

Mateu Orfila i Rotger (1787–1853): Science, medicine and crime in the nineteenth century*

Mateu Orfila i Rotger (1787–1853) occupies a peculiar position in the history of science. Although there are numerous studies of his life and work, his contributions are rarely mentioned in general histories of science and medicine. The four thick volumes of J.R. Partington's encyclopaedia on the history of chemistry contains only five brief lines on Orfila, and these mainly comment that after his death Adolph Wurtz replaced him as professor of the Paris Faculty of Medicine [1]. A recent encyclopaedia of the history of medicine, the *Companion Encyclopedia of the History of Medicine*, devotes only four lines to him, which tell us he was a "Majorca-born physician" (*sic*), "who went to Paris" and published "a famous textbook". Nevertheless, Orfila "does not appear to have been a great experimentalist himself" [2]. Orfila has no entry at all in the *Dictionary of Scientific Biography* [3] or in other biographical dictionaries of medicine or science [4]. Very few textbooks report Orfila's main achievements, except toxicology books, which usually introduce him as one of the founding fathers of the discipline, though without on the whole specifying the reasons for this.

This situation contrasts with Orfila's enormous popularity in France, Spain and other European countries during the nineteenth century. His name already appears in general biographical dictionaries written in the first half of the nineteenth century, before his death [5]. His participation in famous trials made his name echo far beyond the small academic community. A glance through the French press of about 1840 makes it easy to find the name of Orfila mentioned on more than one occasion. The views he maintained in these trials were passionately discussed for a considerable time, provoking a long debate in and outside academic circles that lasted until after his death. Since then, an enormous number of articles and books have been published on this question, including plays and satirical poems. A film about the famous Lafarge case was shot in France in the first half of the twentieth century. In addition, reflecting Orfila's popularity, a large number of biographical studies by French, Spanish, Catalan and Minorcan researchers were published. These, to a greater or lesser extent, are influenced by local traditions of history writing. In a

recent bibliography, about a hundred studies devoted fully to Orfila's life and work were listed [6]. The scant connection of many of these studies with the problems and approaches of the history of science may be surprising, but it merely reflects the situation of neglect noted at the beginning of this paper.

The 150th anniversary of Orfila's death is an excellent opportunity for linking up the different lines of study that have helped to write his biography. This is favoured by current trends that seek to establish closer and closer links between the history of science, medicine and technology. At the same time, the anniversary has served as an excuse for making electronic editions of Orfila's texts that were extremely hard to get hold of. The confluence of the greater accessibility of the historical sources with a multi-disciplinary approach should lead to a different picture of Orfila before too long. The following summary of Orfila's life aims to point out some new directions for future research. It does not pretend to be an exhaustive review of his life or work, but rather to focus on some of the most relevant aspects, with the aim of clarifying three questions of current interest: science teaching practices, the role of experts in the administration of justice and the problems involved in the popularisation of science [7].

Student

Mateu Josep Bonaventura Orfila i Rotger was born in Maó on April 24 1787, to a family of traders from a peasant background who enjoyed sufficient income to ensure a good education for their children. During the eighteenth century Minorca had been under English, French and Spanish control, which occasioned a considerable exchange of influences between the islanders and natives of these countries [8]. Orfila was able to take advantage of this cosmopolitan atmosphere during his early years of education. His French and English tutors taught him the languages which later gave him access to the most important scientific literature of the age. Thanks to his experience in a church choir, Orfila acquired a good musical training, which would enable him to triumph in Paris salons and thus meet people who were to be decisive in his scientific career. If we believe what he tells us in his autobiography, he also initiated in Minorca another of the roads that led him to fame: the teaching of science. When he was only 14, he

* **J.R. Bertomeu Sánchez.** Departament d'Història de la Ciència i Documentació, Facultat de Medicina. Blasco Ibañez, 17. 46010 València (Spain). Tel. 34 963864164. Fax: 34 963864091. Email: Jose.R.Bertomeu@uv.es <<http://www.uv.es/~bertomeu>>

began to teach mathematics, which he himself had learned from the few books available to him. After a failed attempt to study to be a mariner, as his father wished, Orfila opted for medicine, one of the few professions that would enable him to develop his dawning interest in the natural sciences and, at the same time, earn his living. Orfila got in touch with a German teacher called Cook, from whom he received, along with a small group of young Minorcans, classes in “elementary mathematics”, “quasi-experimental physics”, “logic” and “a little natural history”. It was perhaps still more important that Cook knew how to instil “love for the study” of science [9].



Figure 1. Orfila's caricature from François Fabre, *Némésis médicale illustrée, recueil de satires [cinquième satire]*, Bruxelles: Bruylant-Christophe et Cie, 1841. (Bibliothèque interuniversitaire de médecine de Paris).

As it was impossible to study medicine in Minorca, Orfila travelled to Valencia in September 1804 to attend classes at the Faculty of Medicine. This was one of the best-known schools in Spain, and in the forefront of chemistry teaching thanks to the new syllabuses which were introduced at the end of the eighteenth century. The Chair of Chemistry had been held by Tomás de Vilanova Muñoz y Poyanos (1737–1802), who created a chemical laboratory where, with the help of a demonstrator, he conducted experiments in public both for students and for artisans and anyone else interested in chemistry. The laboratory included a large number of glass vessels, ovens, stills of various sizes, vacuum pumps and other instruments specifically designed for experiments with gases, i.e. the new substances that had been discovered in the eighteenth century and which were decisive in

the changes occurring in chemistry at that time [10]. Vilanova was aware of the recent research by Lavoisier and other French chemists and soon introduced the new chemical nomenclature that these authors had created. However, Orfila reached Valencia two years after Villanova's death and the classes were taught by Manuel Pizcueta, a teacher who gave a poor impression on Orfila [11]. In his old age, he still remembered the displeasure he felt in these chemistry classes, in which he was obliged to “recite from memory” “three or four pages” of the *Elémens de Chymie* by Pierre Joseph Macquer (1718–1784), printed in Spanish in 1788 at Valencia to be used as a textbook. Although this was one of the most important books of the eighteenth century, it became completely out-of-date when Lavoisier and other chemists introduced their new findings during what is known as the chemical revolution. Orfila decided to learn chemistry on his own from the works of Lavoisier, Berthollet and Fourcroy and from small experiments he conducted at home with the help of Juan Sánchez Cisneros (*fl.* 1801–1827), an enlightened army officer, who had studied in Paris and carried out a number of studies in mineralogy, chemistry and agronomy through the *Sociedad Económica de Amigos del País* de Valencia [12]. Through this method of study, Orfila acquired an excellent background in chemistry, which enabled him to dazzle his companions and teachers in an open contest held in 1805. This was promoted by a private individual who offered a prize to the winner. Orfila showed evidence of a “vast and profound knowledge in chemistry and everything related to this science” and discussed “with talent” the themes proposed, indicating their “applications to sciences and arts” and analysing “ancient and modern opinions”, in such a way that the judges awarded him the prize by acclamation [13].

