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Arsenic and Old Chemistry: Images of Mad Alchemists, Experts Attacking Experts, and the Crisis in Forensic Science

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ARTICLE

ARSENIC AND OLD CHEMISTRY: IMAGES OF MAD ALCHEMISTS, EXPERTS ATTACKING EXPERTS, AND THE CRISIS IN FORENSIC SCIENCE

DAVID S. CAUDILL*

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At this point it is hard to make a mistake: filter the solution, acidify it, take the Kipp, let hydrogen sulfide bubble through. And here is the yellow precipitate of sulfide, it is arsenious anhydride—in short, arsenic . . . the arsenic of Mithridates and Madame Bovary.¹

In the late winter of 1828, in Northumberland, Pennsylvania, Mrs. William Logan was accused of poisoning her late husband with arsenic. In the “public mouth; [her] virtue began to be suspected, and it was reported that she had been intimate with a neighbouring gentleman.”² She was arrested and sent to prison on the basis of a report by four physicians who conducted a “variety of chemical examinations” of the deceased’s stomach and its contents that “clearly indicat[ed] the presence” of arsenic.³ Thanks to the efforts of Dr.

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¹ PRIMO LEVI, *THE PERIODIC TABLE 171* (Raymond Rosenthal trans., Schocken Books 1984) (1975).

² Samuel Jackson, *Case of Supposed Poisoning with Arsenic*, 5 AM. J. MED. SCI. 237, 238 (1829). See also JAMES C. MOHR, *DOCTORS AND THE LAW: MEDICAL JURISPRUDENCE IN NINETEENTH-CENTURY AMERICA* 67-68 (1993) (discussing *id.*). Northumberland is a small town approximately 160 miles northwest of Philadelphia.

³ Jackson, *supra* note 2, at 239.

Samuel Jackson, William Logan's own physician, who later catalogued the numerous errors and weaknesses in the board of physicians' "ominous" report, "this woman was acquitted . . . by the *grand jury*, twenty-three to one."⁴

Science had triumphed over gossip; an innocent life had been saved. Lest the lesson be lost, [Jackson] published the story in the *American Journal of the Medical Sciences*, being careful to list by name the four practitioners whose lack of medical jurisprudence skills might in an earlier era or in a less sophisticated region have sent the wife to the gallows.⁵

The lesson, alas, *was* lost. In January of 2007, a jury in San Diego convicted Cynthia Sommer of murdering her husband with arsenic.⁶ The Associated Press reported that she began using an internet dating service before her husband's death. Soon she "hosted boisterous parties," used life insurance proceeds for breast augmentation surgery, and took "up with another man."⁷ Based on "laboratory testing and expert opinion evidence that [Marine Sergeant] Todd Sommer died of arsenic poisoning," Sommer spent over two years in the Las Colinas jail.⁸ Thanks to "the fresh insight of neutral experts" ("who had no connection with the previous litigation") from the Quebec Toxicology Center ("considered the 'gold standard' for metal testing worldwide"), the murder charge was dropped. The experts tested previously untested tissue samples from the deceased. They not only failed to find arsenic,

⁴ *Id.* at 248.

⁵ MOHR, *supra* note 2, at 68. In his account of the Logan case, Mohr mistakenly, I believe, identifies Dr. Samuel Jackson as a "former president of the Philadelphia Board of Health and a leading medical educator." *Id.* Mohr is referring to Dr. Samuel Jackson (1787-1872), Professor of the Institutes of Medicine at the University of Pennsylvania. The Dr. Samuel Jackson (1788-1869) involved in the Logan case graduated from the University of Pennsylvania medical department in 1812, and one year later moved to Northumberland to practice there; indeed, he is often referred to as "Dr. Samuel Jackson of Northumberland" to distinguish him from Professor Jackson. Dr. Jackson of Northumberland, nevertheless, was prolific and well-known as a skilled practitioner; he returned to Philadelphia in 1837, became a member of the College of Physicians and Surgeons, and was president (1852-53) of the Philadelphia County Medical Society. See 2 J. THOMAS SCHARF & THOMPSON WESTCOTT, HISTORY OF PHILADELPHIA 1616 (1884); 4 THE AMERICAN CYCLOPAEDIA: A POPULAR DICTIONARY OF CURRENT KNOWLEDGE 495 (George Ripley & Charles A. Dana eds., 1873); UNIVERSITY OF PENNSYLVANIA, *William Henry Salvador*, 5 ALUMNI REG. 116, 116-17 (1900).

⁶ See *People v. Sommer*, Cal. Super. Ct., Case No. SCD195202 (Cal. Super. Ct. Apr. 17, 2008).

⁷ *Marine Wife Accused of Poisoning Husband: Woman charged with first-degree murder for financial gain*, ASSOCIATED PRESS, Dec. 15, 2005, available at <http://www.msnbc.com/id/10479896/print/1/displaymode/1098>.

⁸ *People's Motion To Dismiss at 1, People v. Sommer*, No. SCD195202 (Cal. Super. Ct. Apr. 17, 2008).

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but declared that the earlier reported tissue distributions of arsenic were “physiologically improbable.”⁹ Again, “[s]cience had triumphed over gossip; an innocent life had been saved.”¹⁰

In contemporary accounts of the images of science and scientists (often negative) in popular culture, discussed in Part I below, the portrayal of a “mad scientist” in science fiction film and literature figures heavily as reflecting or causing the persistent, though hardly universal, fear and distrust of science in our culture.¹¹ More specifically, the identifiable fear of chemicals and distrust of chemistry likely is rooted in older fictional images of the “mad *alchemist*,” whose greed, secrecy, fraud, and arrogance together provide an exemplar for the dangerous, amoral, godless image of the “mad scientist” generally.¹² Concerns about scientific hubris and amorality are, however, not limited to the untrained public, but are evident in numerous episodes in the history of scientific expertise in the courtroom. The advancements in toxicology during the first half of the nineteenth-century, particularly with respect to detection of arsenic, left in their wake (in the “arsenic wars”) numerous accusations of arrogant over-confidence, not merely understandable analytic errors, within the scientific community.¹³ Because of the seriousness of a criminal investigation, some viewed scientific hubris as particularly dangerous and morally reprehensible.¹⁴ The link between hubris and amorality, grounded in fictional images, was thereby established in scientific discourse.

Drawing upon the substantial literature concerning the history of scientific experts in British and American trials in the nineteenth-century, this article focuses on several scientific controversies outside of, but related to, the early nineteenth-century courtroom. Much has been written about the origins of scientific expertise in trials, the difficulties faced by nineteenth-century judges and juries due to disagreements among scientific experts, and the corresponding loss of public confidence in science’s interactions with the legal system.¹⁵ My own analysis is centered on several debates, before, during, and

⁹ See *id.* at 2-3.

¹⁰ MOHR, *supra* note 2, at 68 (referring to Jackson, *supra* note 2).

¹¹ See generally ROSLYNN D. HAYNES, FROM FAUST TO STRANGELOVE: REPRESENTATIONS OF SCIENTISTS IN WESTERN LITERATURE (1999) (surveying literary representations of science and scientists as mad, godless, dangerous, and amoral); ANDREW TUDOR, MONSTERS AND MAD SCIENTISTS: A CULTURAL HISTORY OF THE HORROR MOVIE 133-57 (1989) (regarding the image of the mad scientist in film).

¹² See generally Roslynn Haynes, *The Alchemist in Fiction: The Master Narrative*, 12 HYLE—INT’L J. PHIL. CHEM. 5 (2006) (“Western culture relies on and reveres science. . .; yet, paradoxically, the master narrative of scientific knowledge in both literature and film focuses on an evil and dangerous maniac, obsessive, secretive, ruthless, and arrogant, drawing on many of the qualities popularly associated with medieval alchemy.”).

¹³ See *infra* Part IV.

¹⁴ See, e.g., Jackson, *supra* note 2, at 248 (“The identifying of arsenical colours [when testing for arsenic] . . . has deceived some experienced chemists, and it is not to be expected that the laborious village practitioner can have such knowledge of chemistry as may enable him to pronounce on this tremendous business of life and death—a business which the most experienced ought to approach with fear and trembling, with terror and dismay.”).

¹⁵ See, e.g., TAL GOLAN, LAWS OF MEN AND LAWS OF NATURE: THE HISTORY OF

long after the “arsenic wars” that began in late 1830s Paris, that illustrate the manner in which scientists reflected upon and responded to the relation between legal proceedings and advancements in science. That law often needs scientific knowledge is obvious, as is the fact that science gains a greater capacity to provide accurate information as time goes by. One would expect, therefore, to find scientists criticizing their forbears and revising their views on empirical grounds. More surprising, however, is to find scientists employing the terminology of popular discourse concerning dangerous, arrogant, and amoral “mad” scientists when discussing the advancement of “medical jurisprudence” in arsenic poisoning cases.

To explore such discursive contours, this article, in Part II, draws upon the distinction, influential in science studies (including science and technology studies, or the sociology of scientific knowledge) between empirical and contingent “interpretive repertoires” in the discourse of scientific controversies.¹⁶ Briefly, the distinction implies that scientists typically employ two different narrative styles, rhetorics, and/or vocabularies when communicating amongst themselves: (i) a formal, empirical repertoire to describe their own work, and (ii) an informal, contingent repertoire to describe critically the work of those scientists with whom they disagree. The former is exemplified in scientific papers, explaining in agentless prose the results of rigorous research. The latter is exemplified in accusations that a rival was less than rigorous, perhaps influenced by funding, or that a rival’s work reflects insufficient training, arrogant over-confidence, or lack of integrity. Examples of these repertoires are evident in Dr. Jackson’s article on the Logan case (discussed in Part III), the “arsenic wars” in mid-nineteenth century France and England (discussed in Part IV), and the recent Cynthia Sommer trial in San Diego (discussed in Part V).

Part VI then highlights the parallels between (i) scientific discourse just before and during the arsenic wars and (ii) contemporary debates over expertise in the courtroom. Specifically, I note that claims of over-confidence and ethical failures play a role in the current criticism of forensic identification

SCIENTIFIC EXPERT TESTIMONY IN ENGLAND AND AMERICA (2004); Christopher Hamlin, *Scientific Method and Expert Witnessing: Victorian Perspectives on a Modern Problem*, 16 SOC. STUD. SCI. 485 (1986); Stephan Landsman, *Of Witches, Madmen, and Products Liability: An Historical Survey of the Use of Expert Testimony*, 13 BEHAV. SCI. & L. 131 (1995); Stephan Landsman, *One Hundred Years of Rectitude: Medical Witnesses at the Old Bailey, 1717-1817*, 16 LAW & HIST. REV. 445 (1998); Jennifer L. Mnookin, *Idealizing Science and Demonizing Experts: An Intellectual History of Expert Evidence*, 52 VILL. L. REV. 763 (2007).

¹⁶ See *infra* Part II (Scientists during controversies employ an empiricist repertoire to describe their own work – impersonal, agent-absent, universal – while employing a contingent repertoire to criticize the work of others – personalized, agent-centered, particular.).

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experts – the so-called crisis in forensic science.¹⁷ This criticism reflects the same contingent discourse that earlier scientists employed in condemning the work of some chemical experts in criminal trials featuring accusations of arsenic poisoning. Beyond the manifest historical lesson that the crisis in forensic science is not new, I argue that the crisis is not limited to forensic identification techniques. Sometimes it extends even to those techniques, such as forensic toxicology, that are grounded in basic science. Other experts' post-trial criticism of the scientists who confirmed the presence of arsenic in the Sommer case not only involved a contingent discourse implying hubris and ethical failure, but also served to break down any strong distinction between discredited "police science" and credible forensic techniques grounded in "basic science."

I conclude, in Part VII, that the ever-present "contingent" aspects of science, including ambition, advocacy, and confidence, are not always flaws to be corrected. Uncertainty is also part of the scientific enterprise, and not always a correctible flaw. Most importantly, the dynamic advances in arsenic detection techniques in the first half of the nineteenth-century are not unlike the rapid changes in forensic science in the last several decades. The modesty and moral circumspection of some chemists just before and during the arsenic wars provide a model for the appropriate attitude toward forensic science in contemporary courts.

