

The Phenomenon of the Styrian Arsenic Eaters from the Perspective of Literature, Chemistry, Toxicology, and History of Science—"Strong Poison" or "Simple-Minded Reasoning"?

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history of chemistry · mithraditism ·
scientific misinterpretation · Styrian arsenic eaters ·
toxicology of arsenic

To my schoolmates Detlef ("Onkel Deti") Krenkel, Winfried ("Skippy") Kier-
ek, and Thomas ("Dino") Dannenberg
on the occasion of our 55th birthdays

1. Absolutely Innocent!

Lord Peter Wimsey spent one sleepless night in his "black-and-primrose library, with the tall folios ... [which] represented the world's accumulated hoard of mellow wisdom and poetical beauty"^[1] studying the following books "The Trial of Florence Maybrick"; Dixon Mann's 'Forensic Medicine and Toxicology'; a book with a German title ... and A. E. Housman's 'A Shropshire Lad'^[1] in order to deduce how the poison had been administered to the murder victim in Dorothy L. Sayers's detective novel *Strong Poison*^[1] (Figure 1).^[2]

Among these books, the poetry collection *A Shropshire Lad*,^[3] published in 1896, contains an allusion to the antique legend of the Pontic King Mithridates VI (132–63 B.C.), who supposedly gained, by ingestion of gradually increasing doses of different poisons including arsenic, immunity (mithraditism), which he is said to have demonstrated during banquets.^[4]

Mithraditism is also thought to be the explanation behind the arsenic eaters of Styria mentioned in Dixon Mann's *Forensic Medicine and Toxicology*.^[5] In his popular book from 1855 with the original German title *Die narkotischen Genussmittel und der Mensch*^[6] Ernst von Bibra writes:

"... that a not completely insignificant number of people deliberately eat white arsenic without showing any discomfort ... principally in the mountainous regions of Austria, Styria ... One can assume that under unfavorable conditions a man may die from 1 grain^[7,8] of white arsenic, a larger dose is always dangerous. Those mountain climbers, however, take it in doses of 4 and more grains."^[6–8]

With the aid of this information Lord Peter deduces that the offender transferred approximately 7–8 grains^[7,8] of

powdered white arsenic into a cracked egg^[1] with which the victim prepared an omelette, which he consumed together with his murderer. The latter, who had "eaten" white arsenic over the course of two years,^[1] did not show any sign of poisoning due to his (presumed) mithraditism. Since the murderer is thus revealed, the charge against the initial suspect, Harriet Vane, is withdrawn with the words: "...in withdrawing the charge against the prisoner, the Crown proceeds from complete conviction of her absolute innocence."^[1]

2. The Birth of the Legend

White arsenic (As_2O_3), "also known under other names, like flowers of arsenic, rat poison, smelting-house smoke (Hüttenrauch) poison-flour etc."^[9] is deposited in the chim-

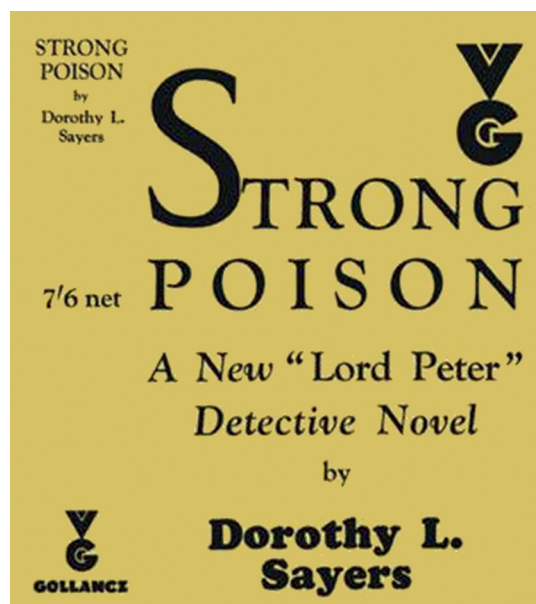


Figure 1. Front cover of the first edition (1930) of D. L. Sayers's novel *Strong Poison*.^[2]

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neys of smelter furnaces during the roasting of arsenic-containing ores.^[10] It was thought that more than 90 % of the poison attacks were executed using white arsenic or other arsenic-containing substances;^[11] thus its sale was restricted starting in the 17th century.^[12] Nevertheless, as far back as the 12th century one finds hints to these “*tiresome peasants in Styria one hears so much about—who are supposed to eat it for fun.*”^[1] People in other Alpine regions^[16–19] and Saxony^[20,21] apparently also indulged in this unusual amusement.

