on a peregrination with a series of stays at the main anatomical institutes in Europe. After stopping briefly in Berlin with anatomy and physiology professor Johannes Peter Müller and then in Zurich, where he met anatomy professor Joseph Engel, he settled in Berne from February 1849, where the illustrious anatomist and physiologist Gabriel Gustav Valentin (box 7) welcomed him with benevolence. The young scholar was admitted not only to the Institute but also to Valentin's house, with whom he formed a deep friendship: this is testified by the correspondence exchanged between the two scientists in the years 1850-1855. Corti spent a few months in Berne, which he remembers as one of the happiest in his life, but his desire to compare himself with his European colleagues and to master the most advanced histological techniques at source drove him to London in August 1849, where he met the histologists Paget, Wharton Jones and Owen, then to Paris, where he spent ten months working at the Sorbonne's Institute of Anatomy and forging links with the histologists Lebert and Robin, and finally to Würzburg, in Bavaria. Here, at the prestigious Institute of Anatomy, he stayed from January to October 1850, having as lecturers Albert Kölliker (box 8), anatomist, and Rudolf Virchow (box 9), pathologist, the fathers of cell theory. Here too, in just a few months, the young marquis earned the esteem and friendship of the two great masters, thanks to his commitment and determination in microscopic research. Corti's apprenticeship was completed with a stay

in August 1850 at the *Observatorium Microscopicum* in Utrecht, Europe's most advanced centre for microscopic anatomy studies, with Jacobus Schroeder van der Kolk and Pieter Harting, respectively the head of the Institute and the author of the fundamental treatise *Das Mikroskop*. In Würzburg, Corti carried out a series of studies on the retina and ciliary motility in the digestive organs of amphibian larvae, which were to be the subject of his first publications in German-language journals in 1850. With these, Corti became a full member of the group of European researchers who, by mastering the use of the microscope and the techniques of tissue fixation and staining, laid the foundations of microscopic anatomy and histology. But during his stay in Würzburg, Corti - a perfectionist - prepared himself for one of the histologist's most difficult tasks, the study of soft tissues contained within a compact bone box, such as the cochlea and the membranous labyrinth enclosed in the petrous temporal bone. On 24 October 1850, Corti left Würzburg for Paris where he remained until the early summer of 1851 at the Sorbonne's Institute of Anatomy, and where he continued his research on the cochlea with his characteristic determination and almost doggedness. This led him to the writing, first in Italian and then in French, and then, on 30 June 1851, to the printing in the journal *Zeitschrift für wissenschaftliche Zoologie*, of his leading article *'Recherches sur l'organe de l'ouïe des mammifères'*.

'Recherches sur l'organe de l'ouïe des mammifères'

In sixty pages of a dense and limpid text, Corti describes the techniques used and the anatomical formations observed. He does so with a rare economy of words and yet with the utmost precision. The morphological explanations are illustrated with two colour plates engraved according to the author's drawings. The indications on the size and number of the various formations are of an admirable accuracy, when one considers the technical limitations of the time. Although not content with the mere presentation of anatomical data, Corti knows how to rigorously separate objective observations from the hypotheses they may suggest. If Hyrtl had been Corti's master in the macroscopic and comparative study of refined anatomical preparations, Corti owes his mastery of microscopic tissue analysis to Kölliker. His personal success is largely due to a successful combination of these two approaches. It is undoubtedly to Kölliker's credit that he quoted Corti's observations on the inner ear in his treatise *Mikroscopische Anatomie oder Gewebelehre des Menschen* (1850-1854) and acknowledged their authorship, calling them *Corti's 'spiral organ*. Kölliker's esteem is well documented by this letter of his dated 19 March 1851, just before the publication of the *Recherches* 'In my opinion your work has been excellently done and I can assure you that it will bring you honours from all quarters, all the more so when we consider the tremendous difficulty of handling this subject. If the physiology of the ear becomes our knowledge, it will only be after someone has studied this organ as diligently and carefully as you have begun'. A careful reading of the *Recherches*, regardless of the information on the histology of the cochlea and the techniques used for its study, allows us to make a few considerations on the feelings that must have animated Corti in those months: the promise to deepen and broaden his observations on the anatomy of the inner ear and the possibility of finding connections between anatomical data and the principles of auditory function. The promise can already be found on the title page: after the title *Recherches sur l'organe de l'ouïe des mammifères* we find *'Première partie - Limaçon'*. Further on, Corti writes "I will finally add that I am convinced that I am far from having exhausted such a difficult subject as the anatomy of the mammalian cochlea. I hope to later extend this research to the relationship between anatomy, physiology and chemistry, and in a larger number of animals, as far as the limited optical and chemical means available to science today will allow". And again, by analysing certain characteristics of dentate cells that could be the effect of exposure to noise, he advances some ideas on the transmission of sounds. But his anatomized brain, which despises hypotheses and only looks at facts and experimental data, holds him back and postpones him to future experiences "I confess, finally, apart from the data, that I do not give the reflections I am making any more im-

portance than a probable hypothesis might deserve. I have added them, as it were, to let a little imagination work alongside patience. Of course, the function of this marvellous part of the organ of hearing can only be explained through the exact application of the laws of acoustics and this is what I hope to soon undertake".

1851-1876: family and land

Then, abruptly, and almost dramatically, a change took place in Alfonso Corti's life and almost in his personality, a change still not clarified by his biographers.