I. MAD ALCHEMISTS: HUBRIS AND AMORALITY

The belief that science is dangerous is . . . central to the horror movie In just over [250] films . . . , science is posited as a primary source of disorder, and in 169 of them that impulse is given flesh in the person of a 'mad scientist.'¹⁸

In his cultural history of the horror movie, Andrew Tudor identifies the prominence of mad-scientist movies in the "classic period" (1931-1936), many "rooted in the Frankenstein story," which pattern continues in the "war years" (1941-1946) and in the late 1950's.¹⁹ In the *Frankenstein* tradition of mad-scientists' movies, the "key protagonists are directed to the pursuit of knowledge at the expense of humane values. . . . These men (they all are men) are not simply mad, bad and dangerous. . . . Dazzled and corrupted by the prospect of progress, scientists ignore the proper limitations, the everyday values."²⁰ While numerous other themes and perceived threats are identified within the horror movie genre, it is the image of the hubristic and amoral "mad scientist" that re-appears in the debates between chemists leading up to and in the "arsenic wars."

As Peter Weingart explains at the outset of his study of chemists in fiction

¹⁷ See generally JIM FISHER, FORENSICS UNDER FIRE: ARE BAD SCIENCE AND DUELING EXPERTS CORRUPTING CRIMINAL JUSTICE? (2008); KELLY M. PYREK, FORENSIC SCIENCE UNDER SIEGE: THE CHALLENGES OF FORENSIC LABORATORIES AND THE MEDICO-LEGAL DEATH INVESTIGATION SYSTEM (2007).

¹⁸ TUDOR, *supra* note 11, at 133.

¹⁹ See *id.* at 29, 34, 40-42.

²⁰ *Id.* at 137, 141.

films, chemistry “is the iconic discipline of the ‘mad scientist,’ reflecting the alchemical imagery that was prevalent until recently . . . in the depiction of science in films.”²¹ “One of the most common stereotypes about science is that scientists generate dangerous knowledge, . . . which is associated with hubris. . . . The ambivalence and potentially threatening nature of scientific knowledge and the technical inventions that accrue from it is expressed in a conflict between scientific knowledge and ethical values.”²²

The link between chemistry and the twin dangers of hubris and amorality is highlighted in Joachim Schummer’s study of “mad” chemists in nineteenth-century literature.²³ “Taking chemistry as the embodiment of the enlightenment ideas of science, writers related chemistry to atheism, materialism, nihilism, and hubris, and eventually reinforced the negative view by transforming the “mad alchemist” into the mad scientist.”²⁴ Indeed, Mary Shelley’s Dr. Frankenstein — “of course, a chemist of the late eighteenth-century” — through his ambitious involvement “in the chemical investigation of nature, i.e., the secrets of divine creation,” was necessarily “driven to commit the sin of hubris with disastrous effects.”²⁵ And while moral perversion is implied in Frankenstein’s hubris, Nathaniel Hawthorne’s *Rappaccini’s Daughter* (1844) combines “the hubris theme . . . with moral criticism of the obsessed and unscrupulous scientist who knowingly runs the risk of doing harm to other people.”²⁶

Finally, Roslynn Haynes, an English literature scholar with a background in chemistry, explains the endurance of the alchemist stereotype as due in part to the parallels between early science and alchemy in terms of their associations with arrogance, power, ambition, maintenance of secret knowledge, and desire to overcome or transcend conventional human limitations.²⁷ However, modern science is also subject to the same ethical suspicions and negative literary representations that confronted early scientists: Dickens’s depiction of the

²¹ Peter Weingart, *Chemists and their Craft in Fiction Film*, 12 HYLE—INT’L J. PHIL. CHEM. 31, 31 (2006). Alchemy, “a metaphor for the pursuit of material goods and immortality,” was criticized in eighteenth-century romantic literature as “the amoral pursuit of mere knowledge about nature.” *Id.* at 34.

²² *Id.* at 38. Weingart notes that in film, “the character of the *mad scientist* grows increasingly amoral as time passes.” *Id.* at 34-35 (citing C.P. Toumey, *The Moral Character of Mad Scientists: A Cultural Critique of Science*, 17 SCI., TECH. & HUM. VALUES 411, 423 (1992)).

²³ Joachim Schummer, *Historical Roots of the “Mad Scientist”: Chemists in Nineteenth-century Literature*, 53 AMBIX 99 (2006).

²⁴ *Id.* at 101.

²⁵ *Id.* at 119, 121 (discussing MARY SHELLEY, *FRANKENSTEIN, OR THE MODERN PROMETHEUS* (1818)).

²⁶ Schummer, *supra* note 23, at 123 (Dr. Rappaccini experimented on his daughter and accidentally killed her.).

²⁷ See Haynes, *supra* note 12, at 14-24.

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members of the British Association for the Advancement of Science “as having lost all humanitarian sympathies and values, as socially irresponsible and emotionally and morally deficient”;²⁸ Balzac’s “romantic belief that preoccupation with science atrophies the normal emotions that sustain . . . social responsibilities,”²⁹ and Wells’s view of scientists as “ruthless in their idealism, prepared to sacrifice people or animals in the cause of their experiments.”³⁰ Modern scientists, Haynes concludes, “have continued to provide writers and film-makers with ongoing instances of the alchemist stereotype” with their mystery and obfuscation, ruthless determination, and failure “to show concern about the social and moral impact of their research.”³¹

The foregoing observations are all intended to provide insight into the popular or public understanding of science as a potentially dangerous enterprise. Chemists, who “see themselves as . . . benefactors of humankind,” would find their “stereotypical public image as the sorcerer’s apprentices who befoul the environment” as “way off target . . . a caricature.”³² One would not expect, therefore, to find chemists discussing their colleagues’ work in terms of hubris or amorality. However, the notion persists that scientists employ two different repertoires in their discourse, one of which preserves the terminology of the public’s fear of science and scientists.

II. CONTINGENT REPERTOIRES

She worked listlessly in the lab . . . , negligently washing the precipitates, weighing the nickel dimethylglyoxime, and I had hard work convincing her that it was not quite the thing to pad the results of the analysis: something she tended to do, in fact she confessed to having done often, since, she said, it didn’t cost anybody anything and pleased the director³³

In their influential study of scientists’ discourse, Gilbert and Mulkey contrasted the “empiricist repertoire” by which scientists frequently present their own work, with the “contingent repertoire” often used in discussing the work of other scientists:³⁴

²⁸ *Id.* at 17 (citing Charles Dickens, “Boz,” *Full Report of the Mudfog Association for the Advancement of Everything*, 2 BENTLEY’S MISCELLANY 397 (1837) (satire of British Association for the Advancement of Science, founded in 1831)).

²⁹ *Id.* at 18 (discussing H. DE BALZAC, *THE QUEST OF THE ABSOLUTE* 84 (E. Marriage trans., n.d.) (protagonist’s wife pleads, “science has eaten away at your heart.”)).

³⁰ *Id.* at 19 (discussing H.G. WELLS, *THE ISLAND OF DOCTOR MOREAU* (1967) (“Dr. Moreau is deaf to the screams of pain of his experimental animals.”)).

³¹ *Id.* at 22-23.

³² Pierre Laszlo, *On the Self-Image of Chemists, 1950-2002*, 12 HYLE—INT’L J. PHL. CHEM. 99, 99 (2006).

³³ LEVI, *supra* note 1, at 72.

³⁴ See G. NIGEL GILBERT & MICHAEL MULKEY, *OPENING PANDORA’S BOX: A SOCIOLOGICAL ANALYSIS OF SCIENTISTS’ DISCOURSE* 56-57 (1984) (describing a controversy among biochemists). The empirical repertoire “portrays scientists’ actions and beliefs as following unproblematically and inescapably from the empirical characteristics of an impersonal natural world,” while the contingent repertoire depicts the “activities and

This suggests that scientists have available and make recurring usage of two contrasting formulas to represent science: one employs an impersonal, abstracted, agent-absent discourse, which makes claim of *universal* applicability, regardless of human action or belief; a second employs a personalized, localized, agent-centered discourse, which makes claims *artefactual*, *particular* to specific human actions and beliefs.³⁵

When one scientist makes a “universally formulated” knowledge claim, for example, “this person died from arsenic poisoning,” another scientist can create a controversy with a counter-claim of “particularity”—i.e., that the first claim was the “outcome of experimental error, personal bias, or ideological interest.”³⁶

In a recent study of crop geneticists working in conditions of controversy, Kevin Burchell confirmed the alternative use of empirical and contingent repertoires—the former when describing themselves, the latter when describing others with whom they disagreed—among the scientists interviewed.³⁷ Burchell also enhances Gilbert and Mulkey’s notion of empirical and contingent repertoires by extending it “to include methodological and ethical considerations.”³⁸ Thus,

the empiricist repertoire describes the view that beliefs and actions flow unproblematically from . . . a method that is distinctive for its objectivity and rigor, and from an ethical framework. By contrast, the contingent repertoire describes the view that beliefs and actions flow from . . . prejudices and interests, from methodological shortcomings, and are perhaps unethical.³⁹

Among the criticisms made by the scientists in Burchell’s study against other scientists, is the claim that some “others” do not take the time to replicate experiments due to the pressure to publish (rigorous checks and balances rely “upon the integrity of the individual”) in particular journals (which are a

judgments of specific individuals acting on the basis of their personal inclinations and particular social positions.” *Id.*

³⁵ Simon Locke, *Sociology and the Public Understanding of Science: From Rationalization to Rhetoric*, 52 BRIT. J. SOC. 1, 13 (2001) (citing J. POTTER, REPRESENTING REALITY: DISCOURSE, RHETORIC AND SOCIAL CONSTRUCTION (1996)).

³⁶ *Id.* at 13. This is not to say that technical discourse among scientists is “mere rhetoric, but [it functions] as a rhetoric, as part of the resources that scientists have available to construct accounts of their work.” *Id.* at 12.

³⁷ See Kevin Burchell, *Empiricist Selves and Contingent “Others”: The Performative Function of the Discourse of Scientists Working in Conditions of Controversy*, 16 PUB. UNDERSTANDING SCI. 145 (2007). “Overwhelmingly, the discourse of this small group of geneticists conformed to the prediction of Gilbert and Mulkey . . . [concerning] the construction of both empiricist selves and contingent ‘others’.” *Id.* at 148.

³⁸ *Id.* at 146.

³⁹ *Id.* at 147.

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“badge” and potentially “not even about the science”) and where peer review breaks down (“There isn’t enough time to do it properly or there are personal things overriding a fair assessment”). This raises the possibility of fraud “where there are large amounts of stress to publish, and you’re in a highly competitive field.”⁴⁰ Such claims, referring not to impersonal “natural” phenomena, but to the “personal inclinations and particular social positions” of individuals,⁴¹ exemplify the contingent repertoire of scientists.

In another recent study of an anonymous, internationally renowned environmental scientist, the authors focused on how the Canadian scientist constructed his identity during his interview with the authors.⁴² Referring to the distinction between empirical and contingent repertoires as “useful in showing how scientists manage their identities through talk,”⁴³ the authors noted that the “participant came out of the interview as a full-fledged member of the scientific community with traits typically ascribed to scientists such as expertise, objectivity, passion, and disinterestedness.”⁴⁴ In his self-presentation, the scientist claimed that he “saw what even scientifically competent people were unable to see” – namely that,

most of the processes drinking water utilities use [are] . . . treatment and disinfection while quality of water is actually a function of the source water you start with. And . . . I started thinking . . . , “If we could actually develop some models and understanding of how ecosystems function at the source water, [we] would be able to help the water utilities better manage the quality of water at the tap and improve human health.”⁴⁵

While others were mired in a ‘mindset’ focused on treatment and disinfection, he “was the prime mover in the eventual change of mindsets.” The new one still a ‘mindset,’ but now one firmly grounded in basic science, “unbiased, disinterested and objective from [his] point of view.”⁴⁶ “He came, he saw (with his trained eye), and he converted. With similarity to the empiricist repertoire of scientists, [he] presented a view that science ultimately triumphs, that the truth would prevail no matter what.”⁴⁷ Although the field of drinking water quality is “closely tied with provincial and federal politics”, his ethical integrity required that he ignore outside pressures and offer his “views

⁴⁰ *Id.* at 150, 154-55.