His brilliant public contest also caused certain unexpected problems for Orfila. A member of the Inquisition who was present heard him assert some views about the age of the Earth that diverged from the view defended by Christian orthodoxy. As a result, Orfila was called to declare before the Inquisitor, though luckily the affair had no further consequences. This may well have been the last straw for Orfila in his discomfort in the city of Valencia. As the intellectual climate for pursuing his studies was non-existent there, he wrote several letters to his father in August 1805 in which he painted in very negative light the medical teaching in the city, asking his father to allow him to move to Barcelona to continue his studies. Orfila was aiming to broaden his training in the natural sciences, especially chemistry, but he considered this impossible in Valencia [14].

There was no Faculty of Medicine in Barcelona, as the University had been suppressed by Philip V after the war installing the Bourbons on the Spanish throne at the beginning of the eighteenth century. However, other educational institutions had filled this educational gap. Among them, the most attractive for Orfila were the College of Surgery [15] and the schools of the *Junta de Comerç* (Trade Board), especially the chemistry courses which Francesc Carbonell i Bravo (1768–1837) had recently begun to teach. After quali-

ying as a pharmacist, Carbonell i Bravo had completed his chemistry studies with Jean Antoine Chaptal (1756–1832) at the prestigious Montpellier Medical Faculty, where he had written his doctoral thesis on the medical uses of chemistry. Carbonell, like other authors such as Antoine Fourcroy (1755–1809), was cautious in the face of certain excesses in the use of chemistry in medicine. Orfila is very likely to have heard his master Carbonell criticising all those who stated that the composition of the body and its physiological functions depended solely on the laws of chemical affinity. For Carbonell it was “absurd, ridiculous and false” to try to explain the action of drugs through the combinations observed in inanimate matter or to base the classification of diseases on the excesses or defects in certain constitutive elements of the human body. Although he supported the views of his teachers at Montpellier on the differences between life force and chemical affinity, Carbonell did not discard possible medical uses of chemistry, but attempted to discuss “how we should proceed in such applications” [16]. For a today’s reader, accustomed to link advances in biochemistry with progress in medicine, such ideas may appear retrograde or absurd. However, as we shall see, one of the keys to Orfila’s subsequent success was that he knew how to balance the differences between life phenomena and laboratory experiments. This contributed markedly to the favourable reception of his work by his contemporaries.

It is very likely that discussion of the possible medical uses of chemistry formed a substantial part of the courses taught by Carbonell, which were followed by a good number of undergraduates and postgraduate students of surgery and pharmacy and some doctors. This was the most numerous group of pupils who, along with Orfila, attended in 1806 the second chemistry course organised by the *Junta de Comerç*. A broad group of merchants and craftsmen also attended, including eight paint manufacturers, a potter, a bricklayer, an architect and a dyer [17]. Given the composition of his audience, Carbonell must have tackled features of chemistry applicable to industrial operations. Through these classes, Orfila was able to improve his knowledge of chemistry enough to have his first article published. This was in Summer 1806 in the *Diario de Valencia*, and in it he discussed a question that was controversial in the chemistry of the period: the composition of the gas that we call today chlorine and which was then known as “oxygenated muriatic acid”. Orfila cast doubt on the views of his friend Juan Sánchez Cisneros about the relationship between muriatic acid and water and the possibility that both were composed of hydrogen bound to different amounts of oxygen [18].

After a favourable report from Carbonell i Bravo, the *Junta de Comerç* awarded Orfila a scholarship (or a ‘pension’, in the language of the time) to travel to “Madrid and then Paris to continue his studies of chemistry and mineralogy” for four years, with the purpose that he should come back and occupy a second chair of chemistry at Barcelona [19]. Orfila became one more in the long list of Spanish *pensionados* who travelled to Paris to study chemistry during the last third of the eighteenth and the first years of the nineteenth centuries



Figure 2. Mateu Orfila (1787-1853). Collection of the Bibliothèque interuniversitaire de médecine de Paris.

[20]. Following the instructions of the *Junta de Comerç*, Orfila went first to Madrid for an interview with the Professor of chemistry Louis Proust (1754–1826), but the meeting could not take place because the French chemist had already left Spain. In these circumstances, Orfila took the road to Paris, which he reached in early July 1807. He went first to the house of another *pensionado*, Francesc Lacoma i Fontanet (1784–1849), a young student who would become the Chamber painter of Fernando VII, and who shared the first years of Orfila’s sojourn in France. Orfila initially contacted Antoine Fourcroy and Nicolas Vauquelin (1763–1829), two leading French chemists who welcomed him into their laboratories and even entrusted him with the preparation of some of their classes [21]. Like other Spanish students, Orfila attended the chemistry courses at the Collège de France, taught by a young pharmacist, Jacques Thenard (1777–1857), who would soon become one of the most influential French scientists in the field of chemistry. Thenard’s contribution to the career of Orfila was in many respects decisive, because of his academic backing and the influence of his works, particularly the famous *Traité de chimie*, one of the most important chemistry books of the first half of the nineteenth century [22]. Orfila also followed the courses given in the *Muséum National d’Histoire Naturelle* of Paris. This was one of the principal new scientific institutions created during the French Revolution, at which some of the most important French scientists of the period taught. Here Orfila was able to attend classes given by many leading naturalists, such as

Jean-Baptiste Lamarck (1744–1829), Georges Cuvier (1769–1832), Étienne Geoffroy Saint-Hilaire (1772–1844), René L. Desfontaines (1750–1833) and René Just Haüy (1743–1822). Haüy singled Orfila out, inviting him to work on his crystallography course [23]. At the same time, the winter of 1807/1808, Orfila matriculated at the Faculty of Medicine of Paris, so starting a course of study that would lead to his medical degree in 1811 [24].