Pressed by sudden and serious family commitments, Corti leaves Paris and returns to Italy. The turning point can be found in this letter written from Turin on 30 July 1851, a month after the publication of the *Recherches*, to his teacher and friend Valentin in Berne "... I was last spring quietly in Paris, waiting for the printed copies of my *Recherches*, to then leave for Italy at my ease and have the great consolation of visiting you in Berne, when pressing business forced me to leave hastily for Turin. There, I had to deal with the division of my father's inheritance between us brothers and then sell, buy, exchange, etc., etc. All this was hampered by the presence of a minor and a curmudgeonly relative. I therefore had to resort to courts, lawyers, notaries, engineers, etc., etc.! And I will still have to do so perhaps until November. And a great deal of prudence and shrewdness was and is required of me so that I do not allow myself to be cheated. In so many cheats I spent the saddest time of my life. You will now easily conceive how I neither had nor can have any head for science nor for writing to friends. But now I am adjusting my affairs in such a way that I will never again be so interrupted in my studies. And in the coming winter I shall begin to devote myself to it again with all warmth and resume my work on the organ of hearing...". And, as if to emphasise his transition from the world of science to the world of family interests, he specifies 'Address me: Marquis Alph. Corti. Turin. Poste Restante. Please omit the title of Docteur for reasons unrelated to me and known to you'. In Turin, Corti continued his research in the laboratory of his friend Filippo De Filippi, professor of Zoology and director of the Zoological Museum, with whom he was planning to write a treatise on comparative anatomy, even though, as he had previously declared, he was not interested in an academic career: "Although I still received a few invitations to Turin as *professeur agregé*, I renounced all employment, and decided to treat science privately and independently". But, torn between family commitments and his love for science (as Corti wrote in a letter to Mrs Valentin in 1852 or 1853: "In addition to my studies, to which I am returning as to my first loves, I have many affairs of great moment at my head"), the sacred fire that had animated him in the previous months and led him to examine 200 mammal cochleae in a few weeks was extinguished. The planned study on the posterior labyrinth is not carried out, other systematic research is not undertaken. Corti only devoted himself to occasional research and only an almost fortuitous occasion gave him the opportunity to publish his fourth and last article on the histology of the elephant. In the summer of 1853, Valentin visited Corti in Turin and urged him to resume work on some more important topics, but despite the urging of his friend and teacher, Corti only occasionally resumed his research, only to interrupt it after a few days. In 1854, he completely and permanently ceased his scientific activity and professional relations and did not keep any manuscript accounts of his unpublished work. Corti's last letter to Valentin is dated 8 January 1854. In it, he thanks his Bernese teacher who had just promoted Corti's election as a member of the *Leopoldinisch-Carolinische Akademie der Naturforscher*. He promises to report the results of some microscopic investigations, but also points out the difficulties in obtaining material for his studies. In his letter of thanks to the president of the Leopoldine Academy, Prof. Nees von Esenheck of Breslau, written on 10 March 1854, Corti mentions for the first time that he was forced to rest: "a non-threatening but very tedious illness has rendered me inactive for the time being'. It is probably rheumatoid arthritis, which in the early stages can limit the fine movements of the fingers necessary for the use of the microscope, but without adequate therapy gradually spreads to all joints causing acute and widespread pain and inability to move. On 24 September 1855, the 33-year-old Marchese

Alfonso Corti married the 20-year-old Maria Anna Carlotta Bettinzoli, heiress to a noble family from the Cremasque with rich landed estates. A year later, and after the birth of a baby girl, the couple left the patrician villa in Pieranica, near Crema, and moved to the Villa Mazzolino estate in Corvino San Quirico, in the hills of Oltrepò Pavese. Two years later, in 1861, his wife died giving birth to their son Gaspare. For 15 years, prevented from using his contorted and blocked hands, racked by the pains of deforming arthritis, immobilised in a wheelchair, Corti devoted himself to his children and the viticulture with the same determination with which he had dedicated himself to histological research. Under his leadership, the Mazzolino estate became a centre of excellence both for innovations in winegrowing techniques and for the excellent production of wines. With his skills and commitment, the adult and disabled Marquis Alfonso Corti earned the same esteem and respect among winegrowers that the young Marquis had earned among European microscopists. The Mazzolino estate, while continuing the winegrowing tradition, was sold in 1980 by the Corti heirs to another property while they still live in Villa Corti in Pieranica. Alfonso Corti died on 2 October 1876, aged just 54, and rests in the family tomb in the cemetery of Corvino San Quirico.

Works and memory

Corti's relations with fellow anatomists ended by his own decision in 1854. His figure began to fade. Highly positive judgements on his person and work can be found in Hyrtl's and Kölliker's treatises, but later only the bibliographical references to the *Recherches*, the leading article, remain in the scientific literature. Throughout the second half of the 19th century, citations of the *Recherches* multiply in articles and treatises on otology, confirming Corti's observations, which remain fundamental in our knowledge of the microscopic anatomy of the cochlea, but the author's memory is lost. Only the eponym *'Corti's organ'* remains. A recurring phrase in the various quotations is "Corti passed like a meteor in the scientific world of the mid-19th century". The complete loss of contact with the scientific world for a long period, the absence of official university appointments and the research carried out outside his homeland in many places, contributed to the man being forgotten. This explains how Corti's death was not reported by any necrological news in the scientific press and how 19th-century textbooks and encyclopaedias ignored the fundamental events of his life. It was not until the beginning of the 20th century that the first contributions to the biography of our character arose, who was still cited in a JAMA editorial in 1914 as *'Alfonso Corti - a submerged histologist'*. The initial works by Brückner (1913) and Schaffer (1914) were followed by the accurate monograph by Pincherle (1932), the original contributions by Hintzsche (1944) and Ullman (1951), the biographical syntheses by Hintzsche (1971) and Grmek (1983) to arrive at the recent volume coordinated by Martini (2022) in collaboration with the co-authors of this article. But much still remains to be discovered about the life and scientific and human personality of a personage who, considering the importance of his discoveries, the perfection of his preparations and the historical significance of his technical innovations, can be considered one of the greatest representatives of 19th century anatomy.