⁴¹ See GILBERT, *supra* note 34, at 56-57.

⁴² See Yew-Jin Lee & Wolff-Michael Roth, *Making a Scientist: Discursive “Doing” of Identity and Self-Presentation During Research Interviews*, 5 FORUM: QUALITATIVE SOC. RES., Art. 12, (Jan. 2004), available at <http://www.qualitative-research.net/fqs-texte/1-04/1-04leeroth-e.htm>.

⁴³ *Id.* at *7 (citing DAVID SILVERMAN, *INTERPRETING QUALITATIVE DATA: METHODS FOR ANALYZING TALK, TEXT AND INTERACTION* (2001)).

⁴⁴ *Id.* at *10 (The interviewee “was not just telling a story about his life . . . he was making himself . . . [He] came out to be a scientist with a particular identity.”).

⁴⁵ *Id.* at *11 (quoting interviewee).

⁴⁶ See *id.* at *13 (The scientist explained that he “started talking to utilities, . . . and the first response . . . was, ‘why do we care about source water?’ . . . It took me about a year and a half . . . to convince the government and industries that this is something worthwhile . . . [N]ow it is a very very well recognized, well respected program. . .”).

⁴⁷ *Id.* at *13.

regardless of whether [his] funding depends on government, . . . on industries or not.”⁴⁸ The self-described independent scientist, impliedly unlike some other scientists, “spoke for objectivity and truth which all (rational) others had to listen to.”⁴⁹ Framing one’s identity as a scientist in terms of ethical independence and fidelity to rigorous methodology exemplifies the empiricist discourse.⁵⁰

Notwithstanding the seeming arrogance of the renowned scientist discussed above, the empiricist repertoire is not hubristic. Accusations of hubris, like accusations of amorality (including ethical failures or lack of integrity, which suggest recklessness or carelessness), are part of the contingent repertoire of scientists. Indeed, the water quality scientist was quite modest with respect to his discovery of the importance of source water – he was surprised that there were “places [in Canada, the “pristine North”] where water quality is so poor, it’s amazing that it is still allowed to be used as a source water.”⁵¹ Although he “did not remain in the dark for long,” he was “astonished initially about the extent of environmental problems” (“[e]ven a scientist can be fooled . . .”).⁵² But he was an “unassuming servant of science”, committed to “doing and applying basic science” without regard to job security or an attractive salary.⁵³ Moreover, his unique success with source water programs was due to his “team,” including economists, environmental psychologists, public health officials, and “terrestrial people who do . . . remote sensing type of modeling so that we can quantify land use on a watershed from an image and then link it to the water quality at the source.”⁵⁴ Although at times he seems to “blow his own horn,” he moderates his claims to acknowledge the support of “an interdisciplinary team of professionals,” thereby walking a fine line between hubris and belittling his own accomplishments in the service of science.⁵⁵

With that framework in mind, I re-visit (in the next section) the medical article, regarding the death of William Logan, published in 1829 by Dr. Samuel Jackson of Northumberland, Pennsylvania.

III. DR. JACKSON’S “HUMBLE” DIATRIBE

This publication, it is hoped, will have its use by exciting the reflections

⁴⁸ *Id.* at *18 (quoting interviewee). “To use the metaphor of a maverick scientist or lone prophet to describe him [from this excerpt] would not be out of place here.” *Id.* at *17.

⁴⁹ *Id.* at *18.

⁵⁰ *See id.* at *6 (“As described by Silverman [*supra* note 43], it was found that scientists engaged in empiricist discourse when they described matters regarding science as truth, which gives the impression that there is a reality ‘out there’ in ‘nature’”).

⁵¹ *Id.* at *11 (quoting interviewee).

⁵² *Id.* at *12.

⁵³ *See id.* at *12-13.

⁵⁴ *Id.* at *15 (quoting interviewee).

⁵⁵ *See id.* at *15.

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of those who are better qualified than the author; with these humble views, therefore, and no other, he offers it to the profession “with the spirit of a man that has endeavoured well”—of one whose position and feelings are fortunately such, that he has neither interest to serve nor malice to gratify.⁵⁶

So ends Dr. Jackson’s article on the case of the supposed poisoning of William Logan with arsenic. No hubris, no interest or malice—simply the self-described “position and feelings” of an alert observer of nature. Indeed, the first two pages of Jackson’s report explain Logan’s death by natural causes: “[I]nflammation of his vein from bleeding.”⁵⁷ Jackson was initially called to the Logan household because William, who had gone out on a very cold day and returned home drunk, came down with a fever, was suffering pain in his head, neck, and limbs, and developed a cold and cough. Jackson treated him by bleeding, providing firewood to keep Logan’s house warmer, and administering small doses of emetic tartar (to induce vomiting); but a vein in Logan’s arm became inflamed, after which he became faint and delirious, and died ten days after his illness began.⁵⁸ Dr. Jackson joined a Dr. Rodrigue to examine the corpse, and while the former comforted the widow, the latter “dissect[ed] out the inflamed vein” to reveal “the most perfect specimen of intense inflammation we had ever seen.”⁵⁹ Dr. Jackson had seen similar cases and,

did conceive that poison could have no part in the matter, for during the whole course of his disease there was no puking, no purging which was not the effect of medicine, no pain nor sensation of heat in the stomach or bowels, no nausea which was not apparently the effect of febrifuge doses of tart. emet.[,] no spitting nor hiccough, no cold sweats, the teeth were never on edge that I heard of, no inordinate thirst, no cramps, numbness, or paralysis of the extremities, stools not unnatural, countenance not changed, the blood was not dissolved after death, the lungs were said to be sound.⁶⁰

It would be “incomprehensible and without a parallel” for the “erosion which was afterwards supposed to be seen in the stomach” to have been caused by arsenic “without exciting some corresponding symptom. . . . To reconcile the phenomena of the disease with the known effects of arsenic, we conceived to be impossible.”⁶¹

But a few days later, Jackson continues, “popular clamour” intervened. Suspensions arose because Logan’s “wife had procured arsenic from an apothecary,” seemingly to keep rats and mice from her butter. The coroner therefore “took various depositions” in the community which, in Jackson’s opinion, reflected hasty assumptions as well as “trifling or irrelevant”

⁵⁶ Jackson, *supra* note 2, at 248.

⁵⁷ *Id.* at 237.

⁵⁸ *See id.*

⁵⁹ *Id.* at 238.

⁶⁰ *Id.* (“I remarked to [Logan’s] mother at the time, the wonderful similarity between his case and that of his brother.”).

⁶¹ *Id.*

testimony that “when properly understood went rather to clear than to convict the woman.”⁶² Nevertheless, the body was disinterred and delivered to a board of four physicians for examination. After only two days, they issued an “ominous” report that Logan died of arsenic poisoning, “in consequence of which the woman was committed to prison.”⁶³

Before analyzing the shortcomings of the board’s report, Jackson surveys the “circumstances favorable to the accused,” including William Logan’s complaints about rats and desire to poison them, as well as the lack of motive “for so hideous a crime” — “there was no hope . . . of her being bettered by his death.”⁶⁴ Jackson also highlights the fact that he “was most carefully excluded” from “the whole business of the examination,” despite his age, experience and doctor-patient relationship with Logan.⁶⁵

Reviewing the minutes of the board’s proceedings, Jackson first points out the contradictions among the physicians’ respective descriptions of Logan’s stomach. “[A]s to the supposed inflammation, it appears to be a mere matter of opinion whether any existed.”⁶⁶ The “whole phenomenon” was explainable in terms of Logan’s “intemperance,” which “appears more reasonable than to suppose an acute inflammation by arsenic, without puking or any mode of distress.”⁶⁷ Moreover, Jackson warns:

Even the most expert have mistaken vascularity and congestion for inflammation, and a coagulum of blood for an ulcer in the stomach from arsenic. To our present purpose, Dr. Shaw, *Anatomy*, p. 51, [states:] “. . . I have come to the conviction that the appearance of the stomach . . . alone, in a question of poison, is not to be depended on.”⁶⁸

⁶² *Id.* at 238-39. Two shopkeepers testified that a child bought poison and “[i]t was at once determined by common consent, that the child was the same in both cases, and that it could be no other than Logan’s daughter . . .” *Id.* at 239. “[Y]et no effort was made . . . to produce her in proof or disproof. . . .” *Id.*

⁶³ *Id.* at 239.

⁶⁴ *Id.* at 239-40. Logan’s wife lived on good terms with her husband, “[a]ttended him faithfully during his sickness . . .,” and cooperated fully with the investigation. *Id.* at 240.

⁶⁵ *Id.* at 240.

⁶⁶ *Id.* at 241.

⁶⁷ *Id.* at 241-42. Logan drank “country whiskey for many years . . . which as it is here made, must often contain some verdigris [which would] . . . [e]xcite chronic inflammation of the stomach. . . .” *Id.* at 241.

⁶⁸ *Id.* at 242. John Shaw (1792-1827) was a British surgeon whose influential *MANUAL OF ANATOMY* (1822) was republished in the U.S.; it bears mention that Jackson’s article also referenced numerous other sources, including the *TRACTS ON MEDICAL JURISPRUDENCE* (1819) compiled by Dr. Thomas Cooper (1759-1839), an article in the *MEDICO-CHIRURGICAL REVIEW* by M. Louis (the author of *MEMOIRES ET RECHERCHES ANATOMICO-PATHOLOGIQUES* (1826)), and works by the Italian chemist Dr. Luigi Valentino Brugnatelli (1761-1818), the British physiologist Dr. John Bostock (1773-1846), and the Scottish anatomist Matthew Baillie (1761-1823). See Jackson, *supra* note 2, at 239, 242, 245-46.

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Adding an ethical component to his critique, Jackson quotes Shaw's hope that "this degree of uncertainty will prevent the anatomist from being called on to decide a question which may involve the life of a fellow creature."⁶⁹

Jackson "readily" forgives the board of physicians for their "hasty assumption" that arsenic was present, even "before any chemical experiment." The doctor blamed their lack of "knowledge of morbid anatomy"—they saw a black spot, which appeared "imposing . . . to the minds of the unphysiological."⁷⁰ Jackson also forgives the four physicians for their chemical experiments, which "were as fallacious as the appearance of the stomach," blaming instead the author of the pharmacological treatise, Dr. John Ayrton Paris (1785-1856), on whom they relied.⁷¹ Jackson details the ambiguous results of the various liquid tests performed by the board of physicians, noting that, comparing "colours is extremely difficult" and "even experienced eyes may be deceived;" the "sulphus cupri" test detects arsenic *but also* "other matters which are sometimes found in the stomach;" "the copper and silver tests were used in the most objectionable forms;" the sulphuretted hydrogen test allows tartar emetic to be mistaken for arsenic; and the physicians failed in their attempts "to obtain the alliaceous odor" and "to metalize the supposed arsenic."⁷² The latter:

negatives conspire with other facts to prove that none of the metal existed in the stomach. They leave us destitute of all *positive* proof, and greatly debilitate the *circumstantial*; therefore, since such strong suspicions arose in their minds, it is greatly to be regretted that they did not proceed further with the enquiry.⁷³

Moreover, "some important [and easily performed] leading tests were omitted."⁷⁴ The examiners did not use a microscope, "though a very powerful one was within their reach." Nor did they have any drawings of the (destroyed)

⁶⁹ Jackson, *supra* note 2, at 242 (quoting SHAW, MANUAL OF ANATOMY 51 (1822)).

⁷⁰ *Id.*; Burchell includes in the contingent repertoire the claim that other scientists fail "to reach the standards of practice that are demanded by the empiricist repertoire. Such failings [can be attributed to] . . . personal preferences which might be linked to poor training." Burchell, *supra* note 37, at 154.

