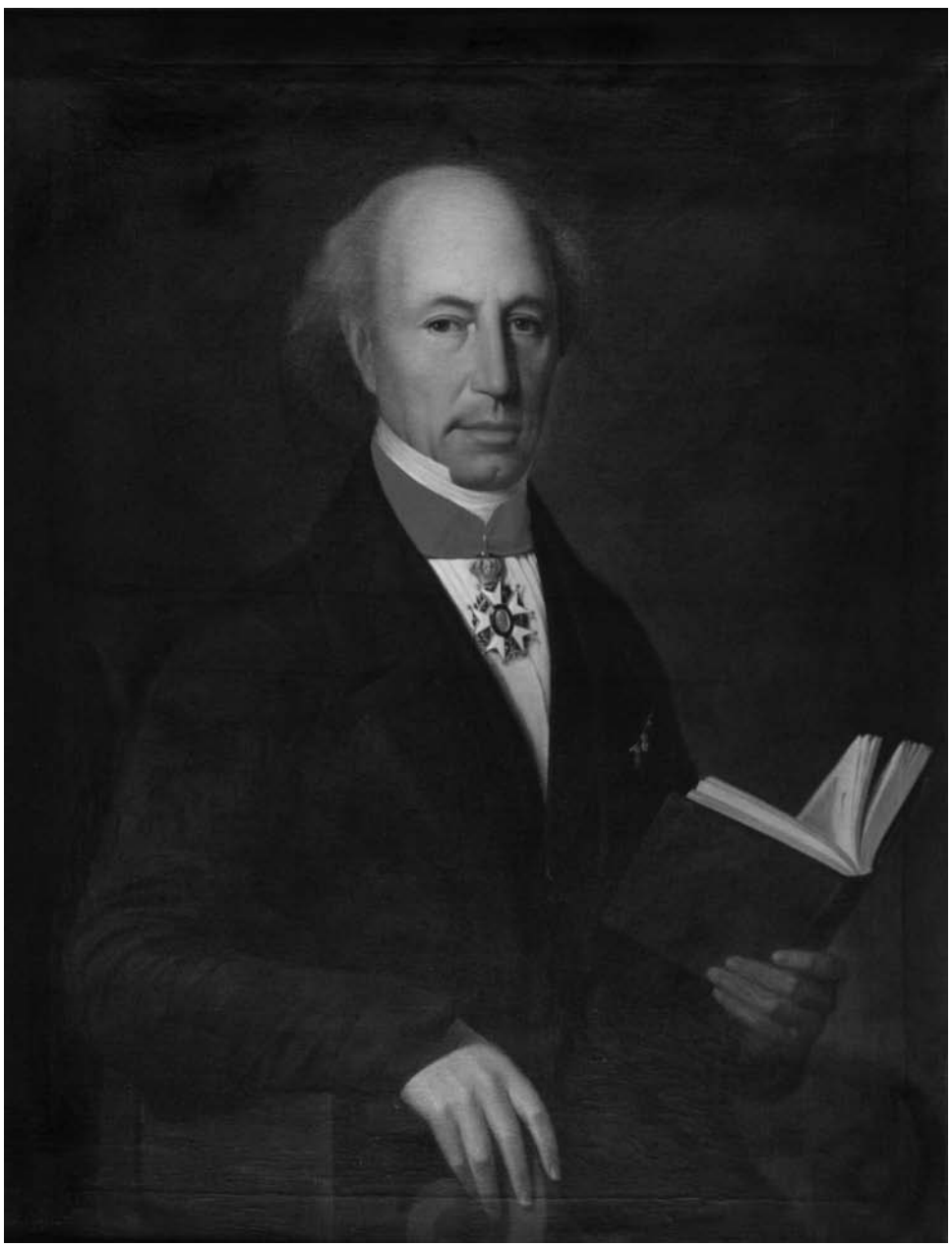
Chemistry, Medicine, and Crime



Mateu Josep Bonaventura Orfila i Rotger (1787–1853).
Oil painting by A.M. Esquivel. Courtesy of the Mahon Council.

Chemistry, Medicine, and Crime

Mateu J.B. Orfila (1787–1853) and His Times

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Preface

The papers in this volume originated from contributions to the international meeting "Chemistry, Medicine, and Crime: Mateu J. B. Orfila (1787–1853), and His Times" held in Mahon, Minorca on 19 and 20 March 2004. The meeting marked the 150th anniversary of the death of Mateu Orfila, a prominent toxicologist and chemist, whose work was analyzed by historians of science from several European countries. So first we should thank the authors of this book and all the participants in the meeting for their contributions.

The international gathering in Mahon was hosted by the Institut Menorquí d'Estudis (IME), one of the island's main cultural bodies. The IME provided us with the ideal setting for the event. In particular, Josep Miquel Vidal, head of research at the IME and co-organizer of the meeting, was fundamental in ensuring that things ran smoothly. Àlvar Martínez-Vidal provided invaluable help with the academic design of the project through the research group "Francesc Salvà" of the "Centre d'Estudis d'Història de les Ciències" (CEHIC), at the Universitat Autònoma de Barcelona (UAB). Our very special thanks go to the Fundació Dr. Antoni Esteve for its support of the meeting in Mahon, as well as for its generous contribution to the publication of this volume. Other institutions such as the Fundació Mateu Orfila (Mallorca), the Societat Catalana d'Història de la Ciència i de la Tècnica (SCHCT), and the Spanish Ministerio de Ciencia y Tecnología (BHA2002-04611-C03) also supported the project.

For making Orfila's sources available to historical research, we should particularly thank Danielle Gourevitch (École Pratique des Hautes Études, Paris), and Guy Cobolet and Henri Ferreira-Lopes (Bibliothèque Interuniversitaire de Médecine, BIUM, Paris). Our thanks to the BIUM for allowing us access to its comprehensive bibliography; electronic versions of Orfila's main books, papers,

images and many of his best-known pamphlets are now available at http://www.bium.univ-paris5.fr/histmed/medica/orfila.htm. We are indebted to the librarians and staff members of the Max-Planck-Institut für Wissenschaftsgeschichte (Berlin) for allowing us to use their excellent bibliographic service. We would also like to thank the Reial Acadèmia de Medicina de les Illes Balears for its kind support of the publication of a facsimile Spanish edition of Orfila's *Socorros que se han de dar a los envenenados o asfixiados* (1818) (*A popular treatise on the remedies to be employed in cases of poisoning and apparent death*), which was handed out to the participants at the meeting. The edition of Orfila's books, leaflets and papers will be a very useful complement to the scholarly work of this volume. Editions of Orfila's correspondence will be published soon with the support of the IME. Under the auspices of the Fundació Dr. Antoni Esteve, a Spanish version of some of the chapters on toxicology will also be published.