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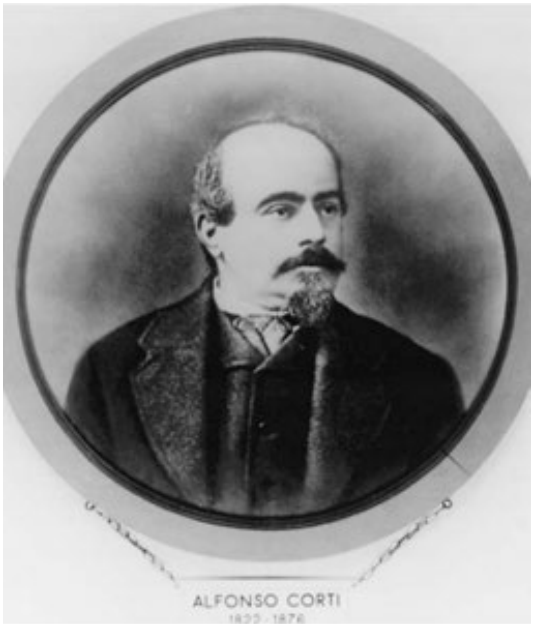


Figure 1- Alfonso Corti's portrait preserved in the Institute of the History of Medicine of the University of Vienna (from Politzer, 1913).

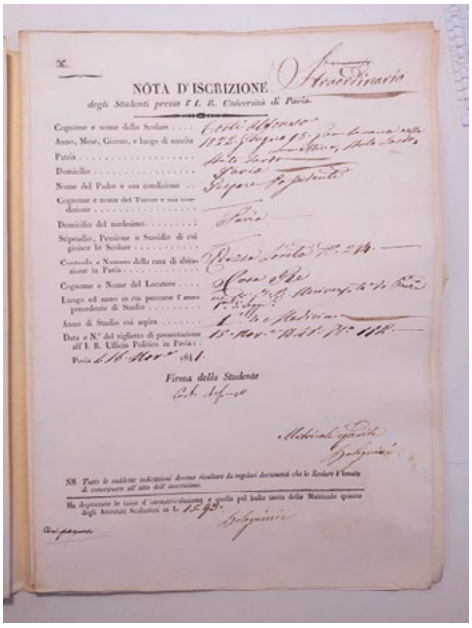


Figure 2. Enrollment of the student Alfonso Corti at the Faculty of Medicine of University of Paviaon November 16, 1841, for the academic year 1841-42.

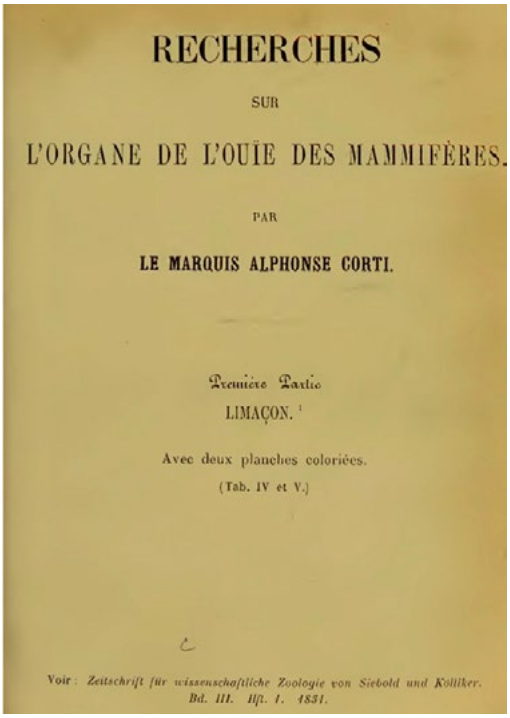


Figure 3. Title page of Alfonso Corti's masterpiece "Recherches sur l'organe de l'ouïe des mammifères" in Z Wiss Zool (3: 109–169, 1851).