⁷¹ Jackson, *supra* note 2, at 243-46 (discussing Dr. Paris's *Pharmacologia, article Arsenic* (1822)). Dr. Paris, a well-known Edinburgh physician, was also the subject of harsh criticism by Sir Robert Christison (1797-1882), one of the most famous of the early British toxicologists and the author of *A TREATISE ON POISONS* (1829), and by others. See Anne Crowther, *The Toxicology of Robert Christison: European Influences and British Practice in the Early Nineteenth Century*, in CHEMISTRY, MEDICINE, AND CRIME: MATEU J.B. ORFILA (1787-1853) AND HIS TIMES 125, 131-32 (José Ramón Bertomeu-Sánchez & Augustí Nieto-Galan eds., 2006).

⁷² Jackson, *supra* note 2, at 243-45; see also *infra* notes 137-47, for a discussion of the various tests.

⁷³ Jackson, *supra* note 2, at 246. See also *id.* at 243 (Failure to "metallize the supposed arsenic" was not considered disproof, since one physician "accounted for [it] by the presence of moisture, a second by their having too little heat, and a third by their using too much – all [of] which circumstances were surely within the power of the chemist to obviate").

⁷⁴ *Id.* at 246.

stomach , even “though some excellent delineators were at hand.”⁷⁵ How can all these misjudgments be explained?

The answer is in the hubris of Dr. Paris – “here then is the reason they were so easily satisfied at the presence of arsenic.”⁷⁶ In “an opinion peculiar to himself, and . . . deeply fraught with error and homicide,” Dr. Paris advises that the silver and copper tests furnish “striking and infallible indications.”⁷⁷

Dr. Paris is so delighted with making these arsenical colours, that, while writing on the subject, he has laid down his pen to “convince himself with how little trouble, and with how much pleasure and profit, such experiments may be conducted.” . . . If this be not mere childish play, it is at least the extravagance of a man transported with novelties. . . . Does not [everyone] perceive how much room there is left for the ardent imagination of a man zealous in the pursuit, to play on these colours[?]⁷⁸

For Dr. Jackson, the colors from liquid tests provide “one degree of evidence only,” following which a metal should be extracted from the precipitate (showing that a metal “struck these colours”), and then “this metal [should be proved] to be arsenic by the proper experiments.”⁷⁹ If the quantity is too small for metallization, then all you have is a presumption, and you cannot “swear the arsenic is there.”⁸⁰

Men have been justly or at least truly convicted by presumptive evidence – this is the business of law and not of medicine; we shall therefore conclude with an opinion contrary to that of Dr. Paris, . . . that the copper and silver tests do *not* afford “infallible indications,” and that it is grossly negligent if not highly criminal to trust them, when so many others may be so easily and so satisfactorily employed.⁸¹

In his hubris and ethical lassitude, Dr. Paris left the board of physicians in the Logan case “like mariners in an ocean to them unknown, the rocks and shoals of which were left unnoted in their only chart.”⁸²

In most of Jackson’s article, he reserves an empirical repertoire for himself, and a contingent repertoire for the physicians as they are misled by Dr. Paris. He carefully considers the symptoms prior to death, finds the cause of death, and is not fooled by appearances. They made hasty assumptions, lacked proper training, failed to make further inquiries when doubts arose, and shared in Dr.

⁷⁵ *Id.*

⁷⁶ *Id.*

⁷⁷ *Id.*

⁷⁸ *Id.*

⁷⁹ *Id.*

⁸⁰ *Id.* at 247 (“Hence the prudence of [the Logan] examiners cannot be too highly commended—they swear, not to the poison itself, but to the mere indications thereof.”).

⁸¹ *Id.*

⁸² *Id.* (In “Dr. Paris’ chapter on arsenic in his *Pharmacologia*, there is not one consecutive test mentioned.”).

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Paris' childish, zealous imagination. At the end, however, he equivocates by conceding that he has "merely point[ed] out those omissions which we should most probably have made ourselves."⁸³ He therefore mentions "the propriety of sending the stomach with a portion of its contents to Philadelphia," to chemists and pathologists, who would "not be expected on this side of the mountain," as this cautionary procedure "is practiced in Europe."⁸⁴ Given the importance of a criminal trial,

no pains ought to be spared to prevent the cruel catastrophe [on families and children], with the consequent endless and wide-spreading imputation of unmerited infamy. . . . [A]nd it is not to be expected that the laborious village practitioner can have such knowledge of chemistry as may enable him to pronounce on this tremendous business of life and death—a business which the most experienced ought to approach with fear and trembling, with terror and dismay.⁸⁵

Though Jackson includes himself in the group that would be misled by "books of blunders," his modesty appears as mere rhetoric, since he confirms that through his efforts Logan's wife was acquitted.⁸⁶

A similar controversy, prefiguring the Logan case in certain respects, arose in New York in 1817.⁸⁷ Abraham Kesler was suspected of poisoning his wife with arsenic. Her remains were disinterred (two months after her death) and, after performing "a superficial series of observations and chemical tests," several local physicians "testified that the woman had . . . been murdered with arsenic."⁸⁸ After Kesler was found guilty and sentenced to death, his attorneys appealed to the governor, whose experts "concluded forcefully that post-mortem observations of the woman's stomach were meaningless, given the extensive putrefaction . . . , and that the local physicians had not conducted the proper chemical tests for arsenic. The governor thereupon stayed the execution"⁸⁹ However, after "another round of medical opinions on the case," taken by the Courts of Justice committee of the state legislature, the stay was overridden and Kesler executed. The "legislature's doctors . . . decided that they had no quarrel on the whole with the original local procedures. . . ."⁹⁰

⁸³ *Id.*

⁸⁴ *Id.*

⁸⁵ *Id.* at 248.

⁸⁶ *Id.*

⁸⁷ See MOHR, *supra* note 2, at 66-67 (discussing the Kesler poisoning case "in 1817 in Montgomery County, New York, hardly a backwater area" (citing 19 MEDICAL REPOSITORY 314-19 (1818))).

⁸⁸ *Id.* at 66.

⁸⁹ *Id.* at 67.

⁹⁰ *Id.* (The governor had sent the case to the legislature to urge it to "exercise [its] constitutional power . . . to pardon Kesler."). See also THOMAS COOPER, *Kessler's Case*, in TRACTS ON MEDICAL JURISPRUDENCE 418, 418-30 (1819) (including (i) an introduction by Cooper concerning "Kessler's" case (Cooper's spelling of "Kesler" differs from Mohr's and most other, even contemporaneous, commentators on the case), which "excited much attention at the time it happened, and properly: for the man . . . was convicted and executed upon testimony that would by no means authorize the proceedings," (ii) a brief summary of the trial; (iii) the report given by Dr. Wm. James MacNeven, a professor of chemistry, to

Decades later in Bethlehem, New York, when the chemical tests for arsenic detection were much more sophisticated, a controversy concerning aconite poisoning repeated the pattern of experts attacking other experts for overconfidence and carelessness.⁹¹ In 1853, John Hendrickson was accused of murdering his wife after the coroner and two local physicians, who conducted a post-mortem and suspected poisoning, received confirmation from Dr. James H. Salisbury of Albany, to whom they had delivered most of the deceased's intestines, that "Maria Hendrickson had been poisoned and the agent of her destruction was aconite, or more precisely aconitine, the alkaloid thought to be the active ingredient of aconite."⁹² Dr. Salisbury, who was highly regarded as an expert medical chemist and who had studied aconite, became the prosecution's star witness against Hendrickson at the ensuing trial.⁹³ Although Hendrickson's defense attorneys accused Salisbury of hubris – "careerist ambitions and perverted professionalism" – as well as carelessness – Salisbury did not save the allegedly isolated aconitine (it was administered to a cat, which "did not die"!)—the jury found Hendrickson guilty and the judge, confident that "science had made another advance . . . [by] detect[ing] a previously undetectable poison," ordered him hanged.⁹⁴

Hardly had Hendrickson been convicted, however, before his remarkable case began to elicit the attention of professionals outside Albany

Governor Clinton criticizing the medical expert testimony at the trial and concluding "that the indictment for poisoning with arsenic is not substantiated by the evidence of the witnesses"; and (iv) a report of the experiments made, in the presence of a legislative committee and several physicians, criticizing MacNeven).

⁹¹ See MOHR, *supra* note 2, at 122-39 (recounting the events in the notorious Hendrickson poisoning case).

⁹² *Id.* at 125 (Maria "had taken minute amounts of aconite in pill form", and testimony suggested that John Hendrickson had purchased aconite "a week before Maria's demise." (citing various editions of the ALBANY EVENING JOURNAL from March 12-April 16, 1853)).

⁹³ See *id.* at 126-27 (Aconite was, however, "one of the most difficult poisons to detect once it entered the body," and "virtually no one else in the scientific world was prepared to defend Salisbury's chemical claims.").

⁹⁴ *Id.* at 129-31. Defense counsel Henry G. Wheaton spectacularly argued, "[j]ust look at it – the confidence of this Dr. Salisbury. He . . . says [he] discovered this aconitine . . . and yet calls no one in to see his discovery, or to confirm it. He is in too great a hurry; he . . . administers it all to a cat. He . . . had such a desire to send his name abroad; he could not stop a single moment; could not bring a particle of it into court for us to see it Ambition urges him on. If the prisoner is convicted, his name goes forth linked with this case To the cat again: The doctor . . . gave it all the substance . . . and yet, after about two hours of trifling sickness, it recovered . . . [t]he cat did not vomit, retained it all, and in three hours was well. What a cat! What a doctor! What an opinion . . . upon such facts! The cat should have died out of deference to the Dr.'s opinion" *Id.* at 129-30 (citing DAVID M. BARNES & WINFIELD S. HEVENOR, *Trial of John Hendrickson, Jr., for the Murder of his Wife Maria, by Poisoning, at Bethlehem, Albany County, N.Y., March 6th, 1853, in TRIED IN THE COURT OF OYER AND TERMINER, AT ALBANY, N.Y., IN JUNE AND JULY, 1853* 289 n. 3 (1853)).

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David A. Wells, [who was] deeply immersed in the study of chemistry[,] . . . was convinced that Salisbury had erred in his chemical testimony [and] that aconitine could not be detected in the manner Salisbury described A formal statement of protest was drafted by Wells's friend, Augustus A. Hayes, [and signed by] an impressive list of American chemists⁹⁵

Wells, like Dr. Samuel Jackson, published in a medical journal a detailed critique of Salisbury's unconventional procedures.⁹⁶ And although "Hendrickson's case had become a national *cause célèbre* among [medico-legal] professionals" by 1854, garnering criticism from numerous quarters, John Hendrickson was hanged that year.⁹⁷ Nevertheless, Salisbury's career was "crippled" by "those who pegged him from the outset as a skillful but rash young scientist willing to rush forward with grandiose claims on the basis of flimsy evidence."⁹⁸

The great American pioneer of medical jurisprudence T.R. Beck (1791-1855) warned that,

[m]edical witnesses . . . too often got carried away in the competitive atmosphere of the courtroom and overstated their findings. "Pressed by perplexing questions, and probably irritated in their feelings," a doctor "is apt to make declarations more strongly corroborative of opinions that he had formerly advanced, and as his examination advances, he may incur the charge of being *biased [sic]*, more than facts will warrant."⁹⁹

Interestingly, Beck's remarks were delivered while William Logan lay dying in Northumberland, Pennsylvania, under the care of Dr. Samuel Jackson, who was about to confront, and later rebuff, the overconfident and careless physicians who allegedly detected arsenic. Beck's warning, and Jackson's parallel concerns, mirrored a growing controversy over arsenic detection techniques in Europe.

IV. THE "ARSENIC WARS"

[The] *British and Foreign Medical Review* . . . saw the controversies raging in Paris as the result of an overwrought toxicological imagination. . . . Urging British readers of Orfila's experimental reports to "guard against being misled by the enthusiasm of the author," the *Review* devoted two lengthy articles to providing a "cool and deliberate examination" [which] concluded that Orfila . . . had placed too much reliance on his own experimental process, his results representing "the height of transcendental analysis."¹⁰⁰

⁹⁵ MOHR, *supra* note 2, at 132-33.