The consumption of white arsenic became known in court and therefore common knowledge among the general public in 1851 on the occasion of a trial in the Lower Styrian city of Cilli (now Celje, slovenska Štajerska), in which Anna Alexander was charged with poisoning *k.k. Ober-Lieutenant Mathias Wurzel*. In this lawsuit^[22–28] the allegation appeared that the victim had the habit “*of taking poison in larger or smaller doses as a preventive means against any sicknesses.*”^[25] Actually, this gossip had no consequence for the final acquittal.^[28] Nevertheless, the presumed consumption of white arsenic by the victim was often used by the defense in later poison trials as an exculpatory argument and is therefore known, particularly in the Anglo-Saxon world, as the “*Styrian defense*”.^[13,29–32]

Immediately after this trial the explorer, physician, and diplomat Johann Jakob von Tschudi^[33] published his report *On the Toxicophagi*,^[34] which was disseminated within a very short time by popular treatises like that of Baron von Bibra^[6] and *Chemistry of Common Life*^[36] by Johnston but especially by journal articles.^[37–41] The main points can be summarized as follows:

- 1) One purpose of poison eating is “*to obtain a fresh healthy aspect, and a certain degree of obesity.*”^[34]
- 2) “*The second object which the poison eaters have in view is to render themselves, as they express it, more airy (lüftiger) or lighter—to facilitate respiration in ascending mountains.*”^[34]
- 3) “*... the toxicophagi dissemble,^[42–44] as much as possible, the use of this dangerous remedy.*”^[34]
- 4) “*The quantity of arsenic, with which the toxicophagi commence, equals, ..., a little piece of the size of a lentil, which would make rather less than half a grain.^[7,8] ... then they increase the dose gradually, with precaution, as the ordinary quantity loses its effect.*”^[34]
- 5) “*It is well to note that no trace of [chronic] arsenical cachexy is visible in ... toxicophagi.*”^[34]



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Admittedly, von Tschudi never claimed that the regular consumption of small doses of white arsenic would lead to mithraditism. On the contrary he mentions:

“*A healthy but spare and pale dairymaid, ...took arsenic several times a week. ...To heighten still further the effects, she imprudently augmented her dose of arsenic and ... died a painful death from the action of the poison. ... The number of deaths in consequence of taking arsenic in too large or frequent doses is by no mean trifling ...*”^[34]

Certainly, von Tschudi never reported any loss of weight or wasting (cachexy) caused by chronic arsenic poisoning, but his second report^[35] contains hints to chronic poisoning. For example he mentions an arsenic eater who “*is always hoarse,*”^[35] one of the “*symptoms of chronic arsenical poisoning*”,^[45] and writes about another:

“*The reason why he has abstained from arsenic for nearly two years is the death of one of his friends, also an arsenic eater, who died of a dropsy,^[46–48] and who had suffered much. He thought this was owing to the arsenic, and [is] dreading a similar fate ...*”^[35]

Owing to such inconsistencies in von Tschudi’s reports^[34,35] it is understandable that they were the subject of great debate.^[6,36,49–61] While von Bibra,^[6] Johnston,^[36] and Husband^[49,50] recognized von Tschudi’s assertions as undisputable facts, Kesteven considered them “*strong stuff*”^[62] and writes, referring to Taylor,^[59] Christison,^[60] and Pereira:^[61] “*the story of the Styrian arsenic eaters is not only unsupported by adequate testimony, but is inconsistent, improbable, and utterly incredible*”,^[58] which he justifies by the following arguments:

- 1) “*The evidence upon which the statements have been made, is simply the loosest kind of second-hand hearsay evidence.*”^[58]
- 2) “*No chemical examinations of the excretions of those alleged to be taking arsenic have been made; neither has any necroscopic examination or chemical analysis been made ... of those who have died after having indulged in arsenic eating.*”^[58]
- 3) “*No analysis of the substance ... eaten as arsenic has been attempted, ...*”^[58]
- 4) “*The testimony of any person who has not for a series of years himself observed these pretended arsenic eaters, must be declined when adduced as evidence.*”^[58]

3. Verification of the Legend

The fact that von Tschudi’s article^[34] and the publications referring to it are really based on pure hearsay is evidenced by his testimony, made under oath (according to § 275 of the Austrian Code of Criminal Procedure from 1850),^[63] when he served as an expert witness during the “*Poisoning Trial in Wiener Neustadt*”^[64–67] in 1852:

“*His experiences are based on communications obtained from the apothecary Sch. from Aspang and from clergymen concerning the confessions which they obtained on the death-bed.^[68,69] He himself had never seen anyone eating arsenic, also he himself never saw the arsenic injected by the alleged arsenic eaters and never asked to see it.*”^[66]

By virtue of the sensation caused by von Tschudi's articles, the provincial *Medizinalrat* of Styria, Julius Edler von Vest, asked, in the mid-1850s, the physicians of the duchy for reports concerning the consumption of white arsenic within the population. The content of the 17 accounts received are summarized by Schäfer^[70,71] and Knapp,^[72–74] extensively quoted by Roscoe,^[75] and also cited in other publications.^[76–78] Independent of this official inquiry, Heisch describes further cases of arsenic eaters.^[21]

In 1857^[70] Schäfer first detected arsenic in the urine of an alleged arsenic eater and repeated the test in 1860 with the urine of a test subject (Johann Wölfler, 30 years),^[70,73] who had ingested $4\frac{1}{2}$ grains^[7,8] of white arsenic in the presence of the physician Dr. Knapp.^[70,71,73] Admittedly, “the traces of arsenic found in the urine were not in accord with its ingestion.”^[70] Furthermore, he observed on a horse that “a considerable amount of the poison was eliminated through the digestive tract.”^[70]

The Bunsen student^[80] Sir Henry Enfield Roscoe gave a lecture^[75] on the arsenic eaters, in which he cites 15 cases of attested consumption of white arsenic. However, one should emphasize that in four cases poisoning effects were observed, which resulted in death in one case.^[75]

Also Roscoe's analysis of the consumed “*Hüttenrauch*” is not really conclusive. He had received this 99.97% pure sample^[75] third-hand by mediation of his Heidelberg classmate Leopold von Pebal (from “Professor Gottlieb of Grätz”),^[75] who in turn had obtained it from *k.k. Bezirksvorsteher* Heufenstein from Knittelfeld (Styria) together with the following certificate translated by Roscoe.