For their helpful comments and support throughout this research project, we are indebted to Bernadette Bensaude-Vincent, Antonio García-Belmar, Ursula Klein, Àlvar Martínez-Vidal, and José Pardo-Tomás. We also thank all the institutions that have kindly provided us with books, documents and images from their libraries and archives. In addition, Michael Maudsley's patient and careful stylistic corrections of the papers written by non-English-speakers have been of great value.

This collective volume attempts to analyze Orfila's life and works from a perspective that is more in tune with recent trends in the history of science. We have tried to show that chemistry, medicine and toxicology cannot be historically understood as fixed and independent disciplines, and that Orfila's contributions had a profound impact on the relationships between these subjects during the first half of the nineteenth century.

January 2006

José Ramón Bertomeu-Sánchez (València)
Agustí Nieto-Galan (Barcelona)

Introduction

José Ramón Bertomeu-Sánchez
and Agustí Nieto-Galan

Mateu Josep Bonaventura Orfila i Rotger (1787–1853) was a medical celebrity, but his work is scarcely mentioned in histories of science and scientific publications. With the exception of books on toxicology, in which he is usually acknowledged as one of the discipline's founding fathers, very few textbooks report Orfila's main achievements. In the nineteenth century, however, he was extremely well known. His active participation in famous poisoning trials meant that his name echoed far beyond the boundaries of the academic community, and even appeared in novels, plays, films, and popular biographies.[1] At the height of his career, Orfila combined his laboratory work with his teaching chair in the Faculty of Medicine, and often attended meetings of the various consultative bodies to which he belonged. As one of his first biographers noted admiringly, his presence was frequently required in courtrooms to give expert forensic evidence; he was a prominent figure at the Paris Academy of Medicine, and wrote several textbooks that were constantly updated and reprinted.[2]

Orfila's career takes us across institutional and disciplinary boundaries and encompasses a variety of academic, legal and scientific areas. He was a key player in a wide range of historical problems, which the chapters of this volume, written from a comparative European perspective, attempt to analyze: (a) The reform of medical studies in the early decades of the nineteenth century; (b) The introduction of new teaching practices and textbooks; (c) The controversies surrounding early nineteenth-century medical chemistry; (d) The nine-

teenth-century techniques of animal experimentation; (e) The emergence of toxicology as an academic discipline; and (f) The new role of forensic medicine and medical experts in courtrooms. Therefore, the figure of Orfila provides an opportunity to reassess the received view of the intersection between chemistry and medicine that is enshrined in mainstream accounts, and to avoid a rigidly disciplinary approach to the history of nineteenth-century toxicology.

Histories of disciplines tend to be accumulative reconstructions of the advance of scientific knowledge, and in narratives of this kind Orfila has been assigned only a minor role. Through his lectures, writings and experiments, he crossed the boundaries of knowledge, and so his contributions should be evaluated in terms of scientific practices in a series of contexts: the lecture-hall, the laboratory, the courtroom, and so on. In fact, Orfila's ambiguous position, moving back and forth between a variety of disciplines and contexts, provides a useful opportunity to explore further the intersection between chemistry, medicine and toxicology. He is also an ideal subject for a new historical approach, which, beyond the great luminaries, seeks to recover unknown actors, shows a particular interest in the ways in which scientific knowledge was transmitted to different audiences, and looks at the controversies surrounding experiments and scientific instruments.

For an analysis along these lines, historians can draw on Orfila's autobiography and on a large amount of his personal correspondence preserved in libraries, museums, archives and private collections. Orfila was a successful writer of textbooks and editor of some of the most influential medical journals of his time. In addition, he was involved in many controversies. As recent historical work has shown, scientific controversies often provide textual sources (papers, leaflets, letters), which help us to analyze the implicit assumptions and widely accepted practices governing a discipline and its adoption of new technologies, or even the ethos of a particular research group. In Orfila's case, courtroom controversies produced a wealth of legal documents: experts' reports, records of cross-examinations, and letters. The contributors to this volume analyze part of this rich historical heritage.

Mateu Orfila was born in Mahon (Minorca) on April 24, 1787. He was educated by French and English tutors and his knowledge of foreign languages would later enable him to read the most important scientific literature of the age. In September 1804, Orfila traveled to Valencia and entered the Faculty of Medicine. Disappointed by the intellectual atmosphere there, he moved to Barcelona to study under Francesc Carbonell (1768–1837) at the School of Chemistry.[3] With a favorable report from Carbonell, he was awarded a schol-

arship to travel to Madrid and then to Paris where, as a *pensionado*, he pursued his studies of chemistry and mineralogy for four years.[4]

Orfila went first to Madrid for an interview with Joseph-Louis Proust (1754–1826), a well-known figure in the circles of the new Lavoisierian chemistry.[5] But by the time he reached the capital, Proust had already left Spain. So Orfila made his way to Paris, arriving in early July 1807. He first visited another *pensionado*, Francesc Lacoma (1784–1849), a young student who would later become the court painter of Fernando VII. Lacoma accompanied Orfila in the first years of his stay in France.[6]

In Paris, Orfila contacted Antoine-François Fourcroy (1755–1809) and Nicolas Vauquelin (1763–1829), two leading French chemists, who admitted him to their teaching laboratories.[7] Like other Spanish students, Orfila also attended Louis-Jacques Thenard's (1777–1857) courses of chemistry at the Collège de France. At that time, Thenard was a young pharmacist who was soon to become an influential figure. His contribution to Orfila's career was decisive in many respects. His work—in particular, his famous *Traité de chimie*, one of the most important chemistry books of the first half of the nineteenth century—and his academic connections played a crucial role in Orfila's entry into the academic and bourgeois circles of Paris.[8]