⁹⁶ See *id.* at 132 (citing David A. Wells, *Interesting Case of Medical Jurisprudence – Poisoning by Aconite*, 50 BOSTON MED. & SURG. J. 289, 289-304 (1854)).

⁹⁷ *Id.* at 134, 136.

⁹⁸ *Id.* at 137-38.

⁹⁹ *Id.* at 98 (quoting T.R. Beck *Annual Address Delivered before the Medical Society of the State of New-York, Feb. 6, 1828* 7 N.Y. MED. & PHYSICAL J. 9, 24 (1828)).

¹⁰⁰ Ian A. Burney, *Bones of Contention: Mateu Orfila, Normal Arsenic and British*

The term “arsenic wars” is, in the first instance, a reference to the debates between Mateu Orfila, a well-known toxicologist and courtroom expert, and his critics in Paris beginning in the late 1830s.¹⁰¹ Orfila (1787-1853), born in Minorca and educated in Valencia, Barcelona, Madrid, and Paris, was appointed professor at the Faculty of Medicine in Paris in 1819. By 1830, he was dean of the Faculty and a “medical celebrity.”¹⁰² His greatest influence was as a “founding father” of toxicology, and his *Traité des poisons* (1814-15) was popular and influential in France and abroad.¹⁰³ As a frequent forensic expert, he was actively involved in the controversial 1840 trial of Madame Lafarge, who was accused of poisoning her husband with arsenic. Orfila’s authoritative detection of arsenic and criticism of other experts who found no arsenic put Madame Lafarge in prison and ignited “a fierce debate . . . in the Paris medical community, soon spreading to other academic contexts and to society as a whole.”¹⁰⁴

The Lafarge case offers a picture of the numerous tests and practices for arsenic detection, as well as disagreements over their conclusiveness, prior to the gradual acceptance of the Marsh test.¹⁰⁵ Local physicians relied on autopsies and symptoms, while Orfila encouraged chemical analysis and was critical of “smell” tests (i.e., attributing a “garlicky” odor to arsenic).¹⁰⁶ Even the initial experts in the case who used hydrosulfuric acid to produce a yellow precipitate, a sign of the presence of arsenic, did not seem aware that their results were ambiguous, since other substances could produce similar precipitates. They also could not finish the test and obtain metallic arsenic.¹⁰⁷

Toxicology, in CHEMISTRY, MEDICINE, AND CRIME, *supra* note 71, at 252 (quoting M. Orfila on Poisoning by Arsenic, Antimony and Copper, 11 BRIT. & FOR. MED. REV. 37, 37, 50 (1849)).

¹⁰¹ See José Ramón Bertomeu-Sánchez, *Sense and Sensitivity: Mateu Orfila, the Marsh Test and the Lafarge Affair*, in CHEMISTRY, MEDICINE, AND CRIME, *supra* note 71, at 225 (discussing “arsenic wars between Parisian academies”).

¹⁰² See José Ramón Bertomeu-Sánchez & Augustí Nieto-Galan, *Introduction*, in CHEMISTRY, MEDICINE AND CRIME, *supra* note 71, at ix-xiii.

¹⁰³ See *id.* at ix, xiv, xvii; see also Mel Gorman, *Sir William Brook O’Shaughnessy, F.R.S. (1809-1889), Anglo-Indian Forensic Chemist*, 39 NOTES & REC. ROYAL SOC. LONDON 51, 52 (1984) (“His treatise on poison is regarded as the founding of toxicology.” (citing M.J.B. Orfila, *TRAITÉ DES POISONS TIRÉS DES RÈGNES, MINÉRAL, VÉGÉTAL ET ANIMAL OU TOXICOLOGIE GÉNÉRAL* (1815))).

¹⁰⁴ Ramón Bertomeu-Sánchez, *supra* note 100, at 208. For a detailed account of the Lafarge trial, see COLIN WILSON & DAMON WILSON, *WRITTEN IN BLOOD: A HISTORY OF FORENSIC DETECTION* 81-87 (2003).

¹⁰⁵ See Ramón Bertomeu-Sánchez, *supra* note 100, at 211. In 1836, James Marsh (1794-1846) constructed an apparatus to capture arsenic. See *infra* notes 147-52 and accompanying text.

¹⁰⁶ See *id.* (“Orfila warned of the dangers of smell tests in his popular textbook.”).

¹⁰⁷ See *id.* at 212-13 (“As Orfila and other experts had stated in previous similar cases, it would be wrong to affirm the presence of arsenic without [obtaining the] dark metallic

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When a second opinion was requested from three pharmacists who employed the new Marsh test, which was enthusiastically embraced by Orfila, they could not obtain any trace of arsenic.¹⁰⁸ As doubts remained, Orfila joined yet another team of experts who reapplied the Marsh test to confirm the presence of arsenic and affirm that the detected arsenic did not come from the chemicals used in their analysis, the earth from which the victim's body was exhumed, or from the "normal arsenic" in the human body.¹⁰⁹ Those latter qualifications were important because critics had pointed out that, (i) zinc used in the early Marsh test could contain arsenical impurities, (ii) cemetery soils could contain arsenic, and (iii) the evidence for "normal arsenic" was inconclusive.¹¹⁰

François-Vincent Raspail (1794-1878) frequently challenged Orfila's methods in trials and in scientific publications. Madame Lafarge's lawyer, after Orfila's final report, tried to contact Raspail, but "when Raspail arrived in Tulle, the legal proceedings were over and Madame Lafarge had been indicted for murder and . . . imprisoned for life."¹¹¹ Raspail, for example, was concerned about (i) arsenic in copper vessels used to boil cadavers, and (ii) the potential effect of transporting cadavers on wood painted with arsenical covering: "There are so many non-criminal circumstances that can bring arsenic or arsenical components into the tissues of buried victims!"¹¹² And he supplemented such criticism with "rhetorical remarks about the contrast between [Orfila's] 'purely theoretical experiments' performed in the 'cabinet' [or 'office'] and forensic science, which could decide between the 'life or death' of the accused."¹¹³ Raspail thereby condemned Orfila's arrogance and suggested he was morally careless. Orfila, however, had the academic and political power to respond and to "defend his credibility and prestige as a medical expert," in lectures, published papers, reprints of his textbooks, salon discussions, and public experiments. This led Raspail to reflect on how much Orfila's "powerful authority"

is contrary to the principles of equality in law. How much it is scarcely favorable to the defense's interests, when . . . an expert . . . in advance is showered with praise . . . An all-powerful expert . . . who is opposed to simple provincial pharmacists, with no other power than their own good reputation, and with no other authority than their knowledge and probity!

crust.").

¹⁰⁸ See *id.* at 208, 213-14. But see Gorman, *supra* note 103, at 59 ("Credit for using the Marsh test for the first time in a criminal trial is accorded to Orfila in the famous Lafarge case in 1840 in France. Yet [Sir William Brooke O'Shaughnessy (1809-1889)], isolated [in India] from the mainstream of chemistry and law, claimed to be the first to describe results of the test as applied to a legal procedure.").

¹⁰⁹ See Ramón Bertomeu-Sánchez, *supra* note 101, at 208.

¹¹⁰ See *id.* at 218-20, 226.

¹¹¹ *Id.* at 208.

¹¹² *Id.* at 218-19 (quoting Raspail in the Mercier trial).

¹¹³ *Id.* at 220 (quoting and translating *Gazette des tribunaux*, 2-3 Dec. 1839, at 106-07). It bears mentioning that Raspail, viewed in his day as a "subversive" Republican activist, was a lifelong political enemy of Orfila, a passionate Monarchist. See Dora B. Weiner, *François-Vincent Raspail: Doctor and Champion of the Poor*, 1(2) FRENCH HIST. STUD. 149, 151, 164 (1959).

Finally, . . . an expert who decides university appointments and dismissals
in Paris. . . .¹¹⁴

Orfila's early role as a skeptic and critic of the over-confidence of the initial experts in the Lafarge trial was, in Raspail's view, eclipsed by Orfila's own over-confidence and blindness to the limitations of his own toxicological experimental methods.

The reception of Orfila in Britain, while generally positive, also reflected concern for his hubris. His discovery of "normal arsenic," which had seemingly disastrous implications for chemical proof of an arsenic poisoning charge, raised "cautious skepticism."¹¹⁵ In "several accounts of the [normal arsenic] controversy Orfila was cast as a brilliant virtuoso who had, in this instance, unhappily over-reached himself."¹¹⁶ George Owen Rees (1813-1889), a chemist at Guy's Hospital, thought Orfila to be too enthusiastic about his experimental prowess:

[Orfila] has excluded some of the most satisfactory and delicate tests . . .
and has somewhat dogmatically insisted upon the infallibility of
appearances which, however they may carry conviction to his own mind,
will scarcely be considered as sufficient by other chemists.¹¹⁷

Orfila's British critics saw him as "sacrific[ing] the higher threshold of interpretive restraint required of an expert operating within the constraints of the criminal courtroom."¹¹⁸ Orfila's excesses could also be attributed to the official, authoritative capacity of experts in French courts, which "shielded them from the adversarial testing experienced by British witnesses." In any event, the concerns about Orfila "underscored the need for modesty in the application of chemistry to medico-legal inquiry, and for an acceptance of the contingencies of toxicological fact-making."¹¹⁹ Alfred Swaine Taylor's (1806-1880) textbooks referred to Orfila to suggest "the dangers of over-interpretation" and Taylor criticized "Orfila's willingness to confirm the presence of arsenic on the basis of "ambiguous indicators."¹²⁰

Taylor himself, however, was soon accused of over-confidence in his work (with his Guy's Hospital colleague Rees) on the trial of William Palmer in 1856.¹²¹

¹¹⁴ See Ramón Bertomeu-Sánchez, *supra* note 101, at 223 (citations omitted).

¹¹⁵ Burney, *Bones*, *supra* note 100, at 251 ("[w]ith normal arsenic as a background evidentiary assumption," it would be easy to obtain an acquittal).

¹¹⁶ *Id.* at 252.

¹¹⁷ *Id.* at 252 (quoting G.O. Rees, *On the Existence of Arsenic as a Natural Constituent of Human Bones*, 6 GUY'S HOSP. REP. 163, 166 (1841)).

¹¹⁸ Burney, *Bones*, *supra* note 100, at 253.

¹¹⁹ *Id.*

¹²⁰ *Id.* at 254.

¹²¹ See *id.* at 255. Palmer was a country physician who was suspected of poisoning his gambling partner John Parsons Cook (as well as his—Palmer's—wife and brother). For a

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Taylor had supported the prosecution's charge of [strychnine] poisoning despite the fact that he had failed to detect poison in the body of the alleged victim, relying primarily on clinical evidence for his conclusions. His critics on the defense team . . . insist[ed] that if the poison existed even in minute amounts, a skilled analyst should have detected it.¹²²

Criticism continued in the popular press. Taylor defended himself in part by recalling Orfila's sins of excess in the Lafarge case and by drawing an analogy to the experts who opposed him in the Palmer trial—" [f]or Taylor, these dogmatists had simply reversed Orfila's error: instead of declaring the presence of poison on the basis of an insecure infinitesimalism . . . they testified to its absence on the grounds of inflated claims to analytical sensitivity."¹²³ Nevertheless, despite Taylor's substantially successful efforts to reframe the Palmer case in his textbooks, his "public image remained ambiguous until his death," and he was condemned in some quarters "as the harbinger of a new and dangerous set of scientific pretensions."¹²⁴ Three years after the Palmer trial, Taylor testified in the arsenic poisoning case of Thomas Smethurst. On the basis of a single result using the Reinsch test, he declared the presence of arsenic and Smethurst was convicted.¹²⁵ However, William Herapath (1796-1868) later showed that Taylor's use of the test was faulty, and Smethurst was pardoned.¹²⁶

In the mid-eighteenth-century, the tests for arsenic detection were so uncertain that accusations, or even the existence, of hubris among experts are rare. Stephan Landsman notes that in two poison cases in 1752 England, the expertise on poisoning was equivocal.¹²⁷ When Ludgate prisoners Pestell and Johnson were tried for poisoning a fellow inmate, two surgeons testified. The first voiced doubts about proof of poisoning and would not charge the defendants "without the clearest physical evidence." The second agreed, and acquittal resulted.¹²⁸ When Mary Carpenter, a servant, was accused of poisoning her employer, a chemist would not swear to the fact that poison was used, an apothecary could not opine to that fact, and a surgeon's autopsy did not support a murder charge. All three witnesses seemed to display "a keen awareness of the high level of proof required."¹²⁹ Ten years later, Landsman

lengthy account of the Palmer trial, see Ian A. Burney, *A Poisoning of No Substance: The Trials of Medico-Legal Proof in Mid-Victorian England*, 38 J. BRIT. STUD. 59 (1999). See also Tony Ward, *A Mania for Suspicion: Poisoning, Science, and the Law*, in CRIMINAL CONVERSATIONS: VICTORIAN CRIMES, SOCIAL PANIC, AND MORAL OUTRAGE 140, 145-46 (Judith Rowbotham & Kim Stevenson eds., 2005).