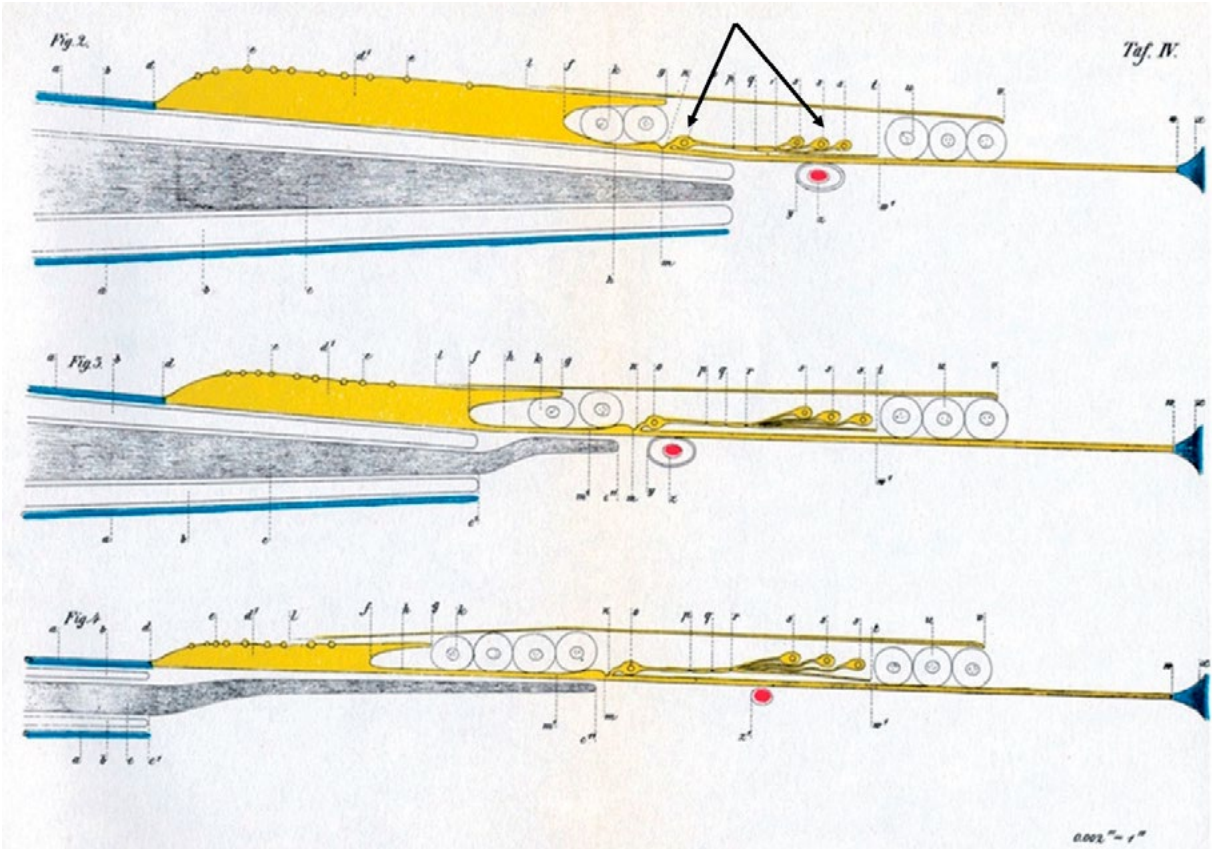


Figure 4. Corti's original 1851 membranous spiral lamina drawing (arrows for the inner and outer ear cells)

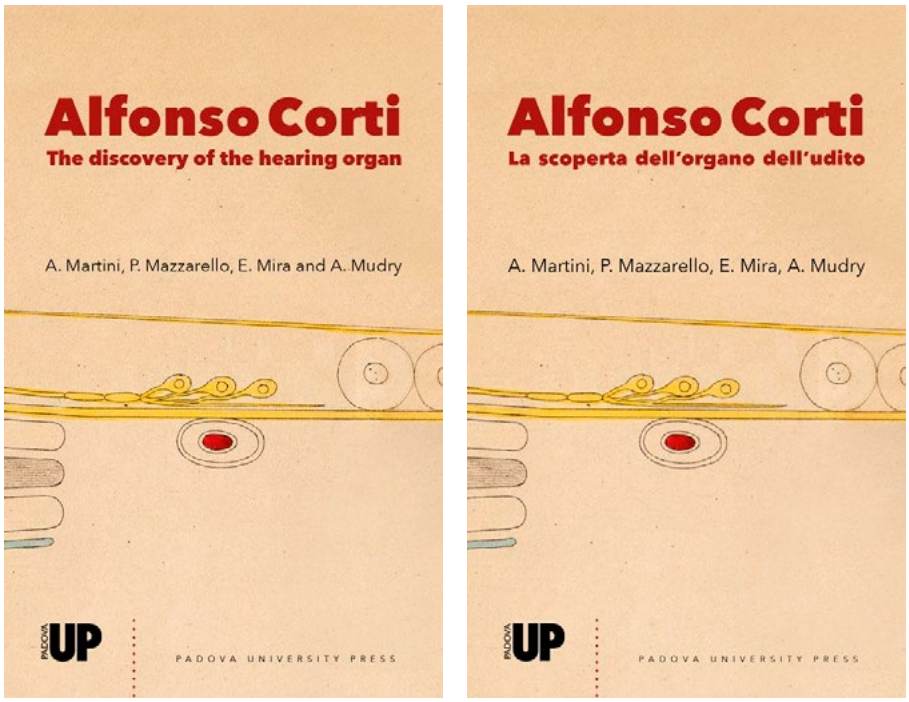
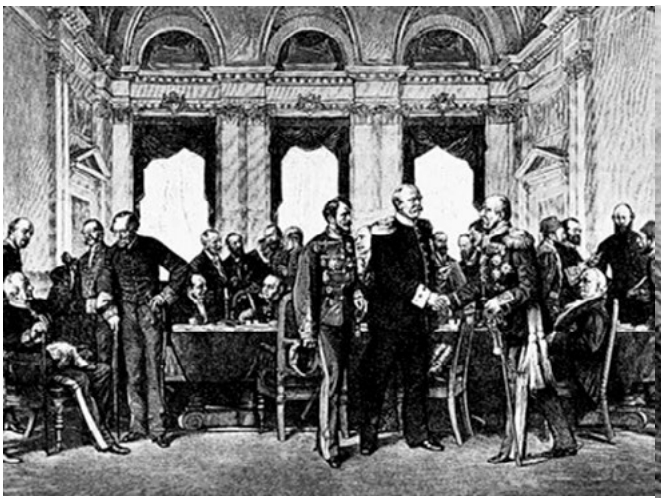


Figure 5. English and Italian editions of Alfonso Corti. The discovery of the hearing organ, Padova University Press, 2022.