The paper by Antonio García-Belmar places Orfila in the large audience of chemistry and medicine students that attended Thenard's lectures. Drawing on two student notebooks, which are almost contemporary to Orfila's early years in Paris, García-Belmar analyzes the contents of Thenard's lectures, their structure and order, his teaching strategies and his frequent use of experiments. These notebooks provide new evidence that broadens our understanding of the context of Orfila's formative years as a student of medicine and his first steps as a teacher of chemistry. In fact, just a few months after his arrival in Paris, he started teaching privately; his private lectures were increasingly successful and continued until 1819, when he was appointed professor at the Faculty of Medicine of Paris. In tune with recent historical studies on scientific teaching, García-Belmar discusses the lectures and their connection with the research that Thenard was carrying out at the time.[9]

Orfila lectured on different scientific topics, but his courses on chemistry for medical and pharmaceutical students stand out. At the very beginning of his career he had published several papers on medical chemistry and his PhD dissertation was an analysis of the urine of persons affected by jaundice.[10] In 1817, on the basis of his lectures, he published a textbook on "medical chemistry" that soon became one of the most successful chemistry books of the nineteenth century.[11] Later, in the 1820s and 1830s, he contributed to the *Société de chimie*

médicale, whose main activity was the publication of the *Journal de chimie médicale, de pharmacie et de toxicologie*.

In medical chemistry, Orfila was originally influenced by the work of his master in Barcelona, Carbonell[12]—who had written his PhD dissertation in 1800 on the relationships between medicine and chemistry—and later by his French masters, Fourcroy and Vauquelin. As is well known, Fourcroy was a famous propagandist of medical chemistry in France. In the belief that the new pneumatic chemistry would revolutionize medicine, he analyzed numerous fluids and solids in the human body. He also wrote on the therapeutic properties of oxygen and published a journal on the applications of physical sciences to medicine. During the late eighteenth and early nineteenth century, other authors also published on medical chemistry: Pierre-Philippe Alyon, John Rollo, Louis-Bernard Guyton de Morveau, Thomas Beddoes, Jean-Baptiste Baumes, Christoph Girtanner, and François Blanchet. The topics they addressed varied widely, ranging from medical treatments based on new chemical substances (oxygen, carbonic acid, chlorine) to new chemistry-based medical systems such as Baumes's chemical nosology.[13]

Not all physicians reacted enthusiastically to the new applications of chemistry to medicine. At the beginning of his textbook, Orfila recognized that "some physicians consider[ed] chemistry not only as useless but also as dangerous." In reply to a critical review, Orfila gave a detailed description of his conception of medical chemistry. He considered that it could provide new clues as to the action of different substances on the *économie animale*, their use in the treatment of diseases and their appropriate doses and the substances which could not be mixed without decomposition. Orfila acknowledged, though, that other authors had a very different perception of medical chemistry; they regarded it as "the science that aims to understand what happens during the transformation of chyle into blood, the secretion of urine, sperm, tears and so on." Orfila disagreed; he claimed that he would never consider the human body as a chemical laboratory, nor "build up theories even when facts were lacking."[14]

These quotations show that Orfila's views on medical chemistry were complex and have to be understood in the context of the wide range of positions adopted by early nineteenth-century physicians and pharmacists. The paper by María José Ruiz-Somavilla studies how these attitudes to medical chemistry were largely shaped by the contemporary debate on vitalism.[15] She describes Fourcroy's program of medical chemistry, its development, and the controversies surrounding the use of chemistry in medicine, and the context in which the *Société de chimie médicale* was created.[16] In addition, she analyzes social and institutional issues such as career opportunities, peer pressure, and educational

background that influenced the debate on vitalism in France. In 1830, as dean of the Faculty of Medicine in Paris, Orfila enjoyed an influential institutional position and good connections with the political authorities. Needless to say, he made the most of his advantageous situation during the debate to make his points of view known on the relations between chemistry and medicine.

Ursula Klein approaches the relationship between medical chemistry and the emergence of the new culture of organic chemistry. She provides a broad introduction to early nineteenth-century plant and animal chemistry, and discusses the failure of the "Lavoisieran program on plant chemistry" and its reception and perception by the most influential chemists.[17] The research by Thenard and Joseph-Louis Gay-Lussac (1778–1850) on the elemental composition of immediate principles of plants had a deep influence on Orfila's chemistry, particularly on the classification of immediate principles that appeared in the first edition of his textbook in 1817. In the 1830s, new research on ethers and the spread of Berzelius's new formulae contributed to the emergence of the experimental culture of organic chemistry. According to Klein, these changes affected the type of experiments conducted, the classification of organic substances and the style of argumentation and justification.[18] Moreover, it restructured the entire area of scientific objects and altered the notion of organic matter. These crucial changes took place between 1828 and 1840, the period in which several revised versions of Orfila's textbook on medical chemistry were published. Reflecting Orfila's attitude to the new organic chemistry, Klein provides a detailed discussion on the changes he introduced.

Ana Carneiro studies Adolphe Wurtz's (1817–1884) research on medical chemistry. After being *préparateur de chimie* in 1845 and *agrégé de chimie*, in 1847, Wurtz succeeded Orfila in the chair of chemistry in the Faculty of Medicine in Paris.[19] Like Orfila, Wurtz held the post of dean of the Faculty of Medicine, between 1865 and 1875, and set up a research school that became a reference point for the development of experimental research in France in the second half of the nineteenth century.[20] His initial research was focused on organic chemistry and his work exemplified the transition from type theory to structural theory. The school's focus on atomism made it unique in French chemical circles. Ana Carneiro describes how Wurtz and his research school continued to focus primarily on organic chemistry, but by the end of his career his school was already contributing to the transition from organic chemistry to biochemistry, through the intermediate stage of biological chemistry.