Teacher

Orfila's studies were suddenly affected by the political upheavals in the Iberian Peninsula. The revolts of May 1808 against the French army marked the start of the war that would lead to the defeat of General Dupont at Bailén in July of the same year. This unexpected defeat aroused Napoleon to energetic action. At the head of a large army, he managed to reconquer lost ground and entered Madrid at the end of 1808. Despite strong opposition, he put back on the Spanish throne his brother Joseph Bonaparte, who had already sworn the Bayonne constitution at the beginning of the summer. The new King took a series of measures to ensure the loyalty of his subjects, among which was an oath of loyalty sworn by all public employees, including the *pensionados* who were out of the country. At the end of Autumn 1808, various of these *pensionados* were summoned to the Paris embassy. Among them were José Radón of the Astronomic Observatory, José María San Cristóbal, with a pension for the study of chemistry applied to the arts, Joaquín Cabezas, Director of the Platinum laboratory in Madrid, and Orfila, who was recorded in the register as "pensionado through the consulate of Barcelona, in the branch of Natural Sciences" [25]. Orfila remembered this disagreeable event for a long time, as he and his friend Lacoma had to spend several hours in jail, until Nicolas Vauquelin, dressed as a member of the Academy of Sciences, attended the police station to demand the release of his new disciple [26]. However, this night of uncertainty was not the main problem that the Napoleonic wars caused Orfila. In June 1808, the *Junta de Comerç* informed him that the circumstances of war obliged them to reduce his pension to a quarter of the original amount. Finally, in April 1809 his grant was suspended, like that of the other *pensionados*. Orfila had to remain in Paris without means of support apart from the kindness of a relative who was living in France. This was the reason why he started an activity that would eventually make him famous: his private courses in the natural sciences. He was able to put on the first of these science courses with the help of a rich friend who let him give the classes in his house three times a week during Summer 1809. Orfila had some twenty students, some of whom were Spanish or English. Although he charged nothing for the course, it made him known on the market of private science courses in the French capital. In addition, he was able to work with a lot of instruments and products, bought by his sponsor, and thus learn a number of interesting questions that were "useful to medicine" [27].

Between May and August 1811, Orfila was successful in the various exams leading to the degree of doctor in medicine. In December of the same year he submitted his doctoral thesis, whose subject was the analysis of the urine of persons affected by jaundice [28]. Once his medical course had finished, there was no reason for Orfila to stay in Paris, where he received no grant and lived on the small amounts supplied by his family. However, Orfila ignored the requirements of his family for him to go back to Mahón, and decided to continue exploring the possibilities of the Paris market in private classes, spurred on by some of his new friends. In that same December 1811, he started a course in medical chemistry in the Croix-des-Petits-Champs street, located between the rear part of what today is the Louvre Museum and the Place des Victoires. Despite its long distance from the Faculty of Medicine, which was on the other bank of the Seine, Orfila had about forty students who paid him forty francs each. Thus, in total, he earned about 1,600 francs, which was roughly what he had received in his grant from the *Junta de Comerç* when he first arrived in Paris [29]. Among the students were colleagues of Orfila's who would become influential doctors and teachers at the Paris Faculty of Medicine: Pierre Augustin Bécclard (1785–1825), subsequently Professor of Anatomy, to whom Orfila dedicated the third edition of his *Elémens de chimie*, and the brothers Hypolitte (1787–1843) and Jules Cloquet (1790–1883), who helped popularise Orfila's works by publishing favourable reviews in medical journals. Some years later, Orfila worked with them on the publication of several medical dictionaries. Another of Orfila's students and friends at this time was William-Frédéric Edwards (1777–1842), who obtained the degree of medical doctor in the Faculty of Paris in 1815 and wrote various studies on new experimental physiology. Orfila dedicated some grateful words to Edwards in his book on toxicology, highlighting his colleague's contribution to his project.

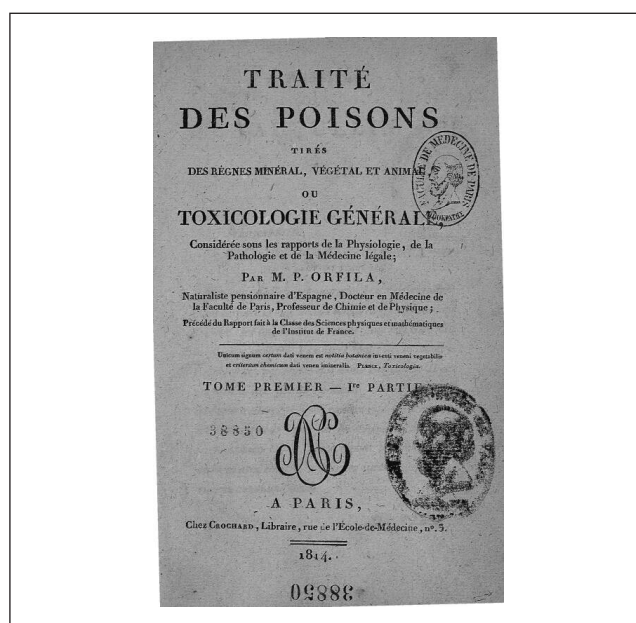


Figure 3. M. Orfila, *Traité des poisons tirés des règnes minéral, végétal et animal ou toxicologie générale*, Paris, Crochard, 1813–1814. (Bibliothèque interuniversitaire de médecine de Paris).