1. Luigi Corti (October 24, 1823, Gambarana – February 18, 1888, Rome)



Luigi Corti was an Italian politician and diplomat; he held important positions: Senator of the kingdom of Italy in the 13th legislature, Minister of Foreign Affairs of the Kingdom of Italy in the Cairoli I Government. Luigi was one year younger than Alfonso: between the two brothers there was a very close bond which remained so, despite the long periods of mutual separation. Luigi graduated in mathematics from the University of Pavia in 1842, and shortly thereafter embraced a diplomatic career; in 1848, when the first war of independence broke out, he enlisted as an artillery volunteer in the Savoy army and followed the campaign until 1849. Corti was appointed secretary of the Piedmontese, later Italian, legation in London (1850), where he remained until his appointment as minister in Stockholm (1864) and in 1867 in Madrid and in 1869 Minister at The Hague. On 13 February 1870 he moved to Washington, where, in agreement with the Queen of England and the President of the United States, he was designated arbiter in the Washington commission to resolve the Alabama dispute (a diplomatic-commercial conflict of the United States against Great Britain, raised during and after the American Civil War which was resolved in 1872-73). He subsequently moved to Constantinople (17 May 1875) and was recalled in January 1877 following his appointment as Minister of Foreign Affairs. However, a very unpleasant episode in the life of Luigi Corti should also be remembered. He represented Italy at the Congress of Berlin (12 June-13 July 1878) that reshaped political influence in Europe for many years in favour of Austria-Hungary, Great Britain and France, while Italy managed to obtain nothing. Corti revealed his concern to the German Foreign Minister Bernhard Ernst von Bülow, however, could not violate the government's directives. In the face of public opinion, the Italian delegate returned from Berlin without results and Corti was subjected to very heavy attacks and on 16 October 1878 he resigned. For a time he withdrew from public life, but in 1881 was again sent to Constantinople by Cairoli, where he presided over the conference of ambassadors upon the Egyptian question. In 1886, he was transferred to the London embassy, but was recalled by Crispi in October 1887 to Rome, where he died a few months later. Corti received important honours: Knight Grand Cross decorated with Grand Cordon of the Order of Saints Maurice and Lazarus, Knight Grand Cross decorated with Grand Cordon of the Order of the Crown of Italy, Commemorative medal for the campaigns of the Wars of Independence and Medal in memory of the Unification of Italy.

2. Bartolomeo Panizza (August 17, 1785, Vicenza - April 17, 1867, Pavia)

Bartolomeo Panizza, son of a doctor in Vicenza, graduated in Surgery in Padua in 1805, then practiced in Vicenza, Bologna and Florence before moving to Pavia, where he graduated in Medicine in 1809. Despite serious economic difficulties, the young Panizza managed to support himself in Lombardy, working with Scarpa at the University of Pavia (he was one of Scarpa's favorite pupils), and in Milan with Giambattista Monteggia, Giambattista Palletta and Paolo Assalini. Panizza enlisted in 1812 as a surgeon in Napoleon's army leaving for the Russian campaign; he was captured and imprisoned by the Russians. After his release in 1814, Panizza abandoned military life and returned to Lombardy, where Scarpa recommended him to the education authorities for the anatomy chair, as his deputy, the following year. Panizza became the official holder of the chair in 1817. He was also a versatile surgeon, and occupied a supply teaching role in ophthalmology in 1818-1930. Working alongside Scarpa, his mentor, Panizza concentrated for years on expanding the anatomical museum collections. He was highly skilled and produced an extraordinary number of anatomical, pathological and anatomo-comparative specimens, collaborating with the physician and naturalist Mauro Rusconi. As part of his physiological studies, Panizza experimentally confirmed the hypothesis advanced by Charles Bell and François Magendie that the posterior roots of the spinal nerves have a sensory function, and the anterior roots a motor function. He also demonstrated the gustatory function of the glossopharyngeal nerve, which some later suggested naming "Panizza's gustatory nerve". His most important work was the discovery of the cortical center of vision that he made at the age of seventy. By experimenting with lesions to the optic pathway in various species of animals (fish, birds and mammals), he was able to trace its route through the nervous system. He located the cortical area receptive to vision in the occipital area, where the animal lost its sight. Panizza was an extraordinary teacher.

3. Mauro Rusconi (November 18, 1776, Pavia –March 27, 1849, Tremezzina)

Mauro Rusconi was born in Pavia to Gaspare, a merchant and Barbara Mazza. Inflamed by the ideals coming from beyond the Alps, he interrupted his studies to enlist in the Cisalpine army and soon reached the rank of artillery captain. In 1800, after the reopening of the University, closed during the Austro-Russian reaction, he enrolled in the faculty of medicine and had as teachers, among others, Alessandro Volta, Luigi Valentino Brugnatelli, Giuseppe Jacopi and Antonio Scarpa. Under the guidance of Scarpa, professor of anatomy and clinical surgery, and Jacopi, professor of comparative anatomy and physiology, Rusconi became a skilled trainer. Having graduated with honors on 11 June 1806, he began to practice as a doctor, but continued to maintain contact with the University, becoming tutor of *materia medica* in 1809 and, two years later, of physiology and comparative anatomy. The assignment did not provide a fixed remuneration, but only compensation from the students who participated in his exercises. Hoping to obtain a better position in the academic field, Rusconi furthered his studies during a stay in Paris in 1812, following the lessons of the famous naturalist Georges Cuvier. Upon his return to Pavia, Rusconi only obtained the role of prosector, a position he lost in 1819. Scarpa attempted to assert his influence with the government to obtain that Rusconi was at least appointed curator of the Natural History Museum, but to no avail. Having retired to private life, Rusconi dedicated himself entirely to biological studies. His work deals with the anatomy and metamorphosis of fish, frogs, salamanders and other reptiles. He was the author of research in animal embryology and comparative anatomy on the reproduction of newts and on the development of the frog: he was the first to observe and report exactly the segmentation of the egg as well as the formation of the morula and the blastopore. The works that Rusconi published partly at his own expense and in a limited number of copies, known in Italy and abroad, earned him vast international esteem and contacts with the main naturalists of the time. He was appointed member of important academies and scientific societies, including the Academy of Sciences of Turin, Naples, Palermo, Modena, Ferrara, the Lombard Institute of Milan, the Societies of Naturalists of Frankfurt, Dresden, Leipzig, Freiburg and the Medical Academy of Paris. After the events of 1848, suffering and ill, he left Pavia and went to Lake Como, where he died sometime later.