“*This Hdrach*^[81] was delivered to me by a peasant woman from Mittenlobing^[82] whose name I am unacquainted with. She saw her farm-labourer secretly eat it, and gave it to me in order that the bad habit might be stopped.”^[75]

In view of the obscure origin of the sample and the numerous cases of poisoning cited by Roscoe it appears incomprehensible how he could interpret the quoted facts as: “...evidence ... which not only satisfied me, but everyone who took the trouble to go into the question, that the peasants in Styria are able to swallow with impunity four times the amount of what is usually a fatal dose of white arsenic.”^[80]

These quotations demonstrate that some of Kesteven's objections^[56–58] could be addressed. However, entirely absent are the required necroscopic examinations^[58] and long-term observations^[58] of arsenic eaters. A summary of the counter-arguments for the existence of arsenic eaters in *The British and Foreign Medico-Chirurgical Review* from 1862,^[45] comes to the conclusion:

“*If any of the believers in arsenic eating will take the doses which they endeavour to make us believe are taken ..., then will we abide by the results. Until then, we conceive that we are justified in doubting their marvels.*”^[45]

The Edinburghian physician Craig Maclagan did not take white arsenic himself. However, during a journey to Italy, which led him through Styria in the spring 1864, he and the physician Dr. Knapp^[72,73] from Ligist administered 5 and 6 grains^[7,8] of white arsenic to two arsenic eaters (Mathias Schober, 26 years, and Joseph Flecker, 46 years), and subsequently detected arsenic in their urine.^[83] During the

following days the two subjects were observed by Dr. Knapp, who reported about this to Maclagan:

“*Mat. Scholer continued perfectly well, ... Flecker, during the same day, continued perfectly well, but applied the drink-money (as our expression is) too literally, so that he during two days was unwell, but the appearances were only those of an immoderate enjoyment of alcohol, ..., as our medicinal-rath Von Vest, was convinced when he visited me some days after your departure. Since that time I have often had these arsenicophagi with me, Scholer took before me, on the 16th April at midday, seven and a-half grains^[7,8] of arsenious acid, without the slightest visible influence on his feelings, ...*”^[84]

This episode demonstrates impressively the carelessness, frequently observed in the description of “arsenic eaters”. Schober^[83]/Scholer^[84] as well as Flecker were, according to their own testimony, accustomed to taking commercial orpiment,^[83] which is an artificial mineral containing a mixture of As_2S_3 and As_2O_3 with varying composition. As the sulfide is practically nontoxic,^[85] a quantitative analysis of the ingested orpiment would be indispensable for the evaluation of its toxicity. However, Maclagan simply communicates that “the yellow substance which Schober used ... contains, ... a considerable portion of free arsenious acid.”^[83]

Although Knapp declares in his letter to Maclagan that “the medical klinik in Gratz will, during eight days, observe such an arsenic eater”,^[84] one finds no publication on this subject nor about his planned “anatomical investigation on one who has indulged in the habit during years.”^[84]

Instead, during a lecture in 1875, which appropriately was held in the refectory of the University of Graz, he again presented Joseph Flecker as well as another test subject (P.H., 25 years), who ingested 0.30 g (ca. 4 Austrian grains) of orpiment and 0.40 g (ca. $5\frac{1}{2}$ Austrian grains) of white arsenic, respectively.^[73] The following day the two subjects were “presented to the conference in absolute well-being.”^[86] Three days later Prof. Hoffmann (Graz) demonstrated “three arsenic mirrors obtained from the urine of the presented arsenic eaters.”^[87] This presentation,^[73,88] which more closely resembled a circus act than a scientific demonstration, reinforced the legend of the “Styrian toxicophagi” in such a manner that it is still mentioned in current textbooks and reference books,^[89–91] popular-science publications,^[30,31,92–96] and even scientific journals.^[11,13,97]

4. The Core of the Legend

The most recent direct description of the Styrian arsenic eaters is likely that published by Knapp and co-workers.^[74] In this paper from 1885 they describe test subjects to whom were, after a clinical examination, administered between 0.020 and 0.200 g (0.3–2.7 Austrian grains) of white arsenic or “sulphured arsenic.” Remarkably Joseph Flecker was again among the test subjects. This was the man who had already been described by Maclagan^[83,84] and by whom together with P.H. “at the conference of the natural scientists in Graz ... the gentlemen naturalists were a little intensely astonished, as the two ... in front of their eyes consumed the spicy poison with pleasure.”^[98] Thus in addition to Johann Wölfler, for whom