Encouraged by his success and protected by this group of friends who would assist so greatly the development of his career, Orfila moved to another address, in the Rue des Fossés Saint-Jacques, on the other bank of the Seine and closer to the Faculty of Medicine, where his potential public was to be found. Here, in the summer of 1812, he started science courses, including both chemistry and legal medicine, anatomy and botany. He repeated these in the following years, until in 1819 he was appointed Professor of the Faculty of Medicine at Paris. It was under these circumstances, before Orfila began his rapid rise within the Faculty, that his main works appeared: the *Traité des Poisons* and his *Éléments de chimie* [30]. His contemporaries bear witness to the enormous success of Orfila's courses in the Faculty of Medicine, equal to that of his private classes. One of his colleagues described them as follows:

“Sa voix bien timbrée, sonore et puissante, dominait ces flots d'auditeurs; elle se faisait entendre de tous les élèves. Son débit était clair, méthodique, simple; il n'entretenait ses auditeurs que de ce qui leur était rigoureusement indispensable; il évitait toute espèce de digression, et autant que possible, il démontrait par des expériences les faits qu'il venait d'énoncer” [31]

The method Orfila followed in his classes was quite common at the time. While the teacher explained and the students took notes, experiments were being conducted to illustrate certain aspects of the theoretical contents of the lectures. Many of his lectures were focussed on new methods of chemical analysis and their possible use in the field of toxicology. On occasion, he used his classes to defend his view on certain controversial questions. At the end of 1840, in the months following the Lafarge affair, Orfila conducted some public classes in the presence of various members of the Academy of Medicine of Paris. The lectures attracted a numerous public and consisted of Orfila's explanation of his views on the new method of analysis of arsenic introduced by James Marsh (1794–1846). To this end, he poisoned several dogs and analysed their bodies chemically, thus proving the differences between organs of healthy animals, animals killed by asphyxia and animals poisoned by varying doses of arsenic. Orfila conducted some experiments with organs taken from corpses in the Faculty of Medicine morgue, sometimes following the suggestions of his audience. In poisoning cases, Orfila showed the audience the stains of arsenic obtained with Marsh's apparatus and indicated how they could be correctly identified [32]. These and many other experiments that Orfila conducted in his courses created various legends that spread among his students. A North-American student described the following fabulous story in a letter to his sister:

“I have a medical anecdote which I will give you. Do you know that the blood contains a very considerable amount of iron? Orfila, the dean of the Faculty of Medicine here, was bled to a considerable amount during an attack of

cholera at the time it was prevalent here some years since. The professor of chemistry took the blood and by some chemical processes obtained the iron in its metallic state, in form of a globule weighing seven grains, which globule Madame Orfila had mounted upon a ring. A very pretty idea” [33]

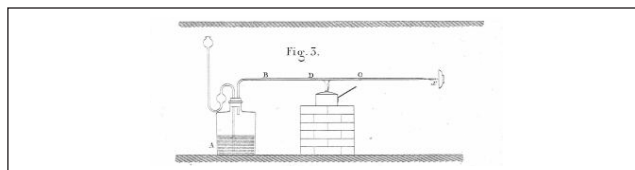


Figure 4. Marsh's test for arsenic in M. Orfila, *Éléments de chimie* Paris: Labé, 8th edition. (Bibliothèque interuniversitaire de médecine de Paris).

Expert

If we believe what Orfila wrote in his memoirs, it was a minor incident in one of his courses that led to one of his main discoveries, opening the door to the toxicological research that made him famous. In April 1813, while lecturing on arsenic, Orfila formed the precipitates that characterise this substance before his students and affirmed categorically that this same result was obtained whether the poison was mixed with organic fluids, broth or drinks like coffee or wine. Orfila took advantage of a cup of coffee present, tipped the arsenic solution into it and repeated the experiments. To his surprise, however, he did not obtain the expected precipitates: the lime liquor produced a violet-grey precipitate instead of the expected white colour. The ammoniac copper sulphate caused some deposits of a dark olive colour instead of the green typical of its reaction with arsenic [34].

How much did this unexpected occurrence determine Orfila's subsequent work in toxicology, as he states in his autobiography? Perhaps the anecdote is just another example of those “Eureka moments” with which accounts of scientists' research are spattered from a distance in time. Numerous historical studies have shown that, in general, scientific research involves more complex, longer-lasting and more subtle processes than these sudden flashes of inspiration with which scientific discovery is often described [35]. Even if we accept Orfila's version, it has to be recognised that all his training had prepared him for assimilating this unexpected event in a class-room. As we have indicated, the writings and teachings of Carbonell Bravo and Fourcroy had already warned him to the differences between laboratory and life phenomena, a question which Orfila also discussed in his later publications and certain passages of his treatises on toxicology and chemistry. Whether this was a finding by chance or the result of his scientific training, or, the most likely, a combination of the two circumstances, this discovery led Orfila to start thinking about the action of the substances which poisons were found mixed with in most of the situations in which legal medicine was involved. Later, Orfila developed methods for eliminating or-

ganic matter and preventing its presence from masking the action of the reagents used to detect poisons.

Thanks to his discovery, Orfila developed critiques of many of the old methods of analysis, which he collected through systematic reading of magazines and other publications. This reading also served as a source of clinical observations on which to base his opinions. To all this he added a small, but significant, number of personal observations based on poisoning cases to which he was called to give expert evidence from 1813 onwards. However, the most novel part of his work was based on a large number of experiments he conducted with dogs, which he poisoned under various circumstances in order to observe the effects of poisons and antidotes, such as we have already seen in his 1840 lectures. In their positive report on Orfila's book, the academicians of the *Institute de France* recognised that these experiments supposed a huge personal and financial effort. Orfila had to "often stay awake all night to care for animals subjected to his trials", "invest important amounts of money", and, at the same time, try to forget the feeling of "disgust for this sad profession" [36].