4. Antonio Scarpa (May 9, 1752, Lorenzaga – October 31, 1832, Pavia)

Praised, feared, and according to tradition almost forgotten: Antonio Scarpa was certainly one of the most acute scientists of his time. Rightly one of the protagonists of medicine, his main scientific contributions concerned anatomy, surgery, ophthalmology and otology. Antonio Scarpa was the most influential figure in the history of anatomy in Pavia. Born in Lorenzaga near Motta di Livenza (on Venetian mainland), he graduated from the University of Padua under the tutorship of Giovan Battista Morgagni, and arrived in Pavia in 1783, after a period of time spent at the University of Modena, now at the Museo di Storia della Medicina, in Pavia. Known for his studies on the membranous labyrinth of the inner ear, and the cranial and cardiac nerves, he was also a distinguished surgeon. An authoritative figure who brought great prestige to Pavia's medical community, Scarpa managed to retain a remarkable amount of academic power despite the changes in the political regime in Lombardy. After retiring in 1814 due to his advanced age and serious problems with his eyesight, Scarpa remained director of the Faculty of Medicine even after the jubilee, and was always influential in the allocation of university teaching posts. His first work was in fact *De structura fenestrae rotundae auris, et de tympano secundario* (Modena, 1772) which paved the way for his interests in otological anatomy and physiology, followed by the *Anatomicae disquisitiones de auditu et olfactu* (Pavia, 1789). According to Scarpa, the membrane that closes the round window, called secondary tympanum, could be used to transmit sound to the cochlea. Scarpa also identified the labyrinth membranous, within the bony labyrinth of the inner ear. Of this structure he described in particular the semicircular membranous ducts and the two membranous sacs: utricle and saccule. Regarding the nerve component, Scarpa believed that the three ampullae of the semicircular canals were innervated by fibers coming from the acoustic nerve. Scarpa identified a fluid present in the membranous labyrinth and was called Scarpa's humor: endolymph. Again, he studied the acoustic nerve of which he recognized the cochlear nerve component and the vestibular nerve component, in connection with Scarpa's vestibular ganglion. With regard to the nervous physiology of the inner ear, Scarpa believed that the structures that formed the membranous labyrinth participated in defining the sense of hearing as they would have derived from the auditory nerve. After Scarpa's death from renal failure on the morning of the October 31, 1832, in his house in Pavia, on the street today named "via Scarpa," two of his disciples and admirers, Carlo Beolchini, MD, and the naturalist Mauro Rusconi, removed the master's head and fingers, now at the Museo di Storia della Medicina, in Pavia

5. Josef Hyrtl (December 7, 1810, Kismatron – July 17, 1894, Perchtoldsdorf Vienna)

Joseph Hyrtl was born in Kismarton in Hungary (later Eisenstadt in Austria). He studied medicine in Vienna, where he obtained a prosectorship in anatomy as early as 1833. In 1837, he was appointed professor of Anatomy at the University of Prague, and in 1845, he accepted a similar post at the University of Vienna, where he became known as an excellent teacher. His scientific activities also produced extraordinarily abundant results. Increasing difficulty with his eyesight forced him to resign from his teaching activities in 1874. He retired to his country home in Perchtoldsdorf, near Vienna, where he continued his scientific research, mainly on anatomical nomenclature, until his death. Hyrtl published a history and criticism of the anatomical language of his time entitled *Onomatologia anatomica* (A Study of Proper Anatomical Terms). As an anatomist and histologist, Hyrtl was passionately interested in making casts of the body's organs using wax, resin or other materials. He developed a technique using injection and corrosion, of which he became a widely acknowledged master. Studying anatomy was hindered by the fact that drawings, however accurate, were the only aid for teaching the subject apart from work in the dissecting room. Hyrtl was a master in the routine activity of injecting blood vessels or other open organs with colored substances that solidify, then corroding away the organic tissue with acid. In 1860 Hyrtl published full details of his technique in his famous *Handbuch der praktischen Zergliederungskunst* (Manual on the Art of Dissection). Hyrtl undertook to fill this void in his otological masterwork published in 1845, *Vergleichend-anatomische Untersuchungen über das innere Gehörorgan des Menschen und der Säugethiere* (Comparative anatomical studies of the inner organ of hearing in man and mammals). He presented a classic description of the variations in the tympanic cavity, the ossicles and the labyrinth in all mammalian genera. To this he added the data he had obtained by measuring the tympanic membrane, tympanic ring, ossicles, semicircular canals and cochlea, and the round and oval windows in various mammals. The different types he discovered were illustrated on nine precious copper plates, based on the preparations in his private museum, all of which had been crafted by his masterly hand. Hyrtl used his corrosion technique to study the anatomy of the organ of hearing, which he first described in 1843.