Knapp attested the consumption of white arsenic in 1860^[70,73] and 1875,^[73] Flecker was the only arsenic eater observed by a medical doctor over an extended period. Here one should emphasize that Flecker in contradiction to the legend did not increase the dose but decreased it from 5–6 grains^[7,8] in 1864^[83,84] to 0.30 g (4.1 Austrian grains) in 1875,^[73] and finally to 0.140 g (1.9 Austrian grains) in 1885.^[74]

The newspaper and journal articles about the Styrian arsenic eaters inspired copycats, as shown by two reports from Canada.^[99,100] For example, Parker^[99] publishes in 1864 the observations he had made two years earlier on a patient, who, inspired by one of these articles, began to consume white arsenic and died after four years of daily consumption with the typical symptoms of arsenical cachexy.^[101] Although Parker^[99] could not give exact specifications about the consumed dose of white arsenic he estimated it be to 2–3 grains per day.^[7,8]

On the other hand, the Québécois toxicologist LaRue^[100] described in 1866 an arsenic eater, who maintained that he had taken white arsenic for 12 years. In the presence of LaRue he took 1½ and 4 grains^[7,8] of pure white arsenic, without showing any poisoning effects during an observation period of 3 and 20 h, respectively.

In summary one can list the following facts, secured by observation, about arsenic eaters.

- 1) The actual amounts consumed in front of witnesses are, with few exceptions (7.5,^[84] 10,^[17] and 14^[73] grains), in the range from 0.3^[76] to 6.0^[70,71,73] grains.^[7,8]
- 2) Beside solid white arsenic, the more readily available^[73] commercial orpiment, also in the solid state, was consumed.^[74]
- 3) Poisoning effects,^[34,75,79,99] and even death,^[34,75,99] were observed even after alleged habituation.

5. Strong Poison! How Strong Is It?

The literature about the Styrian arsenic eaters assumes that 1^[5] to 2^[101] grains^[7,8] represents a lethal dose. This is also consistent with data in more recent publications, which cite the lethal dose for humans as 0.105 g,^[11] 0.07–0.18 g,^[13] and 0.130–0.250 g,^[94] which corresponds to approximately 1.0–4.1 grains.^[7,8] On the other hand, Schneider maintained that “the lowest dose of solid white arsenic, which was followed after 6 days by death [amounts] to 30 grains”^[7,8,19] and that he “had seen that physicians had used daily on patients, suffering from malaria, up to two grains for a period of 3 days without any apparent negative effects.”^[19] Even doses up to 9 grains were administered during the treatment of “some kind of epidemic fever”.^[102] Hahnemann,^[102] nowadays better known for administering very low doses, reported further that:

“... healthy persons 3 to 10 years old have consumed ½ to 1 grain,^[7,8] 10 to 20 years old, 1⅛ to 2 grains,^[7,8] 20 to 30 years old, at most 3 grains,^[7,8] and more than 30 years old, at most 4 grains^[7,8] of white arsenic dissolved in solid food (rarely as powder). They recovered from this for the most part by themselves, without any special assistance ...”^[102]

The U.S. Department of Health and Human Services^[103] indicates for human beings lethal doses in the range of 22–

121 mg kg⁻¹. This value corresponds to the LD₅₀ values for rats and mice of 15–141 and 26–39 mg kg⁻¹, respectively.^[103] If one assumes an average Styrian arsenic eater with a calculated mean weight of 70.5 kg,^[74] the lethal dose of solid white arsenic is estimated to be 1.058–9.941 g or 14.5–136.4 Austrian grains. This completely debunks the myth of the toxicophagi, since the quantities they consumed in front of witnesses are not four or more times^[5,80] more than the lethal dose but significantly lower.

Still, it is wrong to think that the quoted lethal doses of white arsenic in the range of 0.07–0.25 g^[11,13,95] are incorrect. Already in 1862 Husemann and Husemann^[104] ascertained that “with regard to the dose of arsenious acid one had to distinguish whether it was ingested in the solid form or in solution” and indicated as the lowest “dosis letalis” for solid white arsenic as 30 grains^[7,8] and for dissolved white arsenic 2–4 grains;^[7,8] these values are also quoted by Witthaus and Becker.^[105] So one sees that the alleged immunity (mithraditism) of the Styrian arsenic eaters is based on the false assumption that solid and dissolved white arsenic would show the same toxic effect, and is therefore nothing more than the result of “pretzel logic”.^[106]

Also the particle size plays a role, as is shown by Schwartz’s^[107] studies conducted on rats, rabbits, chickens, and cats, which revealed that the toxic effect of the solution was more than 400 times greater than that of particles between 2.5–5 mm.^[107,108] He concluded:

“It is also more than probable that the impunity with which apparently large doses of undissolved arsenious oxide have been administered per os is to be attributed to the administration of the oxide in form of relatively coarse and insoluble particles.”^[107]

6. Let the Experiment Decide

The synopsis of the original reports concerning the Styrian arsenic eaters and the contemporary scientific literature confirms that:

“The utmost that can be admitted is the possibility of the human system coming by long-continued use to endure the administration of doses of arsenic so small as to be within the limits of poisoning.”^[45]

An explanation of how the outrageous fable of the toxicophagi could be spread for one and a half centuries, although it could have been dispelled as far back as the 1860s,^[45,58,104] can be touched only in a few points.