The experiments with animals were not unusual. Many eighteenth century researchers used them to study drugs and poisons, among them the Italian Felice Fontana (1730–1805), who performed innovative research on viper venom, quoted by Orfila in his *Traité des poisons* [37]. In addition, animal experimentation was the basis of the new experimental physiology, which some of Orfila's medical colleagues, with François Magendie (1783–1855) in the lead, were developing at that time [38]. However, not all doctors shared Orfila's optimism about the benefits of this research and its potential use in medicine. As Orfila himself had to recognise, some doctors, among whom was the elderly and influential Antoine Portal (1742–1832), made statements against the use of live animals in experiments on poisons, with the argument that results in dogs could not be extended to humans. Among those who did favour the experiments, there was no unanimity as to Orfila's method. One of the controversial questions was the practice of placing a ligature on the oesophagus to stop the animals vomiting up the poison. In the reviews of the time, several writers pointed out that this practice could cause serious damage to the dogs and thus modify the effects of the poisoning, which would mean that the results could not be at all significant. To convince his critics, Orfila wrote a special section in which he described several experiments he had conducted to show that this operation, when properly and rapidly performed, did not disturb the effects of the action of the poisons. On the contrary, it had to be seen as "indispensable for studying a poison from every point of view", especially to record reliably the properties of antidotes. In fact, Orfila's arguments did not settle the question. Even two decades later, during the heated debates caused by Mercier and Lafarge affairs, several writers used this criticism to discredit all Orfila's findings obtained from his endless experiments on dogs [39].

Ignoring the attacks on his methods, Orfila used his animal experiments to review systematically the tests for detecting poisons. Orfila thought that, to be absolutely sure of the presence of poison, observation of anatomical damage during au-

topsies was not enough [40]. He also thought that organoleptic detection was problematic, as it depended to a considerable extent on the people conducting the experiment. The case of arsenic was sufficiently illustrative. The symptoms caused by this poison were similar to symptoms described for common illnesses. This had led to acknowledged errors in trials in which the forensic experts used only the clinical data prior to death or the anatomical findings in the autopsy. In other cases, experts recognised arsenic from its characteristic garlic-like smell, which it gives off on being heated strongly by red-hot charcoal. Orfila argued that smells could be deceptive, especially when expert tests were conducted with organic matter taken from a decomposing corpse. On this point, he mentioned his own experience in a trial at which he and his teacher Vauquelin had acted as expert witnesses. Orfila believed that he had felt on two occasions a strong smell of garlic when the suspected matter was placed on red-hot charcoal, but subsequent analyses showed that the substance contained "not an atom of arsenic" [41]. On another occasion, during the trial of the presumed murderer of a Chambéry attorney, Orfila criticised severely the reports of the experts who had based their judgement on the smell of bitter almonds detected during their analysis, which had led them to declare that the attorney's death had been caused by prussic acid poisoning. Orfila sustained the opposite: that the symptoms observed were suggestive of a case of apoplexy due to natural causes. After hearing Orfila's report, the court, which had already sentenced the accused to death, decided to change its verdict and released the defendant [42].

To avoid these disastrous errors, Orfila used the growing knowledge provided by analytical chemistry of his time to adapt them to the contemporary forensic medicine practices.

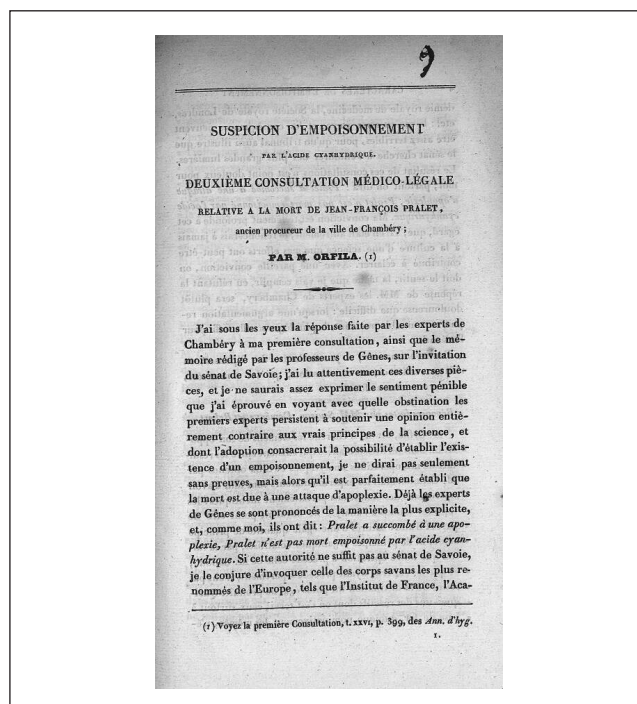


Figure 5. M. Orfila. *Suspicion d'empoisonnement par l'acide cyanhydrique. Deuxième consultation médico-légale relative à la mort de Jean-François Pralet, ancien procureur de la ville de Chambéry, Paris, 1842.* (Bibliothèque interuniversitaire de médecine de Paris).

Most of his assays consisted of forming solid residue or coloured precipitates that were characteristic of each poison and reaction. Thus, for example, arsenic was usually recognised through the white precipitate caused by lime liquor or through the green precipitate caused by copper alkaline solutions. The results were generally confirmed through a reducing process that gave metallic arsenic. A sufficient number of such tests enabled other substances to be discounted and increased certainty about the presence of a poison. As his contemporaries recognised, one of Orfila's great achievements in toxicology was to systematise these chemical tests, indicating the precautions that had to be taken in each case. Although Orfila did not ignore in his analyses the symptoms experienced by the poisoned victim and the anatomical lesions found on autopsy, he alerted against doctors who based their reports solely on these data, as they could give rise to pernicious confusions with common illnesses and thus to unjust prosecutions [43]. Following an aphorism of Joseph Plenck (1738–1807), which he reproduced on the front cover of the *Traité de Poisons*, Orfila believed that the only certain sign of poisoning was chemical analysis in the case of mineral poisons and botanical or zoological identification in the case of vegetable or animal poisons.

The main aim of Orfila's research was to offer systematic and reliable methods of detecting poisonous substances under the complex working conditions of nineteenth-century forensic medicine. In reality, it is very hard to discern — and perhaps there is no point in trying — to what extent these studies belong to chemistry, toxicology or physiology. For example, while he was working on the development of an analytic method to detect arsenic, Orfila found conclusive evidence of the phenomenon of the absorption of poisons, what supposed an important contribution to physiology. In fact, he offered new paths for future experimental studies on the mechanisms of action of both poisons and medicines. At the same time, Orfila used his research to refine toxicological methods. The new techniques allowed to search for poisons not only in the digestive canal, mouth, vomits or other suspected matters, but also in the victims' internal organs. These advantages were especially relevant in cases of corpses that had been buried for a long time. Orfila enthusiastically wrote: « From now on, crime will be successfully persecuted until its last refuge » [44].