From Fourcroy to Dumas and Wurtz, from the chemical revolution to structural theory, from clinical to laboratory medicine, the chapters by Ruiz-Somavilla, Klein and Carneiro reveal the changing relationships between chemistry and medicine as the nineteenth century progressed. Many important

chemists such as Orfila, Dumas and Wurtz were teachers of students of medicine and pharmacy, so they were eager to show that chemistry could shed light on the nature of disease and offer insights for making new drugs and applying them to new medical treatments. In some cases, their claims were either too optimistic or purely rhetorical. By the middle of the century, for instance, the well-known German physician, Rudolf Virchow, wrote: "[chemistry] has already accomplished a great deal for us, although thus far, very little is useful for practical purposes."[21] In other cases, however, new chemical substances and analytical techniques had a real impact on the practice of medicine. Two good examples are the introduction of alkaloids in early nineteenth-century pharmacology and the new chemical tests for research on toxicology. These two areas are analyzed in the second part of this volume, which describes other episodes in which Orfila played an important part.[22]

Though medical chemistry was a key area in Orfila's early career, toxicology soon became the discipline in which he had greatest influence. As well as introducing new methods of chemical analysis and adapting them to forensic practice, he organized all the information available on the clinical symptoms of poisons and possible antidotes, on the results of detailed anatomical observations during autopsies and new chemical tests. He performed a huge number of experiments with animals, particularly with dogs. As reflected in medical journals, reviews, and in a small sculpture at the Musée Carnavalet in Paris (figure 1), Orfila's experiments with dogs were well known and praised by his contemporaries.[23]

Paradoxically, the experimental character of Orfila's research on toxicology is one of the reasons why he is only rarely mentioned by historians of early nineteenth-century medicine, the period of the "birth of the clinic" (Michel Foucault) or the "emergence of 'hospital medicine' " (Erwin Ackerknecht). In one of his first influential books, Foucault described the emergence of a new *medical gaze* ("*regard médical*"), the result of the new hospital-based education, systematic clinical observations and pathological anatomy. The new discourse encouraged the rejection of theory and the abandonment of old medical systems. This empirical approach left little space for basic sciences in medicine. Foucault remarked that "alone, the gaze dominated the entire field of possible knowledge; the intervention of techniques presenting problems of measurement, substance, or composition at the level of invisible structures was rejected": hence, "the rejection of a number of scientific techniques that were nonetheless used by doctors" in previous centuries. Foucault stated that the most significant case was "the rejection of chemistry." Even if "analysis, as practiced by Lavoisier,

Figure 1 Caricature of M. Orfila performing experiments with dogs (*ca.* 1838). Small bronze sculpture. Musée Carnavalet, Paris. Reproduced in Juan Hernández Mora, "Orfila. El hombre, la vocación, la obra," *Revista de Menorca*, 49, (1953): 1–121, p. 120 (plate XXI). Private collection.

served as an epistemological model for the new anatomy" . . . "it did not function as a technical extension of his gaze." Therefore, while eighteenth-century doctors commonly performed chemical analyses of blood and other corporal fluids, "at the beginning of the nineteenth century, this experimental apparatus disappeared."[24]

From a different perspective, Ackerknecht reached similar conclusions on the role of experimental sciences in early nineteenth-century French medicine. For Ackerknecht, the emergence of clinical medicine involved a major shift that moved medical thought away from systems toward a new approach based on empirical clinical enquiry. Again, pathological anatomy was regarded as the key point in this process. Clinical symptoms were correlated with anatomical lesions in tissues, which were identified during postmortem examinations. Based on statistics and work at the bedside or in the dissection room, a new practical approach to medical training rapidly emerged and reached its climax in Paris during the 1820s and 1830s. The focus on statistics, physical examination and macroscopic pathological anatomy, however, "ostracized" experimental physiology, chemistry and microscopy. As a result, by the end of 1840s, French medicine "lost its superiority to Germany" and came to a "dead end," "as all empiricism had done in medical history."[25]

Clearly, Orfila's career and experimental work does not conform to this picture. Ackerknecht praised the quality of François Magendie's research on experimental physiology and other experimentalists but he pointed out that they never held chairs at the Paris Faculty of Medicine. The few lines that Ackerknecht devoted to Orfila mention only his role as administrator of this institution.[26] But, as many chapters in this volume clearly show, Orfila was also a brilliant experimentalist with poisons. He controlled the doses, administration (i.e. oral, digestive tract, subcutaneous) and the duration of the effects. Unlike other experimentalists such as Magendie, Orfila worked at the core of the Paris "clinical school," as professor of the Paris Faculty of Medicine from the beginning of his career and its dean from 1830 to 1848.

Recent historical studies have reconsidered the received view of early nineteenth-century medicine.[27] Some historians have shown the eighteenth-century roots of the clinical revolution,[28] while others have highlighted the important work of some French physicians in scientific fields such as microscopy or experimental physiology.[29] In his detailed study on experimental physiology, John E. Lesch described Magendie's work in the context of a large group of contemporary Paris physicians and pharmacists who performed animal experiments and used chemistry tests in their search for new therapeutic substances.[30] Lesch argued that the Paris clinical school provided "an environment favorable to the development of the laboratory sciences, in particular,

experimental physiology, organic analysis, and pharmaceutical chemistry." He reinforced his argument with an analysis of the important role of experimental science at the Paris Academy of Medicine.[31] Nevertheless, Lesch did not mention Orfila's experimental work.[32] Although Orfila was an outstanding member of both the Paris Medical Faculty and the Academy of Medicine—of which he was president during the last years of his life—and many of his main works on toxicology were presented and discussed at this institution, his contributions have not yet been fully evaluated, perhaps because of the limited number of studies of French nineteenth-century toxicology.[33] Neither the changes in toxicological tests nor the different types of experiments on animals have been the subject of major historical investigation. This is a gap that the present volume tries to fill, from a comparative European perspective, demonstrating the influence of Orfila's work on toxicology in different countries.

Orfila's main contributions to toxicology were summarized in his *Traité des poisons*, 1814–1815, one of the most popular textbooks of the first half of the nineteenth century. In terms of fame and influence, the book could be only compared with the *Treatise on Poisons* by Robert Christison (1797–1882), professor of medical jurisprudence and *materia medica* at the University of Edinburgh. His textbook appeared in 1829 and had gone through four editions by 1845. Anne Crowther's paper analyses Orfila's reputation as a toxicologist and scientific expert in Britain. For more than two decades, Christison was Orfila's interpreter and rival in Britain, discussing, admiring, criticizing, and, sometimes, "improving" Orfila's procedures. By the 1830s, whenever a trial involved poison, British courtrooms regularly coupled Orfila's name with that of Christison. The context of the Scottish legal system enabled Christison to emulate Orfila's standing as an expert witness and to claim a place for Scotland in the international development of the subject. Crowther also offers very interesting data about the public image of Orfila's work in Britain.