¹²² Burney, *Bones*, *supra* note 100, at 255-56.

¹²³ *Id.* at 256.

¹²⁴ Burney, *A Poisoning*, *supra* note 121, at 86.

¹²⁵ See Neil G. Coley, *Forensic Chemistry in 19th-Century Britain*, 22 ENDEAVOR 143, 145-46 (1998); see also Ward, *supra* note 121, at 146-48.

¹²⁶ See Coley, *supra* note 125, at 145-46. Smethurst, however, was then convicted of bigamy; Ward, *supra* note 121, at 141, 147 (Taylor had used copper gauze, lots of it, because it kept dissolving in the solution, which gauze had arsenic in it).

¹²⁷ See Landsman, *One Hundred Years*, *supra* note 15, at 463.

¹²⁸ *Id.*

¹²⁹ *Id.* at 463-64.

reports, “the demand for certainty remained equally vigorous” in the poisoning trial of Jane Sibson.¹³⁰ An apothecary named John Tyrell made a “hasty, overzealous” accusation, but he was attacked at the trial as partisan, dishonest, and lacking medical knowledge. Three surgeons and three physicians declared that there was no evidence of poisoning. Upon acquittal of Mrs. Sibson, Tyrell was seized, tried, and convicted for perjury—“as much for his excessive advocacy as his specific misstatements.”¹³¹

By 1782, however, the hubris of less-than-competent experts was successful in the poison trial of Captain John Donellan, accused of murdering his brother-in-law. The circumstantial evidence was compelling: Donellan’s suspicious behavior, potentially sizeable inheritance (which would go to Donellan’s wife if her brother died), opposition to an autopsy, and experiments with distilled liquids. The prosecution provided five doctors to testify, three who attended the autopsy and two “celebrated physicians.”¹³² The “most eminent forensic medical expert in England, John Hunter,” testified for the defense on the basis of substantial experience that there was no evidence of poisoning; but he was reluctant “to deliver a fully definitive partisan answer to all the questions put to him.” The jury returned a controversial finding of guilt.¹³³

Finally, in an 1826 trial in Sussex, England, Hannah Russel and a lodger were accused of poisoning her husband. Evidence that she had purchased arsenic, together with the testimony of a local surgeon who said he found arsenic in the victim’s stomach, resulted in convictions.¹³⁴ The lodger was hung, but Hannah’s execution was delayed. Dr. Gideon Mantell (1790-1852), a Sussex physician and geologist, took an interest in the story. Mantell was convinced that the deceased had not been poisoned, blaming heart problems instead. He criticized the surgeon’s tests, and sought confirmation of his views from other physicians.¹³⁵ When Hannah Russel was pardoned, due to Mantell’s efforts, the pattern of over-confident and careless experts, later corrected by those with better credentials, was firmly established.

V. SETTLING THE CONTROVERSY?: MODERN ARSENIC DETECTION TECHNOLOGIES

[F]ear of undiscovered crime lay at the heart of the nineteenth-century
obsession with poison murder. . . .

¹³⁰ *Id.* at 464.

¹³¹ *See id.* at 464, 481-82.

¹³² *See* Landsman, *Of Witches*, *supra* note 15, at 141.

¹³³ *Id.* at 141-42.

¹³⁴ *See* KATHERINE WATSON, *POISONED LIVES: ENGLISH POISONERS AND THEIR VICTIMS* 164 (2004).

¹³⁵ *Id.* at 164-65 (citing S. Spokes, *A Case of Circumstantial Evidence*, *SUSSEX COUNTY MAG.*, Jan. – Dec. 1937, at 118-22).

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To dispel these fears, what was needed was an effective way to detect and deter poisoning crimes. For centuries, this had been an almost impossible task, but in the nineteenth century the situation changed. By the 1840s, toxicology had emerged as the first modern forensic science.¹³⁶

In her 2004 study of poison crimes, Katherine Watkins identifies four chemical tests for arsenic detection that were considered standard prior to the 1830s: the reduction test and three liquid or precipitate tests.¹³⁷ As early as 1752, Anthony Addington performed an examination, based on physical, not chemical, properties, in the English trial of Mary Blandy, who was convicted of poisoning her father with white arsenic.¹³⁸ Addington found white powder on the bottom of a pan used to serve gruel. When the powder was placed in water, most of it sank to the bottom, while a “gritty and insipid taste was noted, and the odor of garlic was clearly evident upon placing it in a red-hot pan.” All of which was identical to the behavior of a sample of white arsenic

¹³⁶ Mark Essig, *Poison Murder and Expert Testimony: Doubting the Physician in Late Nineteenth-Century America*, 14 YALE J.L. & HUMAN. 177, 181 (2002); see also IAN BURNEY, POISON, DETECTION, AND THE VICTORIAN IMAGINATION 6 (2006) (“it was the poison detective – the toxicologist – who emerged as the leading representative of the growing field of nineteenth-century medico-legal expertise”).

¹³⁷ See WATSON, *supra* note 134, at 16-17; see also S.W.M., *Forensic Medicine: Observations on the Tests for Arsenic*, 1:1 AM. L. REG. 11, 13-14 (Nov. 1852) (describing three liquid tests and the “reduction process”). Numerous treatises on poisons (most including descriptions of various tests for detection) were published in Europe in the late 18th and early 19th century; S.K. Niyogi, *Historic Development of Forensic Toxicology in America up to 1978*, 1 AM. J. FORENSIC MED. & PATHOLOGY 249, 251 (1980) (citing German and French treatises). “In contrast to overall European development of the field of toxicology, nothing had been written in the United States before the beginning of the 19th century.” *Id.* at 251-52 (noting that American editions of Orfila’s works were available by 1817, and that Thomas Cooper, a professor of chemistry at the University of Pennsylvania, described the tests for arsenic in 1818 (citing J.G. NANCREDE, A GENERAL SYSTEM OF TOXICOLOGY (a translation of Orfila’s *Traite des Poisons* . . . , 1814) and THOMAS COOPER, *On the Tests of Arsenic*, in TRACTS ON MEDICAL JURISPRUDENCE, *supra* note 90, as read at American Philosophical Society, Sept. 18, 1818)). Cooper’s TRACTS ON MEDICAL JURISPRUDENCE, *supra* note 90, was published in 1819, and included a collection of works. For example, Cooper’s TRACTS included the text of his Sept. 18, 1818 paper, COOPER, *On the Tests of Arsenic*, *supra*, at 431-48. Second, Cooper’s TRACTS included annotated versions of previously published tests for arsenic detection: Samuel Farr, *Elements of Medical Jurisprudence*, in TRACTS ON MEDICAL JURISPRUDENCE, *supra* note 90, at 49-54 (Cooper updates Farr’s 18th century methods); George Edward Male, *An Epitome of Juridical or Forensic Medicine*, in TRACTS ON MEDICAL JURISPRUDENCE, *supra* note 90, 154-57. Most of the tests described are reflected in Dr. Jackson’s article published after the Logan case, *supra* note 2. Mohr explains that before “1800 virtually no local practitioners could test a corpse for signs of poisoning; by 1825 there were plenty of physicians around the United States who could.” MOHR, *supra* note 2, at 51. Dr. Jackson seems to be one of those who could, and his description of the typical symptoms of an arsenic victim, *supra* note 60, track closely the descriptions offered by Farr and Male; Farr, *supra*, at 50; Male, *supra*, at 149.

¹³⁸ See Robert H. Goldsmith, *The Search for Arsenic*, in MORE CHEMISTRY AND CRIME: FROM MARSH ARSENIC TEST TO DNA PROFILE 149, 153 (Samuel M. Gerber and Richard Saferstein eds., 1997).

simultaneously tested.¹³⁹ Such early tests were described by: (i) Joseph Black in 1803, who noted that arsenic could be distinguished by its weight, volatility, ability (when heated) to penetrate metallic copper and give it a whitish color, and qualities when burned (whitish smoke or garlic odor); (ii) Thomas Ewell in 1806, who observed that arsenical powder thrown on heated coals will produce white flames and a garlic smell; and (iii) Benjamin Rush, who detected arsenic by the smell of garlic, the appearance of a whitish presence on copper plates heating the powder, and the formation of a green precipitate when the whitish powder is treated with alkaline copper sulfate.¹⁴⁰ This latter test was a version of the first major chemical precipitate test, known as Green's test, which treated a suspected arsenic solution with ammoniacal copper sulfate to produce a green precipitation of copper arsenic or a greenish-blue precipitation of copper arsenate.¹⁴¹

The second precipitation test, described by Joseph Hume in 1809, involved adding a silver nitrate solution in an alkaline environment to produce a bright yellow silver arsenate precipitate.¹⁴² The third test involved "passing a stream of sulfureted hydrogen . . . gas into an arsenic solution previously acidified with hydrochloric acid to produce a bright yellow amorphous precipitate of arsenious sulfide."¹⁴³ Each of these tests had limitations and ambiguities resulting in the possibility of misleading results and typically requiring

¹³⁹ *Id.* at 153-54; see also JÜRGEN THORWALD, *THE CENTURY OF THE DETECTIVE* 273 (Richard & Clara Winston trans., 1965) (suggesting that around 1710, the Dutch physician Hermann Boerhaave "proposed placing substances suspected of containing poison on glowing coals, and testing their smell").

¹⁴⁰ See Goldsmith, *supra* note 138, at 154-55 (citing JOSEPH BLACK, *LECTURES ON THE ELEMENTS OF CHEMISTRY* 419-26 (1803), THOMAS EWELL, *PLAIN DISCOURSES ON THE ELEMENTS OF CHEMISTRY* 252 (1806), and BENJAMIN RUSH, *MEDICAL INQUIRIES AND OBSERVATIONS* 239-40 (1805)). Farr, writing in 1767, notes that a solid substance, taken from the stomach of a person suspected to be poisoned, should be dried and "thrown upon burning coals, which if it produces a vapour of a white colour, and an odour like that of garlic is perceived, it may be suspected with reason, that an arsenical matter was mixed with it." Farr, *supra* note 137, at 52. Male, writing in 1816, notes that such a "test is not to be depended upon, as phosphorous and zinc emit the same smell." Male, *supra* note 137, at 155. Another early test, mentioned by Farr is to give the dried substance (from the stomach of a victim of suspected poisoning) to "fouls, dogs, &c. which if it causes their death, or violent vomiting, it is a proof interaliae, that poison made a part of its contents." Farr, *supra* 137, at 53.

¹⁴¹ See Goldsmith, *supra* note 138, at 155.

¹⁴² See *id.*

¹⁴³ *Id.* at 156. This test is attributed to Samuel Hahnemann's arsenic research in 1785. See THORWALD, *supra* note 139, at 275; WILSON & WILSON, *supra* note 104, at 72. Dr. George Edward Male, *supra* note 137, at 154-57, describes several tests for arsenic, including the early garlic odor/white smoke test, five precipitate tests, and a reduction test (for the reduction test see *infra* notes 145-47).