Science populariser

Orfila's *Traité des poisons* was favourably received by the medical community. A second edition was rapidly printed, followed by three more. It was translated into English, German, Italian and Spanish, making it the principal reference book on toxicology during the forty years which separated the first and last editions. While he was preparing its second edition, Orfila extracted the sections on antidotes and treatments against poisoning and published them in a small-format, low-cost book, which he titled *Secours à donner aux personnes empoisonnées et asphyxiées*. It was a book designed to popularise science, making the contents of chemistry and medicine accessible to non-specialist readers.

Nowadays this genre has become widespread in magazines, daily press, television series or single-theme collections, but it is worth noting that scientific and medical popularisation already had a long history when Orfila's book came out. At the start of the eighteenth century, various genres fulfilled this function: the prescription books or summaries of therapeutic remedies; the *regimina sanitatis*, the most famous of which was the one composed by Arnau de Vilanova; the personal hygiene and care manuals; and books inspired by philanthropic ideals such as those written by Madame Fouquet (1590–1681), which had a resounding success in several European countries. In the second half of the eighteenth century two other books achieved enormous popularity: *the Avis au peuple sur sa santé* by Samuel-Auguste Tissot (1728–1798) and the *Domestic Medicine* of William Buchan (1729–1805). Both books included detailed descriptions of illnesses, so that they could be identified by non-expert readers, as well as remedies and therapeutic advice, so that action could be taken in cases when a doctor could not be found. These books also included strong criticisms of superstitions, remedies of healers and certain popular medical practices that were considered by these authors, especially by Tissot, as dangerous for the maintenance of health [45].

The historians have paid growing attention to this literature in recent decades and popularisation is no longer considered a minor off-shoot of scientists' work. On the contrary, we know today that popularising books are very relevant to science's image and so may condition the support of social, political or economic groups for scientific research [46]. At a time when only a small part of the population had access to reading, Orfila's book was aimed mainly at his colleagues in the provinces, doctors, *officiers de santé* [47] and chemists, who could help spread his ideas on poison among the general population. In addition, as Nicolas Vauquelin's report pointed out, he was trying to reach magistrates, clergy and

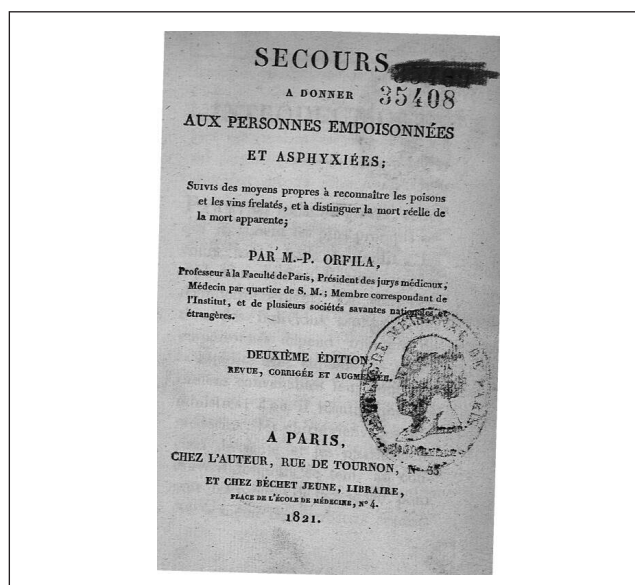


Figure 6. M. Orfila, *Secours à donner aux personnes empoisonnées et asphyxiées*, Paris, Béchét, 1821. 2nd edition. (Bibliothèque interuniversitaire de médecine de Paris).

other influential members of rural society, who were obliged to take rapid decisions in poisoning cases or attend neighbours whilst awaiting the arrival of the doctor. This target public is confirmed by the price of the book, three and a half francs, which was near the upper limit of prices of popularising books in those days. The cost was a long way below more specialist books or encyclopaedias, such as the *Traité des poisons*, whose two volumes cost sixteen francs, or his *Traité de Médecine légale*, sold at twenty francs.

To make his work accessible to his potential buyers, Orfila described with great thoroughness the symptoms of poisoning, the methods of analysis of poison and the products that had to be administered. A major difficulty in this field was the new chemical terminology introduced at the end of the eighteenth century by Guyton de Morveau, Lavoisier, Fourcroy and Berthollet to replace the old names based on alchemical analogies (saffron of Mars), medical properties (emetic) or physical properties (blue vitriol). The new expressions tried to reflect the chemical composition of substances, so that the above-mentioned substances were renamed, respectively, “carbonat of iron”, “tartrite of potash antimoniated” and “sulphat of copper” [48]. Although these latter names are more familiar to a modern chemist, a reader from early nineteenth century must have felt the opposite, as the new expressions were in many cases completely different from the names used up to then. Because of this, their dissemination met some resistance, especially among craftsmen or pharmacists who continued to use the traditional nomenclature, which was much closer to their daily practice and was based on properties such as colour, taste or therapeutic properties [49]. To tackle this problem, Orfila included in his book the old synonyms of the names of the chemical substances that he described, so that readers could easily overcome the difficulties caused by the terminological reform to the popularisation of science.