Bettina Wahrig analyzes a group of German textbooks on toxicology published between 1780 and 1830, including the German versions of Orfila's textbook by Julius Hermbstaedt (1760–1833) and Otto Bernhard Kühn (1799–1863). She explains how authors dealt with the delicate problem of the definition of poison in relation to the general medical theories supported by textbook authors. In that context, poisons were used for testing pathological and physiological theories, so they were "boundary objects" that linked different areas of medical research. Wahrig compares the German views on Orfila's ambiguous definition of poison, showing that he used ideas that had been highly contested in Germany. She also analyzes how German authors received Orfila's classification of poisons, which was based on the classification by François-Emmanuel Fodéré (1764–1835).

Katherine Watson offers a detailed study of one of the most important research tools for nineteenth-century toxicologists: the Marsh test for arsenic. She gives us an overview of the English legal system on poisoning cases as well as a statistical survey of 278 trials held between 1815 and 1860.[34] Watson describes the "Bodle affair," in which the young James Marsh (1794–1846) could not offer conclusive proof of the presence of arsenic in the contents of the stomach of the dead man. This failure, however, spurred Marsh on to seek a better method of arsenic detection. In 1836, his new test was published and soon became a standard procedure in toxicology. It was rapidly adopted in England, Germany and France, not only by prominent toxicologists but also by provincial physicians. Orfila soon showed interest in the Marsh test and used it in some of the most famous poisoning trials in which he acted as expert.

José Ramón Bertomeu-Sánchez describes how Orfila transformed the Marsh test for his studies of the absorption of poisons, which he believed could make important contributions to both physiology and forensic research. During the Lafarge trial, four chemical tests were performed by different groups of local experts and Parisian toxicologists. Bertomeu-Sánchez shows that the Marsh test involved practical laboratory training and tacit knowledge, which were not easily available to local physicians. In 1841, after the Lafarge trial, a fierce controversy broke out at the Paris Academy of Science and the Academy of Medicine, fueled by many different factors: disputes between political ideologies in the Orleanist regime; differences in practices, and opposition between local and Parisian experts; the enduring influence of earlier toxicological practices; and the unequal distribution of academic power and the different institutional frameworks.

Ironically, the strong sensitivity of the Marsh test for detecting arsenic was one of the main causes of the controversy. The new test introduced new risks of arsenic contamination (reagents, vessels, cemetery soils, etc.), which could mask the effects of the poison used by the murderer. Perhaps the most embarrassing problem was "normal arsenic." At the beginning of 1839, Orfila stated that, using the Marsh test, he had found arsenic to be a natural constituent of the human body. Ian Burney's paper studies the British reaction to Orfila's unexpected findings. British chemical and medical journals followed the French debates closely, in particular on normal arsenic, and more generally on the evidence of arsenic poisoning based on "infinitesimal" results. The British response was characterized by cautious skepticism and a strong sense that, owing to its pernicious consequences for the value of chemical tests during poisoning trails, the subject needed to be carefully reviewed. Burney studies the long-term legacy of the episode for attempts by British toxicologists to shape a reliable framework for producing medical and legal evidence.[35]

One of the last controversies in which Orfila was involved was a dispute with the Belgian toxicologist Jean Servais Stas (1813–1891) on the chemical test for nicotine.[36] Nicotine was a poison that belonged to a group of substances discovered during Orfila's career, the alkaloids. Sacha Tomic describes the problems that this new group of substances posed to toxicologists. After 1817, the isolation of morphine was followed by the discovery of new alkaloids (strychnine, quinine, etc.), most of them by French pharmacist-chemists such as Joseph Pelletier (1788–1842), Joseph-Bienaimé Caventou (1795–1877) and Pierre-Jean Robiquet (1780–1840). By 1835, about 20 alkaloids had been identified and a new category—"vegetable alkalis" or "alkaloids"—soon appeared in chemistry textbooks. One of the most striking characteristics of these substances was their dramatic physiological effect in the human body.[37] Most of them were soon recognized as powerful poisons and used with criminal intentions. The difficulty of detecting them by chemical tests presented a real challenge for nineteenth-century toxicologists.[38] Starting with Orfila's paper on morphine published in 1818, Tomic studies his research in that field and analyzes his participation in the Castaing affair. Its inconclusive results clearly showed the limits of the chemical tests for alkaloids used in the 1820s and 1830s, and led the *Société de pharmacie* to offer a prize for the best new method for testing alkaloids.

These examples show that Orfila was actively involved in many scientific controversies of the first half of the nineteenth century. Recent historical studies have shown that these episodes can provide relevant insights on ideas, practices or instruments whose value has been too often taken for granted and, in some cases, "black-boxed" for historical analysis. The protagonists of the disputes attempted to undermine their opponents' views by pointing to the conventional status of their beliefs and practices and produced accounts of great interest to historians of science.[39] Poisoning trials are particularly interesting sources of scientific controversy. Apart from academic publications, the legal regulations in trials often compelled expert witnesses to support their views with detailed accounts of the clinical symptoms observed or the chemical tests and autopsies performed. The reports of the experts and of the trial sessions are underused sources that deserve more attention from historians of science who are interested in laboratory life, experimental practices, expert knowledge, and the public image of science.

Several types of scientific controversy are discussed in this volume. In some cases, the issue at stake was a theoretical system (such as vitalism) or a scientific instrument and its use (the Marsh test) while, in other cases, the debate focused on the results of a chemical analysis (for example, normal arsenic) or the

reliability of a method for detecting new chemical substances (alkaloids). The controversies we analyze took place not only in scientific journals and academic institutions, but also in crowded courtrooms, and were reported in the press. They brought together provincial physicians, local pharmacists, famous toxicologists, lawyers, politicians and the general public from different backgrounds and with different ideas on scientific evidence and demonstrative proof. The episodes studied provide examples of the various ways in which controversies are brought to closure: by negotiating or achieving a new consensus, by political or institutional fiat, or by appealing to new arguments, observations or experiments. Furthermore, as the case of "normal arsenic" shows, scientific controversies have a life of their own, and they can be used for purposes that may be substantially different from the original intentions of the protagonists.

The case studies in this volume shed new light on the development of medical chemistry, forensic toxicology, and the consolidation of expert knowledge and scientific evidence as conclusive legal proof in European courtrooms throughout the nineteenth century.[40] They show clearly that Orfila was a key actor in these changes. His work offers new material for further studies on the development of legal and scientific cultures of inquiry and their interactions in different national contexts. His expertise in trials and his activity as government advisor, chemistry teacher and administrator at the Paris Faculty of Medicine, among his many other activities, enrich our understanding of the complex intersection between chemistry, medicine and crime in the nineteenth century.