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combined tests.¹⁴⁴

The “reduction” test refers to the heating of “white arsenic to decompose it to oxygen and metallic arsenic, which would then form a deposit on glass” that could be dissolved in water and tested with liquid tests.¹⁴⁵ In another formulation, “[s]mall amounts of solid arsenic compounds could be reduced by carbonaceous flux, recently ignited charcoal, to the elemental state of arsenic.”¹⁴⁶ James Marsh (1794-1846), from his own account, relied most heavily on the reduction test in his work on the 1833 prosecution of John Bodle for the arsenic poisoning murder of his grandfather, George Bodle.¹⁴⁷ John Bodle was acquitted, at least in part, because the tests Marsh “used were simply not delicate enough to detect tiny quantities” of arsenic. That “failure . . . stimulated Marsh to try to find a better method of detecting arsenic.”¹⁴⁸ Relying on Carl Wilhelm Scheele’s 1775 demonstration that zinc and arsenic mixed in an acid solution formed a gas (arsine), and on Johann Daniel Metzger’s 1787 experiments converting arsenic vapors into a metallic arsenic deposit, Marsh devised a simple apparatus to capture arsenic.¹⁴⁹ Though there were reliability problems in Marsh’s early experiments, the method was variously modified and became a standard test in Britain and abroad.¹⁵⁰ (Jöns Jacob Berzelius (1779-1848) modified the apparatus, and though the Marsh-Berzelius test required great skills to avoid errors, it offered a way to discover small quantities of arsenic in the bodies of poison victims.¹⁵¹) The Marsh test was publicized in the 1840 Lafarge trial by Orfila, and was soon the prominent method of arsenic detection in English trials.¹⁵²

Soon thereafter, Hugo Reinsch (1809-1884) “introduced . . . a simple, effective test that could pick up arsenic” at miniscule levels, and it was also used in many poison trials.¹⁵³ “The test consists of placing a copper leaf or copper plate . . . previously treated with dilute nitric acid into an arsenical

¹⁴⁴ See generally Goldsmith, *supra* note 138, at 155-56.

¹⁴⁵ Katherine D. Watson, *Criminal Poisoning in England and the Origins of the Marsh Test for Arsenic*, in CHEMISTRY, MEDICINE, AND CRIME, *supra* note 71, at 192.

¹⁴⁶ Goldsmith, *supra* note 138, at 156.

¹⁴⁷ See Watson, *supra* note 145, at 188-92.

¹⁴⁸ *Id.* at 184.

¹⁴⁹ See *id.* at 192-93; see also THORWALD, *supra* note 139, at 275; WILSON & WILSON, *supra* note 104, at 72, 79-80. As to detecting arsenic already absorbed into the body, another German, Valentin Rose on the faculty of medicine in Berlin, conceived of a method in 1806 to boil and filter portions of the stomach to produce a liquid that could be tested. See THORWALD, *supra*, at 275; WILSON & WILSON, *supra*, at 73.

¹⁵⁰ See Watson, *supra* note 145, at 193-94 (“Marsh made a u-shaped glass tube . . . with one end open, the other terminating in a stopclock. The reagents [including the solution in which boiled organic samples allegedly contained arsenic] were placed at the bottom of the u-shaped tube. . . . Upon opening the stopclock, the arsenic escaped . . . and had to be quickly ignited. . . . When this was done, a glass or porcelain plate was held over the stopclock, and bright metallic arsenic deposited on the plate. If no arsenic was present in the sample tested, the plate remained clear.”).

¹⁵¹ See *id.*

¹⁵² See *id.* at 196-99.

¹⁵³ See Goldsmith, *supra* note 138, at 159-60.

solution that had been previously acidified with hydrochloric acid and heated nearly to boiling. Arsenic then reveals itself as a brilliant gray metallic-like coating or a black coat.”¹⁵⁴ In the late nineteenth-century, Professor Alfred Naquet’s *Legal Chemistry* (English translation, 1884) included a section on detection of arsenic, in which he provided detailed instructions for the best test used prior to Marsh’s test, Marsh’s test, and Raspail’s method (“we have not, however, personally tested its merits”). His translator added the Reinsch test (“the omission in the text . . . should be supplied”).¹⁵⁵ In the first half of the twentieth-century, Anton J. Bettendorf’s (1839-1902) test (a modification of the Reinsch test), Ernest W.H. Gutzeit’s (1845-1888) test (a modification of the Marsh test, still regarded as a valid method), the Hefti tests (using “electrolytic deposition of arsine upon an electrode”), and the Kage modification of the Gutzeit test (using mercuric bromide as the reagent) were used by forensic scientists.¹⁵⁶

Today, Curry’s modernization of the Gutzeit test by inserting “the framed reagent dried filter paper into a spectrophotometer to take optical readings” can detect arsenic at low concentrations, but the atomic absorption technique and neutron activation analysis are preferred.¹⁵⁷ The standard method in arsenic testing since the mid-1980s is mass spectrometry, such as the inductively coupled plasma-mass spectrometry used in the Sommer investigation.¹⁵⁸

¹⁵⁴ *Id.* at 159.

¹⁵⁵ See A. NACQUET, LEGAL CHEMISTRY: A GUIDE TO THE DETECTION OF POISONS, EXAMINATION OF TEA, STAINS, ETC., AS APPLIED TO CHEMICAL JURISPRUDENCE 17-30 (J.P. Battershall trans., 1884). Naquet was on the Faculty of Medicine of Paris.

¹⁵⁶ Goldsmith, *supra* note 138, at 160-61. Henry T. F. Rhodes’ FORENSIC CHEMISTRY details (i) Chamot’s “micro modification of the Gutzeit reaction in its classical form using silver nitrate as indicator”, but warns that it is a “very delicate test for arsenic [that is] not absolutely specific”, as well as (ii) Stryzowski’s method (the most satisfactory of chemico-microscopical tests, but confirmation by an alternative method is “desirable”), (iii) the Reinsch test, (iv) Pregl’s modification, (v) the Gutzeit test, and (vi) the Marsh-Berzelius test (“still employed for all quantitative determinations of traces”). HENRY T. F. RHODES, FORENSIC CHEMISTRY 149-54 (1946). A. Lucas’ FORENSIC CHEMISTRY AND SCIENTIFIC CRIMINAL INVESTIGATION describes the Reinsch test (simple, valuable, sensitive), the Marsh test, and the Gutzeit test, as well as spectrographic tests (“as a rule . . . too delicate for use in poisoning tests”). A. LUCAS, FORENSIC CHEMISTRY AND SCIENTIFIC CRIMINAL INVESTIGATION 289-98 (4th ed., 1945).

¹⁵⁷ Goldsmith, *supra* note 138, at 161. See also ALAN S. CURRY, POISON DETECTION IN HUMAN ORGANS 103-05 (4th ed. 1988) (describing Gutzeit modification and the use of a nuclear reactor); Niyogi, *supra* note 137, at 258 (“[In toxicological analysis], the paper chromatography has largely been superseded in thin-layer chromatography in terms of speed and detection limit. Improvements . . . have been achieved in ultraviolet spectrophotometer, spectrofluorometer, atomic absorption spectrophotometer, infrared spectrophotometer, x-ray diffraction, and neutron activation analysis.”).

¹⁵⁸ See *infra* note 160. See also Robert A. Middleburg, *Forensic Toxicology In The Fore . . . And Aft*, FORENSIC MAG., June - July 2008, at 16, available at

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Looking back, a progression can be seen in the tests, beginning with the purely qualitative and intuitive, moving to crude chemical tests, and now arriving at the more sensitive modern tests for arsenic detection. Arsenic may have a reputation as a popular poison, but it now faces a near certainty of being detected.¹⁵⁹

It is that level of confidence that was expressed by the expert witness for the prosecution in the Cynthia Sommer trial, in late 2006 in San Diego. He was Chief of Biophysical Toxicology in the Department of Environmental and Toxicologic Pathology at the Armed Forces Institute of Pathology (“AFIP”) in Washington, D.C., held a doctorate in physical chemistry, and was highly published. Sommer was convicted as an arsenic poisoner on January 30, 2007, but in the ensuing post-trial litigation challenging the verdict, sufficient questions were raised concerning the laboratory procedures and results to lead the prosecutor to send newly discovered tissue samples (preserved in paraffin) to the Quebec Toxicology Center, which found no arsenic in any of the samples.

In retrospect, the Sommer trial re-enacted the pattern (over-confident hubris and moral carelessness on the part of a toxicological expert, conviction of the defendant, re-analysis by a better expert, and acquittal of the defendant) that sometimes occurred in the early nineteenth-century when arsenic detection technologies were rapidly evolving. The criticism of the prosecution’s experts and evidence raised by the Technical Director of the Metals Department of NMS Labs in Willow Grove, Pennsylvania¹⁶⁰ is not unlike Dr. Jackson’s diatribe following the conviction and acquittal of Mrs. Logan. Having testified in the case, the NMS Director received additional information about the procedures at the AFIP and offered the opinion that (i) the chain of custody for liver and kidney tissues, which allegedly revealed extremely high levels of arsenic, had omissions and unexplained alterations; (ii) the victim’s specimens were not properly managed; (iii) AFIP’s lab was neither accredited by the American Board of Forensic Toxicology, nor did it participate in voluntary performance testing for arsenic (*and* AFIP’s standard operating procedures for using Inductively Coupled Plasma Mass Spectrometry (“ICP-MS”) were not in place until after the tests were completed); (iv) AFIP did not use Graphite Furnace Atomic Absorption Spectrometry for determination of arsenic in liver and kidney tissues, and therefore did not cross-validate the newly-received ICP-MS technology that was used; (v) this was the analyst’s first arsenic test, there were no standard operating procedures, and the analyst did not have the experience that would be required by EPA, for example, to test drinking water; (vi) the possibility of contamination was present (cacodylic acid is used in spectroscopy), but the analyst rejected that possibility on the basis of an unscientific belief that a contaminating source can be monitored; (vii) arsenic

http://www.forensicmag.com/Article_Print.asp?pid=210.

¹⁵⁹ Goldsmith, *supra* note 138, at 167.

¹⁶⁰ Letter from Elzbieta Bakowska, Technical Director, Metals Department, NMS Labs, to Robert Udell, Esq. (Mar. 22, 2007), *available at* http://www.wizozkansas.com/sommer/Bakowska%20National%20Medical%20Medical%20Services_3222007.PDF.

speciation in tissues is a questionable procedure, and the method used by AFIP neither followed a peer-reviewed method nor employed appropriate documentation for assessing validity; and (viii) numerous quality control deficiencies corrupted the AFIP tests.¹⁶¹ In addition, “the analytical findings of the Sommer case are not in agreement with Sgt. Sommer’s activities prior to his death and the autopsy findings.” The finding of 100% dimethylarsenic acid (DMA) is not consistent with other case studies involving death by inorganic arsenic, and Sgt. Sommer did not display the appropriate symptoms before his death.¹⁶² While it is not unusual for criminal defendants to challenge the prosecution’s forensic scientists, this is a unique case where the evidence against Cindy Sommer was so increasingly doubtful, after her conviction, that the prosecutor dismissed the case:

District Attorney Bonnie Dumanis said [on April 17, 2007,] “Today justice was done. . . . This is how the system is supposed to work. As soon as we had information that pointed to reasonable doubt, we [were determined] . . . to get the matter dismissed. . . .” Defense lawyer Allen Bloom was unconvinced. “No one should say that this system worked. . . . This dismissal wasn’t because of the prosecution’s efforts; it was done because the defense demanded it.”¹⁶³

Failures in the “system” of forensic science have become common enough to lead some to declare a crisis.