By explaining the new chemical terms, based on the chemical composition of substances, Orfila was offering one of the keys to understanding the new toxicological methods that he himself had helped to create. His aim was to bring his readers into contact with medical advances, and offer them advice in urgent cases when “the doctor is not nearby and cannot arrive for an hour or more after the incident”. At the same time, Orfila pointed out the risks inherent to the use of medication or when trying cures without the necessary supervision of a doctor. Orfila was thus following a trend that became well established in the nineteenth century, with the changes that had occurred in the medical profession, and which led to many of the medical books of previous centuries being seen as useless. Many writers thought that, without ever more complex and specialist physical and chemical knowledge, it was impossible to understand medical theory and practice sufficiently to follow without risk the therapeutic precepts of popularising works. These works should limit themselves to offering preventive measures, first aid and, above all, information warning against healers and superstitions. Decisions on the therapeutic practice required in each case should be left in the hands of experts. In

tune with these views, Orfila criticised certain popular ideas on poisons and antidotes and the practices of healers who, it should not be forgotten, played an important role in French rural communities at the start of the nineteenth century, perhaps even more so than qualified doctors did [50]. In this respect, Orfila’s popularising publications contain rich information on popular remedies and healing practices which have often disappeared without leaving hardly any written record or other traces permitting their study. In other passages, he also alerted against “the dangers” involved in using certain medicines “without consulting the doctor” or the hazards of “self-administration”. Orfila indicated, for example, that mercury preparations were “heroic remedies in the hands of a good doctor”, but could turn into dangerous preparations due to the abuse of “quacks playing on people’s credulity”, who administered them “without the slightest precaution” [51].

Not all doctors shared this view of the relationship between academic and popular medicine. At the opposite pole from Orfila and his thinking was François Vincent Raspail (1794–1878), a socialist and republican thinker, and opponent of Orfila in various trials at the end of the 1830s that would make them both famous. Raspail thought that cures were quicker and safer if medicine left the academy and was disseminated among the population. He spoke against medical practice based on ideas that were inaccessible to ordinary people. He sought to create a popular medicine, different from official medicine, such that each person could act as his/her own doctor. Raspail boasted, though perhaps fatuously, that, where his books were read, “medical attendance dropped off in number and importance” [52].

Raspail’s posture was fairly risky and brought down on his head various accusations and prosecutions for illegal practice of medicine [53]. Nevertheless, Orfila’s arguments, despite being more in line with the dominant ideas of the medical elite of the time, were not exempt from problems and contradictions. One of them was the very meaning of what is called “academic medicine”. It was not easy to define this idea in an age in which many points of view, at times counterposed, existed inside the medical community about the theory and practice of medicine. The controversies were even stronger in the case of the topic that Orfila aimed to popularise, *i.e.*, toxicology. His new analytic methods, though favourably received by some major scientists, also aroused suspicion and criticism. It has been already mentioned that influential doctors argued against the use of experiments on animals to reach conclusions about the action of a poison in human beings. Even in cases in which researchers used similar methods, experiments could reach different conclusions. Orfila wrote in 1835:

“The difficulty of checking certain facts, differences in wisdom and skill of observers and several other causes are sufficient to explain the diversity of opinions given by the forensic doctors of our days and give rise to the controversies that have reigned for several years” [54].

In consequence, there was no general agreement on either antidotes or on the analytic methods for detecting poisons. Shortly after the appearance of *Secours*, Antoine Portal strongly criticised the antidotes suggested by Orfila and, more generally, the very idea that specific remedies could be used for each poison. Orfila acknowledged in 1826, in the third edition of the *Traité des Poisons*, that Portal's criticisms were not isolated: many doctors had rejected his antidotes without having used them. These debates and polemics are discussed in Orfila's academic papers and treatises but they are absent from his popularising books [55]. In these, Orfila's recommendations and therapeutic precepts are often presented as "tested in irrefutable experiments" and contrasted with the obvious errors of other doctors and pernicious popular superstitions.

One can wonder about the consequences that this way of popularising science had on the public image of toxicology, especially among judges and magistrates who in subsequent years increasingly had to take decisions based on forensic science. Orfila's popularising books undoubtedly contributed to the greater presence of experts in the courts and to the dissemination of his views on how medical expertises should be conducted. They did, however, convey too rosy a vision of toxicology as a reliable and exact science. This optimism could lead to dangerous attitudes, which Orfila himself had to criticise years later. "Give conclusions," demanded a judge at Riom of the experts during a famous case of supposed poisoning in 1843. "Toxicology cannot admit a doubt of this kind. Poisoning either occurred or did not occur". In his reply Orfila reminded the public that the complexity of toxicological work does not always allow such definite conclusions. Judges often had to make do with expert reports indicating that poisoning was "probable, very probable or extremely probable" [56]. In addition, there was no expert consensus on the question of analytic methods. Advances in analytical chemistry could render procedures and techniques obsolete that had been considered practically definitive just a few years before. Raspail used this argument often to attack Orfila at several trials in which they clashed at the end of the 1830s. He accused Orfila of constantly changing his opinion, such that "every edition of the books of Orfila" could be read as "a condemnation of the methods described in previous editions" [57]. In a discipline such as toxicology these changes could have serious consequences and Raspail knew how to exploit on behalf of defendants the contradictions arising from the provisional nature of scientific knowledge vs. the definitive conclusions demanded by judicial procedure. Given that methods of detecting poisons changed rapidly with new research, how could a sentence of death be pronounced on the basis of a chemical analysis that might the following day be considered ambiguous or not very conclusive? "If the head of the defendant rolled before the new experiments were known..., could the withdrawal of the erroneous conclusion perhaps stick the head back onto the condemned man's neck?", Raspail argued during one of the trials in which he clashed with Orfila [58].



Figure 7. Mateu Orfila (1787-1853). Collection of the Bibliothèque interuniversitaire de médecine de Paris.