An important stimulus for the dissemination of the fable of the toxicophagi was its cordial reception by defense attorneys. For example, only four months after the publication of his article^[34] von Tschudi was appointed by the defense as an expert witness in a poisoning trial.^[64–67] With regard to this lawsuit von Tschudi said, according to Boner, that “the conclusion arrived at was, almost beyond the possibility of doubt, that the man suspected to have been poisoned was a poison eater.”^[40] It might be consistent with this statement that the prosecutor in his final speech establishes that “there is no sensible reason to consider the unfortunate Joseph E. ... to be an arsenic eater”.^[67] But then, von Tschudi’s assertion

should have been appeared at least in the defense's speech and the court's opinion, which was not the case.^[67]

In Heisch's report^[21] one also finds this discrepancy between the exaggerated description of the influence of the toxicophagi legend in criminal trials and its real appreciation. For example, he writes with regard to Anna Alexander, accused in Cilli^[22–28] that “*the systematic arsenic eating in the district was pleaded so successfully in her favour, that she was acquitted.*”^[21,109] Actually, the suspicion that the victim Wurzel was a poison eater was reduced to the fact, “*that [Lieutenant Istenitsch] had once seen in the office, in which Wurzel ... had written, a small box with ... little spheres, which he conjectures to be white arsenic*”^[26] and is not even mentioned in the closing arguments.^[27,28]

Although as in these two cases the “Styrian defense”^[13,29–32] usually had no influence on the final verdict,^[32] the repeated and exaggerated description of the toxicophagi as an exculpatory argument in criminal trials aroused the impression among the general public that it was a proven scientific fact.

A further point that contributed to the survival of the legend is the way in which it was criticized. Przygoda et al.^[13] remarked correctly: “*Merely to deny the phenomenon of the Styrian arsenic eaters on the grounds of ‘common sense’ is not scientifically tenable.*”^[13] But exactly this was the procedure used by the critics^[45,56–61,101] of this legend.

For example, Taylor and Rees write in a footnote to Pereira's *Materia Medica*:^[61] “*the so called ‘undisputed facts’ regarding the benefit derived from arsenic eating have been rejected by all authorities of repute.*”^[61] Christison also attached great importance to the doctrine; he maintains: “*all medical men, experienced in the use of arsenic as remedy, will treat the story of the Styrian arsenic eater as a pure fable.*”^[60]

Furthermore the critics denied that the “eaten” substance would be white arsenic or ascertained that “*the quantity here alleged to have been taken is so large as to lead to the suspicion of jugglery.*”^[45] However, these objections were refuted by MacLagan's reports^[83,84] and Knapp's demonstration in the refectory of the University of Graz.^[73] Therefore, in contradiction, one perceived the conventional doctrine as falsified and assumed the legend to be true.

This shows that at that time the fable of the toxicophagi owed its acceptance and dissemination to at least two factors. On one side, the “believers” totally ignored the inconsistency of their alleged facts; on the other hand, the “critics” refused any objective discussion and simply denied the ingestion of white arsenic. From the point of view of true science one would have had to assume that even the prevailing doctrine was nothing more than provisional knowledge. Thus the alleged mithraditism, as a possible refutation of the doctrine, should have been taken seriously and should have undergone appropriate experimental investigation, instead of it being denied only because it was in contradiction to conventional knowledge.^[110]

7. Without Chronic Effects?

Here one should remark that the exact mechanism of the toxicity and carcinogenicity of white arsenic is not known,^[103] although its hazardous nature was already recognized in prehistoric times.^[10,111] One assumes that arsenite ions coordinate to (vicinal) thiol groups.^[103,112–114] This occurs, for example, by the formation of stable ring structures between arsenite and vicinal dithiols in keratin.^[114] The binding of arsenite to functional thiol groups leads to modification or inhibition of the enzyme activity and thus explains its toxicity.^[112–116] Due to the numerous thiol groups in enzymes, receptors, and co-enzymes, the toxic effect of white arsenic is extremely unspecific, so that during acute poisoning in addition to gastrointestinal symptoms,^[112,113,115] urological,^[115] cardiological,^[112,115] neurological,^[113,116] hematological,^[114] hepatological,^[112] pulmonological,^[112,113] nephrological, and dermatological^[113] symptoms may appear and multiple organ failure finally leads to death.^[112]

According to Doyle,^[97] arsenic acts as a vasodilator. The resulting dilation of the blood vessels together with water retention^[97] give the “arsenic eaters” a flushed^[97] “*fresh healthy aspect, and a certain degree of obesity*”^[34] and explains further the increased sexual power of male arsenic eaters, mentioned by Knapp^[73,74] and MacLagan.^[83] A hypothetical^[117] explanation of the “*facilitate[d] respiration in ascending mountains*”^[34] might be an arsenic-induced epigenetic modification of carboanhydrases, whose inhibition is supposed to accelerate acclimatization to higher altitudes.^[118] The antibiotic properties of arsenic compounds are well established, at least since Ehrlich's drug Salvarsan,^[113,119] so that the alleged protection of arsenic eaters against infectious diseases^[21,70,73–75] is plausible.