In the 1830s and 1840s, Orfila became a medical celebrity. On his death in 1853, obituaries appeared everywhere in academic journals and leaflets. Further commemorations of his birth and death added to this body of literature. Thus, drawing on recent works on commemorative practices in science, Agustí Nieto-Galan and José Ramón Bertomeu-Sánchez explore the different images of Orfila that were projected by his nineteenth- and twentieth-century biographers.

Notes

1. A recent bibliography listed around a hundred titles devoted fully to Orfila's life and work. Most of these titles were published in toxicology journals, crime book series, and local newspapers, but only rarely in scholarly or academic books. The bibliography can be found at: http://www.bium.univ-paris5.fr/histmed/medica/orfila.htm, together with a bibliography, a chronological table and other studies written on the occasion of the 150th anniversary of Orfila's death.
2. François Dubois, "Éloge d'Orfila," *Mémoires de l'Académie de Médecine*, 18 (1854): I–XXXIV, p. 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 . . . ."

3. Agustí Nieto-Galan, "Un projet régional de chimie appliquée à la fin du XVIIIè siècle. Montpellier et son influence à l'École de Barcelone: Jean-Antoine Chaptal et Francesc Carbonell," *Archives Internationales d'Historie des Sciences*, 44 (1994): 23–64; Agustí Nieto-Galan, "Seeking an Identity for Chemistry in Spain: Medicine, Industry, University, the Liberal State and the new 'Professionals,' " in David Knight and Helge Kragh (eds.), *The making of the Chemist* (Cambridge: Cambridge University Press, 1998), 177–190.
4. Antonio García-Belmar and José Ramón Bertomeu-Sánchez, "Viajes de cultivadores de la química españoles a Francia (1770–1830)," *Asclepio* 53(1) (2001): 95–139; Antonio García-Belmar and José Ramón Bertomeu-Sánchez, "Constructing the center from the periphery. Spanish travellers to France at the time of the Chemical Revolution," in Ana Simoes, Ana Carneiro, Maria Paula Diogo (eds.), *Travels of Learning. A Geography of Science in Europe* (Dordrecht: Kluwer Academic Publishers, 2003), 143–188.
5. On Proust in Spain, see Ramón Gago, "The New Chemistry in Spain," *Osiris*, 4 (1988): 169–192; Agustí Nieto-Galan, "The French Chemical Nomenclature in Spain: Critical Points, Rhetorical Arguments and Practical Uses," in Bernadette Bensaude-Vincent and Ferdinando Abbri (eds.), *Lavoisier in European Context: Negotiating a new Language for Chemistry* (Canton: Science History Publications, 1995), pp. 173–191.
6. This is why we have some beautiful portraits of Orfila during his young years. For a list and some reproductions see Juan Hernández Mora, "Orfila. El hombre, la vocación, la obra," *Revista de Menorca*, 49, (1953): 1–121.
7. William A. Smeaton, *Fourcroy chemist and revolutionary* (Cambridge: Cambridge University Press, 1962); Alain Queruel, *Vauquelin et son temps (1763–1829)* (Paris: L'Harmattan, 1994). On the role of Fourcroy in the disciplinary changes and the relationship between chemistry and pharmacy, see Jonathan Simon, "The Chemical Revolution and Pharmacy: A Disciplinary Perspective," *Ambix*, 45(1) (1998): 1–13.
8. Louis-Joseph Thenard, *Traité de chimie élémentaire, théorique et pratique, par . . .* (Paris: Crochard, 1813–1816). On Thenard and the chemistry courses in early nineteenth-century France, see Bernadette Bensaude-Vincent, Antonio García-Belmar and José Ramón Bertomeu-Sánchez, *L'émergence d'une science des manuels. Les livres de chimie en France (1789–1852)* (Paris: Éditions des Archives Contemporaines, 2003). On Thenard's experiments on ethers, see Ursula Klein, "Experiments at the Intersection of Experimental History, Technological Inquiry, and Conceptually Driven Analysis: A Case Study from Nineteenth-Century France," *Perspectives on Science*, 13 (2005): 1–48.
9. For a recent review of studies on science teaching, see David Kaiser (ed.), *Pedagogy and the Practice of Science: Historical and Contemporary Perspectives* (Boston: MIT Press, 2005).
10. Mateu Orfila, *Nouvelles recherches sur l'urine des ictériques, présentées et soutenues á la Faculté de Médecine de Paris, le 27 décembre de 1811, par . . .* (Paris: Didot jeune, 1811).