Conclusions

These described episodes are examples of the multiple facets of Orfila's life. One of his first biographers pointed out that, during the apex of his career, Orfila moved customarily between his laboratory and his teaching chair in the Faculty of Medicine. In addition, he often had to attend meetings of the various consultative bodies to which he belonged, such as the *Conseil de l'Instruction Publique* (Public Instruction Board) or the *Conseil des Hospices de Paris* (Paris Hospitals Council). He was often required in the courts as an expert witness and, in the time he had left, laboured for hours in his office to assemble the information he needed to write his books, which were constantly being revised in succeeding editions [59]. All these activities lead to different aspects of Orfila's biography that need to be examined carefully: his toxicological research, his educational practice and his text books, his work as administrator of the Faculty of Medicine and reformer of medical studies and, finally, his contribution to establishing the role of the forensic medicine in the courts. Thus, by way of example, the polemic between Orfila and Raspail shows the interesting lessons that can be drawn from the study of toxicology in the nineteenth century. These polemics unveil the difficulty of settling scientific controversies that arise during trials. They also throw new light on the problems involved in introducing new methods into forensic practice. The new technique of DNA fingerprinting, which, like the Marsh's test, has also been linked to famous cases, has led to debates that to some extent recall those that we have explained in the preceding pages [60]. These questions impose reflections on just how laboratory research can be transferred to forensic practice. When is a method sufficiently reliable to be used as a basis for a verdict beyond all reasonable doubt? In Orfila's time that question was related

to the debate on experiments with animals. To what extent can experiments with dogs under the special conditions of a chemical laboratory throw light on poisoning of human beings? It has been showed that Orfila's contemporaries cast doubts on the medical uses of animal experimentation. Even those who accepted animal experimentation disagreed about the methods that should be used and the conclusions that could be reached in each case.

Under these circumstances, in the midst of the fierce polemics that surrounded nineteenth century toxicology, it is very interesting to understand the strategies that Orfila adopted in his teaching and popularising work. It has been pointed out that, as professor of chemistry, he also had to face another debate concerning medical applications of chemistry. The success of his text books was partly due to his talent in offering contents and organisation that responded to the challenges posed by this debate. His teaching practice was intimately related to his research work, so that boundaries between one and the other could not be drawn. It is possible that, as Orfila wrote in his autobiography, certain events occurring by chance in his classes decisively moulded his subsequent toxicological research. However, more certain is the positive influence of having to organise constantly the growing information available on cases of poisoning in his textbooks. In addition, his appropriation of contemporary toxicological literature often gave him new arguments to defend his view-points in the scientific journals or the trials he took part in. Thus, in his constant movement from laboratory to classroom, from the Faculty to the courts of justice, Orfila not only spanned several institutional spaces, but also diverse contexts of legitimisation of science, with different images of scientific objectivity and of the procedures required to attain it. In his daily activity, Orfila also crossed the frontiers of what today we consider different disciplines, such as chemistry, medicine or physiology. His forensic reports, composed to answer specific questions in the trials at which he appeared, led him into research of enormous theoretical importance, which he published in major scientific and medical journals of the time. Finally, though perhaps less known, the work of Orfila as a medical populariser offers an opportunity to tackle burning contemporary questions with a fresh approach. What should the main aim of scientific and medical popularisation be? Towards whom should it be directed? What kind of language can be used in popularising works? What image of science do the readers of these books receive? The analysed examples, taken from various episodes in Orfila's life, show that neither in the nineteenth century nor today is it easy to find an accurate answer to these questions.

The described episodes are no more than a tiny sample of the many interesting features of Orfila's life. To analyse all these aspects in an integrated way, specialists in various historical disciplines are needed, each of whom can offer a particular approach to Orfila. This was the main aim of a meeting held in Mahón in March 2004, at which various historians from several European countries analysed Orfila's work from many different perspectives [61]. At the same

time, thanks to the Paris Medical Faculty Library (BIUM), electronic editions of the main writings of Orfila and of many of his best-known pamphlets and polemical articles were published [62]. Easy access to Orfila's texts and new historical questions should lead in the coming years to a new image of the famous Minorcan doctor. Thus, the personality of Orfila shall become an interesting meeting point for historians of science, technology and medicine.

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- [51] M. Orfila, *Socorros que se han de dar a los envenenados o asfixiados...*, Madrid, 1818, Imprenta de la calle de la Greda, *passim*.
- [52] Quoted in C. Blanckaert, La Médecine Philosophique de F.V. Raspail. In: J. Poirier, C. Langlois (eds.), *Raspail et la Vulgarisation Médicale*, Paris, Sciences en situation, 1992, pp. 129–198, quoted on p. 132.
- [53] J. Martineau, *François Raspail ou le bon usage de la*

- prison*, Paris, Martineau, 1968, which contains various texts by this author, among which is his defence against allegations of illegal practice of medicine.
- [54] M. Orfila, Mémoire sur plusieurs points de médecine légale par ..., *Annales d'Hygiène Publique et de Médecine Légale*, 13(2) (1835), 485–500, pp. 485–486.
- [55] See, however, Orfila's refutation of Portal's ideas on poisons in *Secours à donner aux personnes empoisonnées et asphyxiées ... 2nd édition revue, corrigée et augmentée.*, Paris, Béchét jeune, 1821, pp. 6–11.
- [56] M. Orfila, Quelques réflexions critiques sur les moyens de conclure en médecine légale, et sur la prétendue localisation des poisons, *Annales d'Hygiène Publique et de Médecine Légale*, 31 (1844), pp. 430–443.
- [57] *Gazette des Hôpitaux*, 11 June 1840.
- [58] Letter of Raspail, 2 August 1839, reproduced by Martineau, *op. cit.*, 413.
- [59] Dubois, 1853, *op.cit.*, xxiv. «Il passait en effet chaque jour de son laboratoire dans la chaire de professeur, du conseil de l'Instruction Publique dans celui des hospices ou dans le conseil départemental, ou même, comme je le dirai tout à l'heure, dans le sein de quelque tribunal pour y déposer comme expert. Il devait enfin passer de longues heures dans son cabinet; car c'est là qu'il a composé les importants ouvrages...»
- [60] There is a good collection of studies in Lynch, M., Jasanoff, S. (eds.), *Contested Identities: Science, Law and Forensic Practice*, *Social Studies of Science*, 28 (5-6), 1998, 675–869.
- [61] There is a description of the meeting at <<http://www.uv.es/=bertomeu/orfila/index.html>>. An edition with a revised version of the papers is in press.
- [62] These works are available at <<http://www.bium.univ-paris5.fr/histmed/medica/orfila.htm>>. I am grateful to Guy Cobolet (Paris Medical Faculty Library, BIUM), for his kind help in providing sources and images for this paper. I also thank Agustí Nieto-Galán (Universitat Autònoma de Barcelona) for his helpful comments and revision of the draft version.