VI. THE CRISIS IN FORENSIC SCIENCE

The increase use of DNA analysis, which has undergone extensive validation, has thrown into relief the less firmly credentialed status of other forensic science identification techniques (fingerprints, fiber analysis, hair analysis, ballistics, bite marks, and tool marks). These have not undergone the type of extensive testing and verification that is the hallmark of science elsewhere. . . . [R]eliable error rates are not

¹⁶¹ *See id.*

¹⁶² Letter from Laura Labay, Forensic Toxicologist, NMS Labs, to Robert Udell, PA (Mar. 7 2007), *available at* <http://www.wizozkansas.com/sommer/Labay%20N06356.PDF>. At the trial, the author of the letter testified for the defense that, “It is not conceivable that he walked around for 10 days without being ill.” 10News.com, Toxicologist testifies in Poisoned Marine Trial, *available at* <http://www.10news.com/print/10817606/detail.html> (last visited Nov. 9, 2008) (quoting Laura Labay). Note that Dr. Jackson also, in his evaluation of the four physicians in the Logan case, not only criticized their chemical tests, but also noted that William Logan’s symptoms did not indicate arsenic poisoning. *See supra* notes 60-61 and accompanying text.

¹⁶³ Dana Littlefield, *Case vs. Marine widow is dropped; Prosecutors could refile charges later*, SAN DIEGO-UNION TRIBUNE, Apr. 18, 2008, at B1, *available at* <http://news.topic.com/category/cynthia-sommer>.

known.¹⁶⁴

The primary concern with forensic science is that many identification technologies, unlike DNA profiling, have their origins in law enforcement agencies and therefore do not share in the usual norms, protocols, and validation techniques that we associate with the best science. The general problem of litigation-driven expertise, associated with civil litigation and the reliance of experts on studies performed after litigation has begun, has been highlighted by those concerned with funding sources, identifiable interests, and partisanship of trial experts.¹⁶⁵ Until recently, however, law enforcement forensic science, which is obviously “litigation-driven” by its association with prosecutors, has not been criticized for its funding sources, prosecutorial interests, and partisanship.¹⁶⁶ But concerns now arise over

law enforcement-sponsored research relevant to the reliability of expert evidence in criminal cases, evidence that virtually always is proffered on behalf of the government’s cases. Of primary concern is research directly focused on the error rates of various currently accepted forensic identification techniques, which have not been subject to any formal validity testing.¹⁶⁷

Despite public perceptions of near-infallibility, the research supporting handwriting examination techniques, fingerprint identification, and hair analysis is weak,¹⁶⁸ and independent studies of polygraph tests do not validate their accuracy.¹⁶⁹ There is also an “embarrassing lack of empirical research on

¹⁶⁴ Donald Kennedy and Richard A. Merrill, *Assessing Forensic Science*, ISSUES IN SCI. & TECHNOLOGY 33, 34 (Fall 2003), available at <http://www.issues.org/20.1/kennedy.html>.

¹⁶⁵ See generally Gary Edmond, *Supersizing Daubert: Science for Litigation and Its Implications For Legal Practice And Scientific Research*, 52 VILL. L. REV. 857 (2007); Susan Haack, *What’s Wrong with Litigation Driven Science?: An Essay on Legal Epistemology*, 38 SETON HALL L. REV. 1053 (2008).

¹⁶⁶ See Edmond, *supra* note 165, at 865 (Scientific “endeavors closely tied to law enforcement may indeed have the courtroom as a principal theatre of operations As to such disciplines, the fact that the expert has developed an expertise principally for purposes of litigation will obviously not be a substantial consideration.”); see also *Daubert v. Merrell Dow Pharm., Inc.*, 43 F.3d 1311, 1322 (9th Cir. 1995). But see Haack, *supra* note 165, at 1078 (“It is true, as [Judge Kozinski] says [in the above quotation from *Daubert*], that the fact that forensic scientists acquire their expertise for the purposes of the justice system isn’t in itself grounds for doubting the reliability of their testimony Perhaps the thought implicit here is that . . . while [forensic science] is needed only because there are crimes to be solved and prosecuted, it is not inherently motivated by the desire to make one side of a case; but this is pollyannish to say the least. After all, such work is undertaken almost exclusively for the police or prosecution, and it seems likely that [the] desire to be helpful, to find something to make a case against a suspect, sometimes biases [forensic scientists’] judgment.”).

¹⁶⁷ D. Michael Risinger & Michael J. Saks, *A House With No Foundation*, ISSUES IN SCI. & TECHNOLOGY (Fall 2003), available at <http://www.issues.org/20.1/risinger.html>.

¹⁶⁸ See *id.*

¹⁶⁹ See David L. Faigman, Stephen E. Feinberg, & Paul C. Stern, *The Limits of the Polygraph*, ISSUES IN SCI. & TECHNOLOGY (Fall 2003), available at <http://www.issues.org/20.1/faigman.html>.

well-accepted techniques such as . . . firearms identification, and bite-mark comparisons.”¹⁷⁰ Indeed, many of the prisoners recently exonerated by DNA evidence were convicted on the basis of unreliable forensic identification techniques.¹⁷¹

Ethical concerns about forensic identification techniques have also been raised. “The blowing smoke phenomenon [in forensic testimony during criminal trials] is particularly vexing. If there is an answer to the blowing smoke, muddying the waters problem, it will have to come from within the forensic science community in the form of a tighter code of ethics.”¹⁷²

The problem of over-confidence in weak scientific methodologies is compounded by the sense that some of those who testify have little regard for the rights of the accused. In this critical onslaught, a distinction is typically made between “what we might call ‘normal forensic sciences’ (e.g., forensic toxicology and forensic chemistry),” on the one hand and the forensic individualization or identification “sciences” which “have no basic science to undergird them.”¹⁷³ “Normal forensic science does things like determining what substance something is (e.g., what is this white powder?). . . . [It] borrow[s] and appl[ies] principles from normal basic sciences such as . . . chemistry. . . . The forensic identification sciences . . . are an enterprise consisting of nearly all application and no science.”¹⁷⁴

Without questioning the validity of the critique of forensic identification techniques, one must ask, in light of the history of arsenic detection technologies, whether such a strong distinction is sustainable. Forensic toxicology shares some of the problems identified as weaknesses in forensic identification science. First, even though forensic toxicology has a foundation in the basic sciences, its application in a particular case is “science-for-litigation” and is driven by “a single unambiguous desired result . . . [which] will be presented to a reviewing community (judges and juries) that typically is not scientifically literate.”¹⁷⁵ Second, forensic toxicology is often associated with crime laboratories, some of which are unaccredited, and even the best have been the site of problems.

[P]erhaps the best example is the Federal Bureau of Investigation (FBI) laboratory, considered to be the country’s premier crime lab. A 1997 Inspector General’s report on the lab found scientifically flawed testimony, inaccurate testimony, testimony beyond the competence of

¹⁷⁰ Paul C. Giannelli, *Crime Labs Need Improvement*, ISSUES IN SCI. & TECHNOLOGY (Fall 2007), available at <http://www.issues.org/20.1/giannelli.html>.

¹⁷¹ *See id.*

¹⁷² FISHER, *supra* note 17, at 285.

¹⁷³ Michael J. Saks, *Banishing Ipse-Dixit: The Impact of Kumho Tire on Forensic Identification Science*, 57 WASH. & LEE L. REV. 879, 881-82 (2000).

¹⁷⁴ *Id.*

¹⁷⁵ Risinger & Saks, *supra* note 167.

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examiners, improper preparation of laboratory reports, insufficient documentation of test results, scientifically flawed reports, [and] inadequate record management and retention¹⁷⁶

Ten years later, the NMS Lab's toxicologists (testifying on a behalf of Cindy Sommer) found the very same flaws in the Department of Environmental and Toxicologic Pathology at AFIP. Finally, the same concerns over partisanship, interest, and sources of funding that worry the critics of forensic identification techniques are just as applicable to assessments of forensic toxicology. Even in the mid-nineteenth-century, when there were no law enforcement-sponsored crime laboratories, charges of partisanship among forensic toxicologists can be found. (Indeed, from the nineteenth-century, when party-driven expertise became the norm in American and English courts, until the present, concerns over partisanship are evident.)¹⁷⁷ In the famous Palmer case, both Taylor and Herapath, from opposite sides of the case, were accused of partisanship. Defense counsel for Dr. Palmer maintained that,

[f]rom the very beginning of his association with the case . . . Taylor had been the quintessential partisan. Taylor's initial examination had been biased by the stepfather's suspicions that Cook had not died a natural death. His performance at the [inquest, where Taylor confidently declared strychnine as the agent of death,] confirmed him as an interested party. Having staked his credentials as an expert witness on a highly speculative theory supported by mere "tearoom gossip," he had publicly backed himself into a corner. . . .¹⁷⁸

Hence Taylor's consistent testimony, even when his chemical tests revealed no strychnine, and his explanation of absorption. But Herapath, testifying for the defense, "was made to confess on cross-examination that he had again and again bragged among friends that he too thought Cook was poisoned by strychnine but that Taylor did not know how to find it."¹⁷⁹ Taylor, therefore, later accused Herapath of belonging "to a class of 'traffickers in evidence' who would for a fee align themselves to any cause."¹⁸⁰

Thus while the recent concerns over the forensic identification sciences focus on its features as science-for-litigation, its association with law enforcement-sponsored crime laboratories, and its potential for partisanship, there is nothing about the scientific foundation of forensic toxicology that removes it from these types of concerns. That is neither to say that forensic toxicology is not more reliable than the commonly-used forensic identification techniques, nor that forensic toxicologists are on the whole partisans who are willing to testify falsely. Rather, it is to say that hubris in the form of over-confidence and overstatement remains a risk in the field of arsenic detection, and that carelessness in the laboratory reflects a moral failure in the criminal justice system.

¹⁷⁶ Giannelli, *supra* note 170.

¹⁷⁷ See generally Mnookin, *supra* note 15, at 769-75.

¹⁷⁸ Burney, *A Poisoning*, *supra* note 121, at 81.

¹⁷⁹ GOLAN, *supra* note 15, at 99.

¹⁸⁰ Hamlin, *supra* note 15, at 490 (quoting ALFRED SWAINE TAYLOR, *THE PRINCIPLES AND PRACTICE OF MEDICAL JURISPRUDENCE* 38 (2d ed. 1873)).

VII. CONCLUSION

In addition to knowledge and experience, complete honesty and objectivity are . . . required [in my role as an expert witness]. Integrity and reputation are essential in my business.¹⁸¹

Such aphorisms, I suspect, represent the majority opinion of scientific experts, even though most, in my experience, will concede that they have faced, as opposing experts, scientists who were not so honest or objective and who were willing to testify with much—too much—confidence. That shortcoming is a concern, not a crisis, but the affirmation of experts with integrity and a good reputation illustrates the empirical discourse reserved for self-description and the contingent discourse reserved for others. For example, “I have encountered opposing lawyers who actually try to invent science and have seen some of them unwittingly sound like stand-up comedians.”¹⁸² With respect to arsenic detection, the pattern of over-confidence on the part of experts later proven to be unreliable, evident in Dr. Jackson’s re-analysis of Mrs. Logan’s conviction (a preview of the “Arsenic Wars” in France and England), repeated itself in the Cindy Sommer “affair” (as they called the Lafarge case) in San Diego during 2007. And the image of the mad scientist, recently kept alive in popular culture by Mr. Blue aka Dr. Sterns (the character played by Tim Blake Nelson) in the latest *The Incredible Hulk* (2008) film, can be faintly detected in the arrogant over-confidence, the hubris, of the irresponsible treatise writer (Dr. John Ayrton Paris) identified by Dr. Jackson, and in the careless AFIP toxicologists criticized by NMS Labs toxicologists and impliedly by the experts at the Quebec Toxicology Center. It is not only forensic identification specialists, but all forensic scientists who are tempted, at times, by hubris.

Contingencies will always accompany the empirical aspects of science – funding will come from somewhere, scientists are ambitious, and bias toward a preferred theory is commonplace. Those phenomena do not signal junk science, and in situations of scientific controversy or uncertainty, scientists will disagree, which likewise does not imply that one side is less than scientific. We do, however, expect scientists to have integrity and some degree of modesty, the opposites of amorality and hubris, which might keep them from being persuaded to offer an over-confident opinion in disregard of the consequences for a litigant or criminal defendant.

¹⁸¹ David M. Manuta, *A Consulting Chemist’s Perspectives*, CHEM. & ENG. NEWS, Feb. 21, 2005, at 6.

¹⁸² *Id.*