Due to the nonspecific interaction of the arsenite ion with the protein structure, one also observes a wide range of arsenic-induced chronic diseases, including developmental disorders, mutations, diabetes, and numerous types of cancer.^[112,114,120,121] These chronic syndromes, summarized under the generic term arsenicosis,^[121] are observed in populations whose drinking water has high levels of arsenic. Chakraborti et al.^[122] enumerate 20 cases of communities with endemic arsenicosis worldwide that are due to contaminated ground water, principally in the East Asiatic region (India, Bangladesh, China etc.) as well as in other regions such as Northern Argentina.^[122,125–127]

Although the results gained by these studies cannot be applied directly to the consumption of solid white arsenic or orpiment over many years, they demonstrate that the symptoms of arsenicosis appear insidiously^[124] and in different forms and that even within the same family not all members show clinical symptoms.^[121]

Regular arsenic eating is comparable to the use of traditional Asian remedies,^[128–142] which are often applied over years^[128,133,134,140] and even decades.^[132] The arsenic minerals orpiment (As_2S_3), realgar (As_4S_4), and arsenolite (As_2O_3) are widely used in such remedies and the ingested amounts may vary between 0.140^[130] and 84.3 mg^[142] of arsenic per day. In most publications only the total amount of arsenic is determined without considering the different

biological activities of orpiment ($LD_{50} = 6.4 \text{ g kg}^{-1}$),^[141] realgar ($LD_{50} = 3.2 \text{ g kg}^{-1}$),^[135,141] and arsenolite ($LD_{50} = 15\text{--}121 \text{ mg kg}^{-1}$).^[103] One may assume a bioaccessibility of arsenic of 3–100% and 0–76%, according to the studies of Koch et al.^[137] and Giacomino et al.,^[142] respectively.

Here it should be noted that the latency time between the consumption of arsenic-containing drugs and the appearance of chronic complaints may be up to 50 years.^[133] Therefore, the allegation that the Styrian arsenic eaters would be safe from chronic consequences^[13,34] of their consumption of white arsenic is untenable, even though Knapp's long-term subjects, Joseph Flecker^[73,74,83,84] and Johann Wölfler,^[70,71,73] did not show chronic poisoning effects after consuming white arsenic for more than 30^[74] and 27^[73] years, respectively, and in spite of the fact that von Tschudi had immunized prophylactically, ascertaining ad hoc *"that the symptoms of chronic arsenical poisoning never appear in those who know how to apportion the dose, sometimes very considerable, of the poison, to their constitution and tolerance"*;^[34] however, he did not reveal how the dose should be determined.

That habitual arsenic eaters did indeed suffer from chronic diseases was already observed in the 19th century, for example, by Parker,^[99] who described a patient who died from arsenical cachexy. Also Schäfer noted *"dry and rough, scaly skin and striking shrinkage of the entire subcutaneous tissue"*^[79] of a female arsenic eater, whose lower leg had to be amputated due to gangrene.^[79] As already mentioned, von Tschudi,^[35] as well as Heisch,^[21] Schäfer,^[70] and popular depictions^[44,98] hint at the occurrence of incurable diseases as a consequence of habitual arsenic eating. Therefore, one may absolutely agree with the conclusion drawn by Peter Rossegger, well-known for his exact description, based on personal experience, of the habits of the Styrian peasants and craftsmen in the second half of the 19th century:

"In the end arsenic eating is nothing more than a vestige of the devil's medieval elixir of health. 'One drank it, became young and, after some time, was fetched by the devil.'"^[98]

8. Ne bis in idem (Not Twice for the Same Thing)

The attentive reader of detective novels certainly wonders about the significance of the report of "The Trial of Florence Maybrick",^[1] studied by Lord Peter Wimsey in addition to Housman's poem,^[3] Dixon's Toxicology,^[8] and one of the innumerable German volumes^[5,9,15–20,47,98,102] that mention "toxicophagi". Was the trial report meaningful for the solution of the criminal case. The answer is: No!

Certainly, poisoning by white arsenic was also the subject of the Maybrick trial, but in contrast to Ms. Vane's case the sentence pronounced versus Mrs. Maybrick was: *"... that you be there hanged by the neck until you are dead; ..., and may the Lord have mercy on your soul."*^[143]

Admittedly, this case shows an interesting parallel to the legend of the Styrian toxicophagi. Although, it was proven that the prisoner had administered white arsenic to her spouse (in the same way that it was confirmed that the toxicophagi indeed ate white arsenic), only *"one-twentieth part of a fatal dose of arsenic"*^[144] could be detected in the corpse (and in

analogy the amount of solid white arsenic taken by the toxicophagi was also well below the lethal dose).