11. Mateu Orfila, *Elémens de chimie médicale* (Paris: Crochard, 1817). It went to 8 editions in French, and had several Italian, Spanish and English translations. An abridged version was even translated into Spanish, Italian and Dutch. For additional information, see: http://www.bium.univ-paris5.fr/histmed/medica/orfila/orfila03.htm.
12. Agustí Nieto-Galan, "Los nuevos 'médicos-químicos' en la Barcelona del 1800: el caso de Francesc Carbonell," *Estudios de Historia Social de las Ciencias Químicas y Biológicas*, 3 (1995): 83–96.
13. See Frederic L. Holmes, "The chemical revolution and the art of healing," *Caduceus*, 11(2) (1995): 103–126. For a recent review, see Stéphane Castonguay and Camille Limoges, *François Blanchet. L'étudiant et le savant. Avec le texte intégral et annoté des Recherches sur la médecine, ou l'application de la chimie à la médecine de François Blanchet* (Montreal: VLB Editeur, 2004).
14. Quotations from Mateu Orfila, *op. cit.* (11), vol. I, p. vi, and *Nouveau journal de médecine, chirurgie, pharmacie*, 4 (1819): 93–98. The translation into English is ours. On this point, see also Mateu Orfila, "Chimie," in: Nicolas Adelon et al., *Dictionnaire de Médecine* (Paris: Chez Béchez Jeune, 1821–1828), vol. V (1822), 127–133. On Orfila's ideas on medical applications of chemistry, see José Ramón Bertomeu-Sánchez and Antonio García Belmar, "Mateu Orfila's *Élémens de chimie médicale* and the debate about the medical applications of chemistry in early nineteenth-century France," *Ambix*, 47(1) (2000): 1–28.
15. On vitalism, see Guido Cimino and François Duchesneau (eds.), *Vitalism from Haller to the Cell Theory* (Firenze: L. Olschki, 1997); Roselin Rey, *Naissance et développement du vitalisme en France de la deuxième moitié du XVIII siècle à la fin du Premier Empire* (Oxford: Voltaire Foundation, 2000). Elisabeth A. Williams, *A Cultural History of Medical Vitalism in Enlightenment Montpellier* (Aldershot: Ashgate Publishing, 2003).
16. María José Ruiz-Somavilla, "La Société de Chimie Médicale y la institucionalización de la química médica en el París de la Restauración," *Cronos*, 3(1) (2000): 143–173. See also María José Ruiz-Somavilla's chapter in this volume.
17. Ursula Klein, "Shifting ontologies, changing classifications: plant materials from 1700 to 1830," *Studies in History and Philosophy of Science*, 36 (2005): 261–319. Ursula Klein, "Contexts and Limits of Lavoisier's Analytical Plant Chemistry: Plant Materials and Their Classification," *Ambix*, 52 (2005): 107–159.
18. Ursula Klein, *Experiments, Models, Paper Tools: Cultures of Organic Chemistry in the Nineteenth Century* (Stanford: Stanford University Press, 2003).
19. The process was complex. It involved a new organization of lectures, including the end of Jean-Baptiste Dumas's chair on organic chemistry and pharmacy. For further details, see the chapter by Ana Carneiro in this volume.
20. Ana Carneiro, *The Research School of Chemistry of Adolphe Wurtz, Paris 1853–1884* (PhD thesis: University of Kent at Canterbury, 1992); Ana Carneiro, "Adolphe Wurtz and the Atomism Controversy," *Ambix*, 40 (1993): 75–95; Ana Carneiro and Natalie Pigeard, "Les chimistes alsaciens à Paris au XIXe siècle: un réseau une école?," *Annals of Science*, 54 (1997): 533–546. For further information on Wurtz, see Alan Rocke, *Nationalizing Science: Adolphe Wurtz and the Battle for French Chemistry* (Cambridge: MIT Press, 2001).
21. Quoted by William F. Bynum, *Science and the practice of medicine in the nineteenth century* (Cambridge: Cambridge University Press, 1994), p. 123.

22. On the changing relationships between chemistry and medicine during the nineteenth century, see Frederick N. L. Poynter (ed.), *Chemistry in the Science of Medicine* (London: Pitman Medical Pub., 1963); William F. Bynum, *op. cit.* (21); William. F. Bynum, "Chemical Structure and Pharmacological Action: A Chapter in the History of 19th Century Molecular Pharmacology," *Bulletin of History of Medicine*, 44, (1970): 518–538; Eduard Glas, *Chemistry and physiology in their historical and philosophical relations* (Delft: Delft University Press, 1979); see also the review by Noel G. Coley, "Studies in the History of Animal Chemistry and its Relation to Physiology," *Ambix*, 43(3) (1995): 164–187.
23. See, for instance, the review of his *Traité de toxicologie*, which was written by Vauquelin, Pinel and Percy and read at the Paris Academy of Sciences. It was included in Mateu Orfila, *Traité des poisons tirés des régnes minerál, végétal et animal* (Paris, Crochard: 1814–1815), I, pp. xvii–xx. and III, ix–xvi: "Pour composer ces deux dernières parties de son ouvrage, M. Orfila a fait plus de huit cents expériences; il s'est constamment occupé de ce travail difficile pendant trois ans; il lui a fallu souvent de passer des nuits entières pour soigner les animaux soumis aux essais, et beaucoup de courage pour surmonter le dégoût qui accompagne un aussi triste métier; enfin il a dépensé des sommes considérables pour acheter les animaux et préparer les poisons dont il a fait connaître les effets," quoted on III, xvi.
24. Michel Foucault, *La naissance de la clinique: Une archéologie du regard médical* (Paris: Preses universitaires de France, 1963). Quoted from the 5th edition (Paris: Presses universitaires de France, 1983), pp. xiv–xv and pp. 170–172. English translation by A. M. Sheridan, *The Birth of the Clinic* (London: Tavistock Publications, 1973), pp. 168–169.
25. Erwin H. Ackerknecht, *Medicine at the Paris Hospital, 1794–1848* (Baltimore: The Johns Hopkins Press, 1967), p. 123.
26. Erwin H. Ackerknecht, *op. cit.* (25), pp. 41–42 and 180. See also Erwin H. Ackerknecht, "Early history of legal medicine," in Chester R. Burns (ed.), *Legacies in Law and Medicine* (New York: Science History Publications, 1977), 249–271. In the latter paper, Ackerknecht considered Orfila as a very influential author in "the development of scientific legal medicine" for his contribution to the introduction of "the new experimental methods and the new chemistry into one of the most important branches of legal medicine" (quoted on p. 261).
27. Caroline Hannaway and Ann La Berge (eds.), *Constructing Paris Medicine* (Amsterdam: Ed. Rodopi, 1988), 1–71.
28. Toby Gelfand, *Professionalizing Modern Medicine. Paris Surgeons and Medical Science and Institutions in the 18th Century* (Westport, CT: Greenwood Press, 1980); Othmar Keel, *L'avènement de la médecine clinique moderne en Europe, 1750–1815. Politiques, institutions et savoirs* (Montréal: Presses de l'Université de Montréal, 2001).
29. Ann La Berge, "Medical Microscopy in Paris, 1830–1855," in Ann La Berge and Mordechei Feingold (eds.), *French medical culture in the nineteenth century* (Amsterdam-Atlanta, G.A: Rodopi B., 1994), 296–327; Ann La Berge, "Dichotomy or Integration? Medical Microscopy and the Paris Clinical Tradition," in Caroline Hannaway and Ann La Berge (eds.), op. cit. (27), 275–313.
30. John E. Lesch, *Science and Medicine in France: The Emergence of Experimental Physiology, 1790–1855* (Cambridge, Ma: Harvard University Press, 1984); John E. Lesch, "Conceptual Change in an Empirical Science: The Discovery of the first Alkaloids,"

Historical Studies in the Physical Sciences, 11(2) (1981): 305–328. For the eighteenth-century roots of animal experimentation see Andreas Holger Maehle, *Drugs on Trial: Experimental Pharmacology and Therapeutic Innovation in the Eighteenth-Century* (Amsterdam: Rodopi, 1999). On Magendie and Bichat, see William R. Albury, "Experiment and Explanation in the Physiology of Bichat and Magendie," *Studies in History of Biology*, 1 (1977): 47–131.