6. Vienna Riots.

1848 was also a year of revolution, however - known as the Springtime of the Peoples - in the Habsburg Empire ruled from Vienna. Multitudes of people began a series of uprisings demanding autonomy and independence. The unrest in Vienna broke out on 13 March, around the same time as in Milan and Venice. It dragged on until the end of the year with riots, looting, cannon fire and destruction. In Pincherle's account, Professor Hyrtl recalled these painful events in a speech at the Imperial Royal Academy of Sciences at the end of the year: "*In the tragic events that preceded the return of legal order to our city, I lost all my possessions.*

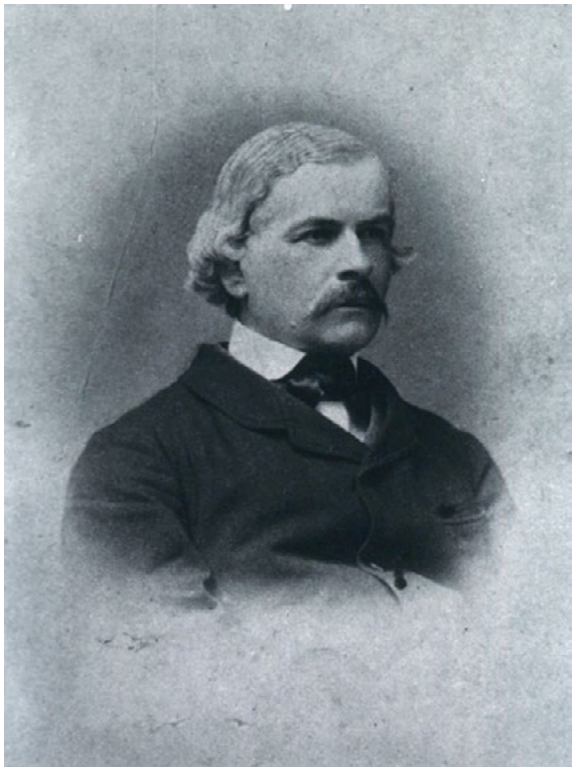
When I returned from the makeshift hospital, where I had been confined for a few days, to change my shirt, which was all stained with blood, I found the smoking ruins of what had once been my home. Although I am philosophical enough to be able to resign myself to the loss of my earthly possessions, the destruction of my whole library, my preparations, my manuscripts, and drawings, was such a severe blow that I was reduced almost to despair. As regards the preparations that were destroyed, I can assure you that my collection of injected microscopic preparations was the only one of its kind, and it will be impossible to restore it to the same degree of perfection ever again. It included some 5000 preparations of the vascular systems of all the organs of all those indigenous and exotic animals that I had succeeded in mastering in fifteen years' work. It was arranged in such a way that every order, every tissue could be studied in relation to the development of the vessels, beginning with mollusks and cartilaginous fishes, and upwards through all the classes and orders to humans. I feel this loss very acutely because the large number of double specimens in 26 my possession, and their continual renewal put me, so to speak, in a position to be able to exchange preparations with other anatomists around the world. My collection of hearing organs was no less valuable. From mice to gigantic species of pachyderms, there was no animal of which I had not represented the auditory organ in the most complete and detailed manner. Every anatomist who deals with technical matters knows what this means. The anatomy of the human auditory apparatus alone was represented by a collection of 90 preparations, spanning the development of the labyrinth from the three-month-old embryo to the seventy-year-old adult. There were also the auditory organs of monstrosities, deaf mutes and different races of man, and the auditory organs of some mummies. I shall never regret such a loss enough, for one makes such a collection only once in a lifetime".

We can assume that some of the preparations, and perhaps those of the ear, were the work of Hyrtl's student-assistant, Alfonso Corti.

7. Gabriel Gustav Valentin (July 7, 1810, Breslau – May 24, 1883 Bern)

He studied medicine in Breslau, before moving to Berlin, where he obtained his medical degree in 1833. Student of Johannes Evangelista Purkinje, he published important discoveries in the field of microscopic anatomy (in 1834 on the ciliated epithelium) and studies that contributed to laying the foundations of cellular biology; following some tensions with Purkinje, Valentin moved to Bern, where he taught physiology, permeated with mathematics, for 45 years. He was full professor of physiology and comparative anatomy at the university of Bern (1836-82; dean 1843-47 and 1861-65). He was a very active medical writer, author of over 200 contributions on anatomy, physiology, and evolution (cytology, histology, and embryology) and of several books. He referred to and commented on the works of his predecessors and contemporaries. He explained that the semicircular canals were outward protuberances of the vestibular vesicle. Valentin was interested in the cerebral nerves and notably designated the glossopharyngeal as the main nerve of taste. In 1840 he described "a gangliar swelling at Jacobson's anastomosis [i.e. the tympanic nerve] in man". The tympanic branch of the inferior ganglion of the glossopharyngeal nerve (also petrosal ganglion) showed a slight swelling 1-1½ inches beyond where it left the petrosal ganglion. Numerous small branches originated at this point, connecting it to the sheath of the tympanic branch. This slight swelling gradually grew smaller and disappeared at the entrance to, or within the tympanic cavity. The swelling contained numerous gangliar cells and Valentin named it the "small tympanic ganglion" or "gangliar swelling on the tympanic nerve". Valentin published two famous books that also contained otological details, the *Lehrbuch der Physiologie des Menschen* (A Textbook of Human Physiology) in 1844, and an abridged form, *Grundriss der Physiologie des Menschen* (An Outline of Human Physiology) in 1846, which was translated into English. In the second edition, published in 1847, Valentin provides no details about the precise anatomical structure of the membranous lamina.