Therefore, the reason to commute her sentence to penal servitude for life was: *"although the evidence leads clearly to the conclusion that the prisoner administered and attempted to administer arsenic with intent to murder, yet it does not wholly exclude a reasonable doubt whether his (James Maybrick's) death was in fact caused by the administration of arsenic."*^[144]

However, we find exactly these circumstances in Sayers's novel. As proven, solid white arsenic was administered to the victim insidiously and with a base motive. However, the amount actually ingested was below the lethal dose.^[19,103–105] In other words, the convicted murderer executed his intent to murder but there are reasonable doubts whether his action really killed the victim. Sayers could have been aware, at the date of the publication of the novel, of the different toxicities of solid and dissolved white arsenic.^[103–105,145] In this case, however, the reference to the Maybrick case would not be a meaningless detail, but an expression of choicest irony.

Unlike in the real Maybrick case, Sayers's fictitious forensic pathologists were able to confirm that the murder victim *"[had taken about three days before the death] a large and fatal dose of arsenic—four or five grains, perhaps."*^[1] However, such a dose would be lethal only if the victim had ingested it in solution. This throws suspicion back on Harriett Vane, who had offered the victim, three days before his death, *"a cup of coffee which was standing ready upon the gas-ring"*.^[1] In this cup, she could have dissolved (easily) up to 5 g^[149] (79 grains) of white arsenic. Due to the fact that Sayers, by mentioning the Maybrick case, revives a reasonable suspicion against Harriett Vane, she raises doubts whether the *"complete conviction of [the] absolute"*,^[1] which is aimed and pronounced in the novel, is generally possible. With this, she holds up a mirror, not only to criminal justice, but also to science, which in the novel was used to clarify the execution of the murder.

With foresight, Sayers let *"one of the most sensational murder trials of the century"*^[1] conclude with the jury's verdict *"Not Guilty, my Lord."*^[1] Therefore, due to the Latin legal concept *"ne bis in idem"* (not twice in the same [thing]), it is, despite the newly aroused suspicion, impossible to question the *"absolute innocence"*^[1] of Harriett, who would be nowadays the still-sprightly, 114-year-old^[150] Dowager Duchess of Denver.^[151]

Acknowledgements

First of all I thank all the busy hands, which one sometimes may admire personally, and which through working on digitalizing the folios preserved for generations on the shelves of the libraries, make it possible for one to enjoy, even without a *"black-and-primrose library, ... the world's accumulated hoard of mellow wisdom and poetical beauty"*. I particularly thank Bernard Ornezeder, University Library, Vienna, for immediately providing Ref. [74]. Furthermore, I thank one of the reviewers for bringing to my attention Ref. [92b]. Most notably, I thank Father Michael Andreas Leja, Episcopal Ordinariate Mainz, for his helpful explanations and hints

concerning the Seal of the Confessional and the Last Rites. Furthermore, I thank Prof. Klaus Roth, Free University Berlin, for sending a copy of his article “Chemie im Kriminalroman” (*Chem. Unserer Zeit*, **1992**, 26, 76–85), which partly inspired me to write the present essay. I also thank all who have inspired me to reflect on whether Sayers’s *Strong Poison* may describe a perfect murder method.