31. John E. Lesch, "The Paris Academy of Medicine and Experimental Science, 1820–1848," in William Coleman and Frederic L. Holmes (eds.), *The Investigative Enterprise. Experimental Physiology in Nineteenth-Century Medicine* (Berkeley and Los Angeles: University of California Press, 1988), 100–139, p. 101.
32. There are just a few lines on Orfila in Lesch (1984), *op. cit.* (30), p. 160.
33. The finest study on experimental toxicology in nineteenth-century France is still the book by Mirko Grmek on Claude Bernard. See Mirko D. Grmek, *Raisonnement expérimental et recherches toxicologiques chez Claude Bernard* (Genève: Droz, 1973). See also Feliciano Gutiérrez, *Magendie, fundador de la toxicología experimental* (Barcelona: Richard Grandio, 1976).
34. See Katherine Watson, *Poisoned Lives: English Poisoners and their Victims* (London: Hambledon, 2004).
35. For additional information on this point, see Ian A. Burney's recent publications on British legal medicine and toxicology: Ian A. Burney, *Bodies of Evidence: Medicine and the Politics of the English Inquest, 1830–1926* (Baltimore: Johns Hopkins University Press, 2000); Ian A. Burney, "Languages of the Lab: Toxicological Testing and Medico-legal Proof," *Studies in History and Philosophy of Science*, 33(2) (2002): 289–314; Ian A. Burney, *The Crime of Civilization: Poison, Detection, and the Victorian Imagination* (Manchester: Manchester University Press/Rutgers) (to appear in 2006).
36. We are grateful to Brigitte van Tiggelen for the paper she delivered in Mahon during the meeting "Chemistry, Medicine and Crime" (March, 2004). See Brigitte van Tiggelen, "Les chimistes à la barre: le verdict de l'expertise dans les affaires d'empoisonnements," *Scientiarum Historia*, 31 (to appear in 2006).
37. For more information, Frederic L. Holmes, "Analysis by Fire and Solvent Extractions: the Metamorphosis of a Tradition," *Isis*, 62 (1971): 129–148. John E. Lesch, (1981), *op. cit.* (30); Jonathan Simon, "Naming and Toxicity: A History of Strychnine," *Studies in the History and Philosophy of Biology*, 30(4), (1999): 505–525; Ursula Klein (2005), *op. cit.* (17). Sacha Tomic, "L'Analyse chimique des végétaux: le cas du quinquina," *Annals of Science*, 58 (2001): 287–309. Sacha Tomic, *Les pratiques de l'analyse et les débuts de la chimie organique* (Rennes: Presses Universitaires de Rennes) (to appear in 2006).
38. See, for instance, Christopher Hamlin, "Scientific Method and Expert Witnessing: Victorian Perspectives on a Modern Problem," *Social Studies of Science*, 16, (1986): 485–513; Jonathan Simon, *op. cit.* (37); Ian A. Burney, "A Poisoning of No Substance: The Trials of Medico-Legal Proof in Mid-Victorian England," *Journal of British Studies*, 38(1) (1999): 59–92.
39. See, for instance, Jan Golinski, *Making Natural Knowledge. Constructivism and the History of Science* (Cambridge: University Press, 1998), 113–118; Peter Machamer, Marcello Pera and Aristides Baltas, *Scientific Controversies. Philosophical and Historical Perspectives* (Oxford: Oxford University Press, 2000); Dominique Raynaud, *Sociologie*

des controverses scientifiques (Paris: Presses universitaires de France, 2003). On scientific instruments see: Albert van Helden and Thomas L. Hankins (eds.), "Instruments," *Osiris, 2nd series*, 9 (1994); Frederic L. Holmes and Trevor H. Levere (eds.), *Instruments and Experimentation in the History of Chemistry* (Cambridge, Mass: MIT Press, 2000). See also: David Gooding, Trevor Pinch and Simon Schaffer, *The Uses of Experiment. Studies in the Natural Sciences* (Cambridge: Cambridge University Press, 1989).

40. See Frédéric Chauvaud, *Les experts du crime. La médecine légale en France au XIXè siècle* (Paris: Aubier, 2000); Frédéric Chauvaud and Laurence Dumoulin (eds.), *Experts et expertise judiciaire: France, XIXè et XXè siècles* (Rennes: Presses Universitaires de Rennes, 2003). See also the special issue on expert witnesses of *Studies in the History and Philosophy of Science*, 33(2) (2002). On the development of expert knowledge in other countries, see Michael Clark and Catherine Crawford (eds.), *Legal medicine in history* (Cambridge: Cambridge University Press, 1994); Thomas R. Forbes, *Surgeons at the Bailey: English Forensic Medicine to 1878* (New Haven: Yale University Press, 1995); Ian A. Burney, *The Crime of Civilization, op. cit.* (35); James C. Mohr, *Doctors and the Law. Medical Jurisprudence in Nineteenth-Century America* (Oxford: Oxford University Press, 1993); Marc R. Essig, *Science and sensation: poison murder and forensic medicine in nineteenth-century America* (Ann Arbor, Mich.: University Microfilms International, 2002). Most of the studies have focused on the analysis of forensic psychiatry. See, for example, Joel P. Eigen, *Witnessing Insanity. Madness and Mad-Doctors in the English Court* (New Haven: Yale University Press, 1995); Marc Renneville, *Crime et folie. Deux siècles d'enquêtes médicales et judiciaires* (Paris: Fayard, 2003). Some of these publications on expert knowledge have been inspired by the works of Michel Foucault. Apart from his famous books *Histoire de la folie à l'âge classique* (Paris: Gallimard, 1972) and *Surveiller et Punir: Naissance de la prison* (Paris: Gallimard, 1975), Foucault published a detailed study on a particular case in which Orfila was one of the experts: *Pierre Rivière, ayant égorgé ma mère, ma soeur et mon frère . . . : un cas de parricide au XIXè siècle* (Paris: Gallimard, 1977).