8. Rudolf Albert von Kölliker (July 6, 1817, Zurich – November 2, 1905, Würzburg)



Albert Kölliker entered Zurich university in 1836. After two years, however, he moved to the University of Bonn, and later to that of Berlin, becoming a pupil of noted physiologists Johannes Peter Müller and of Friedrich Gustav Jakob Henle. He graduated in philosophy at Zurich in 1841, and in medicine at Heidelberg in 1842. Prosector of anatomy under Henle, but his tenure of this office was brief – in 1844 he returned to Zurich University to occupy a chair as professor extraordinary of physiology and comparative anatomy. His stay here was also brief; in 1847 the University of Würzburg, attracted by his rising fame, offered him the post of professor of physiology and of microscopical and comparative anatomy. He accepted the appointment, and at Würzburg he remained thenceforth, refusing all offers tempting him to leave the quiet academic life of the Bavarian town, where he died. In 1852, Kölliker explained the importance of the study of microscopical preparations in the first edition of his famous *Handbuch der Gewebelehre des Menschen* (Manual of Human Microscopical Anatomy): "Microscopical anatomy is concerned with the understanding of microscopic forms, and with the laws of their structure and development, not with any general doctrine of the elementary parts. Composition and function are only involved insofar as they relate to the origin of forms and to their variety. Anything else concerning the activity of the perfect elements and their chemical relations is to be found in histology, and is there either on practical grounds in order to indicate some useful application of the morphological conditions, or to complete them; or, given its close connection with the subject, it is added only because physiology proper does not afford a due place for the functions of the elementary parts. If histology is to attain the rank of a science, it first needs to have as broad and certain an objective basis as possible. To this end, the minute structural characters of animal organisms are to be examined on all sides, and not only in fully-formed structures, but in all the earlier periods from their first development. When the morphological elements have been perfectly identified, the next object is to discover the laws according to which they arise, wherein one must not fail to have regard also to their relations of composition and function. In discovering these laws, here as in the experimental sciences generally, continual observation increasingly separates, among the collective mass of scattered facts and observations, the occasional from the constant, the accidental from the essential, till at last a series of more and more general expressions of the facts arises — from which, in the end, mathematical expressions or formulae proceed, and thus the laws are enunciated".

9. Rudolf Carl Virchow (October 13,1821, Schivelbein - September 5,1902, Berlin)

Rudolf Ludwig Karl Virchow was an eminent pathologist, author of the doctrine of "cellular pathology", a true milestone in the history of medicine (1858). In fact, he understood that a cellular theory that postulated the formation of cells from other cells and not from amorphous material could broaden the horizons of medicine and give a new vision of pathological processes. He attended school in his hometown, where he immediately expressed an early interest in the natural sciences and graduated in 1839. For economic reasons, he had to choose the career of a military doctor and in the autumn of 1839, he entered the Training Institute for military doctors in Berlin. Virchow graduated from the most important hospital in Berlin, the 'Charitè' in 1843. At the Charité he began his professional career; in 1846 he obtained the position of prosector. Promoted to professor of anatomy, Virchow was commissioned in the spring of 1848 by the Prussian government to conduct research into the causes of an epidemic of petechial fever that broke out in Upper Silesia. In his report Virchow gave a crude description of the terrible social situation in which the population lived, mostly made up of miners and weavers, who struggled to survive precariously. His ideas about poverty as a real cause of disease created a series of political and work difficulties for him. In 1849, Virchow was appointed to the newly established chair of Pathological Anatomy in Würzburg, the first chair dedicated to the subject in Germany. He pioneered the modern concept of pathological processes by applying cell theory to explain the effects of disease in the organs and tissues of the body. In 1856, Virchow was invited to return to Berlin Charité Hospital, where he became Director and stayed for 20 years — working, teaching, investigating, and writing. He also contributed with his studies to the knowledge of inflammation, tumors, tuberculosis, leukemia, embolisms, etc. Furthermore, he extended his interests to different fields of pathology and carried out vast studies of ethnology and prehistoric and protohistoric archaeology, as well as fundamental research in the field of anthropology. He was also a notable politician, he was deputy to the Prussian parliament (1861) and then to the Reichstag (1862-93), he was an opponent of Bismarck and, at the same time, of the cultural and political influence of the Catholic Church.

10. Filippo de Filippi (April 20, 1814, Milan - February 8, 1867, Hong Kong)

Graduating in Medicine in Pavia as a student at the Ghislieri College, under Panizza's influence, Filippo de Filippi soon developed a strong interest in the natural sciences. After a short period of activity at the same University as an assistant in Zoology, he moved to the Civic Museum of Milan to hold lessons in zoology, mineralogy and geology. In 1848 he was called by Carlo Alberto to teach Zoology at the University of Turin, succeeding Giuseppe Gené; due to his scientific contribution, the Turin school occupied a dominant position in the field of natural philosophy. De Filippi's name is associated with the early spread of Darwinism in Italy: initially a fixist, although very critical, upon the release of the *Origin of Species* he accepted Darwin's theory, taking a position against creationism in the historic Turin conference of 11 January 1864. The text, published and distributed throughout Italy, was a sort of scientific manifesto of evolutionism, which opens discussions and controversies not only in the scientific field, and brings new interpretative tools of reality. De Filippi also broadened his interests to embryology and comparative anatomy; he was the precursor of fish farming in Italy: it promotes the introduction of fish species such as whitefish into Piedmont lakes, with the aim of increasing fish abundance. De Filippi was also a great scientific traveler. As director of the Zoological Museum of Turin, to which he contributed to enriching the collections, he participated in the Italian scientific mission to Persia in 1862 and to China and Japan in 1865 (again under the initiative of the Italian government) on the steamer Magenta, on a route that also stopped in Indonesia and Vietnam. During the voyage, at the beginning of 1867, he was struck by infectious hepatitis, it worsened, and he was disembarked in Hong Kong, where he died within a few days, in February of the same year, probably from cholera. What remains of the expedition are the highly detailed autograph catalogs of the scientific material collected and sent to the Turin Museum.