How to cite: *Angew. Chem. Int. Ed.* **2015**, 54, 15622–15631
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- [62] The German original uses the phrase “*starker Tobak*” as a colloquial expression for an exaggerated assertion, which ones perceives as unreasonable, and which might be translated as “strong stuff” or “a bit thick” (*Langenscheidts Handwörterbuch Englisch*, Langenscheidt, Berlin, **1992**, p. 1345).
- [63] J. von Würth, *Die österreichische Strafprozeßordnung vom 17. Jänner 1850*, Braumüller, Wien, **1851**, p. 449.
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- [65] Anonymus, *Allg. Österr. Gerichts-Z.* **1852**, 3, 170–172.
- [66] Anonymus, *Allg. Österr. Gerichts-Z.* **1852**, 3, 178–180.
- [67] Anonymus, *Allg. Österr. Gerichts-Z.* **1852**, 3, 182–184.
- [68] In the Roman Catholic Church persons on their deathbed are usually administered the Viaticum (cann. 921, § 1) and the Anointing of the Sick (cann. 1004, § 1). Here one should consider, that “*a person who is conscious of grave sin is not to celebrate Mass or receive the body of the Lord without previous sacramental confession*” (cann. 916). However, if for the Styrian peasants of the 19th century eating arsenic was considered a sin,^[42] the sacrament of confession, a rite that did not have a defined beginning and no defined ending, was a prerequisite to receive the Viaticum. Therefore all the information given to the priest was covered by the Seal of the Confessional. Indeed the Seal of the Confessional would not be violated, if in reporting the sin, the priest does not indicate either directly or indirectly the penitent, so that his identification would be impossible. “*However, one should ... in general abstain from such narrations ... because frequent and repeated such narrations may arouse the danger that the penitent would be really suspected.*” (Ref. [69], p. 731) Furthermore, it would be a violation if the clergyman “*says, this or that vice is rampant in a town or in a village ... if the place is very limited, p.e. if it has not casually three thousand inhabitants.*” (Ref. [69], p. 732) Under these circumstances it seems more than doubtful whether von Tschudi, by the means he had given, could had obtained any useful and conclusive statement about arsenic eating.
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- [81] Remark in the text: “‘Hidrach’ is the corruption of the word ‘Hütten-rauch’, the name arsenious acid is generally known by in mining districts in Germany.”
- [82] A municipality named Mittenlobbing does not exist. However, near Knittelfeld (5 km) is the village Großlobming, which nowadays includes the villages Kleinlobming and Mitterlobming. (<http://de.wikipedia.org/wiki/Großlobming>).
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- [103] U.S. Department of Health and Human Services (Ed.), *Toxicological Profile for Arsenic*, Agency for Toxic Substances and Disease Registry, Atlanta, **2007** (<http://www.atsdr.cdc.gov/toxprofiles/tp2.pdf>, access in February 2015).
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- [106] The German original uses here the expression “*Milchmädchenrechnung*”, which characterizes “a simple-minded reasoning” (*Langenscheidts Handwörterbuch Englisch*, Langenscheidt, Berlin, 1992, p. 1165); an appropriate English expression is “pretzel logic”, which means a “logic that is idiosyncratic or based upon faulty or devious reasoning” (http://nws.merriam-webster.com/pendictionary/newword_display_alpha.php?letter=Pr&last=100; access in July 2015).
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- [109] As Heisch explicitly asks:^[21] “*Can any official report be obtained of the trials of the two people mentioned ...?*”, he demonstrates that even for him the information about the mentioned trials, which he had received third-hand, were apparently insufficient to confirm the existence of toxicophagi.
- [110] Another inappropriate strategy of the “critics” was, instead of refuting mithraditism by careful experimental examination, explaining it as, for example Taylor in Ref. [59], by “*some national idiosyncrasy among the Styrians which render them proof against ... arsenic under certain circumstances*”, and thus immunizing the doctrine by an ad hoc auxiliary hypothesis.
- [111] According to Ref. [10] the earliest bronze around 3500 B.C. contained about 2% of arsenic. In Europe and the Middle East, within a relative short period of 300–400 years, arsenic was nearly completely replaced by tin even though the mechanical properties of arsenic bronzes and tin bronzes are very similar and the arsenic bronzes possess the advantage of being workable over a wider temperature range. Furthermore, the tin ores had to be imported over a greater distance. Interestingly, the Indo-European religions represent their gods of metal-working and forge (Hephaestus or Vulcan of the Greek–Roman mythology, Wayland of the Germanic and Norse mythology, and Ilmarinen of the Finnish mythology) as lame, which might be taken as a hint to the observation of polyneuropathy caused by chronic arsenic poisoning among the Bronze Age metal workers.
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- [125] For the sake of completeness, one should mention that during completion of this article, Schlebusch et al. published a paper^[126] in June 2015 in which they describe the evolutionary adaptation of the indigenous population (Atacameños) in San Antonio de Los Cobres in Northern Argentina upon arsenic contamination. This ethnic group was presumably exposed to higher amounts of arsenic in their drinking water for the last 7000 to 11 000 years, and possesses, in comparison with other native inhabitants living in less contaminated areas, a modified arsenic metabolism. However, these results cannot be transferred to the Styrian arsenic eaters. According to Köbler,^[127] Styria was already populated in the Palaeolithic (100 000–50 000 BC); however, there were several population movements starting with the the immigration of the Taurisci (Noric) in the 1st millennium B.C. and continuing with the Roman conquest (15 B.C. to 45 A.D.), the passage of various Germanic tribes during the Barbarian Invasions (4th–6th centuries), and the settlement by the Slovenes, who currently make up the majority in Lower Styria (*slovenska Štajerska*). The German colonization only started with the Bavarian occupation in 772 and was completed in Upper, Western, and Eastern Styria in the 13th century. Therefore, an evolutionary adaptation of the Styrians to the consumption of white arsenic can entirely be excluded.
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- [145] For example, she could have consulted Ref. [105] or Ref. [107] in Oxford’s *Bodleiana*.
- [146] The reference to the Maybrick case, which has no parallels with the trial described in Sayers’s novel and which also does not mention the Styrian toxicophagi, makes no sense, unless it is

meant as a hidden hint to the significance described below. One would have expected a reference to the Madeleine Smith case^[144] instead. The Styrian toxicophagi^[148] are mentioned in this trial and the case may have also inspired Sayers.

- [147] A. F. Irvine, *Report of the Trial of Madeleine Smith*, T. & T. Clark, Edinburgh, **1857**.
- [148] Anonymus, *Lancet* **1857**, 2, 255–256.
- [149] Assuming a volume of 250 mL and a solubility of 2.05 g of white arsenic in 100 mL of water (*Handbook of Chemistry and Physics*, 91st ed., CRC, Boca Raton **2010**, pp. 4–49).
- [150] At the time of the novel (1930) her age is given to 29 years.
- [151] Dorothy Sayers did not publish any further novels with her heroes following *Busman's Honeymoon*, published in 1937,

which describes the wedding and honeymoon of Harriet and Lord Peter. However, after 1998 a couple of novels authored by J. P. Walsh were published which revive Lord Peter and Lady Harriet. In their course Peter's brother, the Duke of Denver, dies and therefore, as his son and heir to the title was already killed in action as pilot of the Royal Air Force, the dukedom falls to Peter Death Bredon Wimsey, D.S.O., M.A., born in 1890, as the 17th Duke of Denver.

Received: June 19, 2015

Published online: September 9, 2015