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TRANSFORMING SUBSTANCE

GENDER IN MATERIAL SCIENCES – AN ANTHOLOGY

Transforming Substance:
Gender in Material Sciences – An Anthology
Edited by Helen Götschel

Crossroads of Knowledge
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Sciences, humanities and the 'scientific unconscious': Gender-related images in alchemy and chemistry

Introduction

The development of ancient, medieval and early modern alchemy into modern chemistry was a slow and continuous process that was completed between the sixteenth and the late eighteenth century. Whereas chemistry, in the current science system, appears to be a discipline for whose epistemology gender is of rather little importance, alchemy – as the spiritual and technical 'precursor' of chemistry – was full of gender-related images: astonishing hermaphrodites and copulating couples were not the only preferred figures in the illuminations, technical alchemical devices and nomenclatures were sexualised too.

This article discusses a paradox: the development of an apparently non-gendered science (chemistry) out of a very highly gendered knowledge (alchemy). Such a reflection is only possible with the historiographic method of "longue durée", a study of long-term historical structures which was firstly proposed by the French Annales School, and which today is considered as one of the methods of cultural history. I work with relevant literature concerning the history of alchemy, which is partly concerned with the subject matter of gender (cf. Patai, 1994; Szász, 1997; Warlick, 1998; Moran, 2005; Cislo, 2010; Frietsch, 2013).

It seems to me that the sacrifice of blatantly gender-related im-

ages was one of the prerequisites and concomitants for transforming alchemy into modern chemistry. In changing the images, names and characters, and in getting rid of spiritual contents, alchemy lost not only its Arabic article "al", but also its representations of scientific creativity as fertility. This process was completed, as we will see, in the nineteenth century. For the modern chemist of the nineteenth century the alchemical setting was a past, somehow humanities-like knowledge, an anecdote to be brought out on jubilee days, but with the rather important function of supporting the chemist's own scientific reputation as a creative mastermind.

In my contribution, I will first, rather briefly, describe some features of the alchemical tradition and then provide a more detailed analysis of the function of the alchemical heritage represented in the well-known Ouroboros story by Friedrich August Kekulé von Stradonitz (1829-1896). This story has already been well explored in research, with the sole exception of the special function of an *alchemical* symbol in the plot. An analysis of this aspect, however, shows that the gendered knowledge of the past can assume new functions and so emerge again – even in modern sciences.

Gender-related images in ancient, medieval and early modern alchemy: some aspects

The history of alchemy knew female as well as male adepts. A certain Cleopatra of the first or second century AD appears, but only legendarily. Better shown in books is Mary, the Jewess, also called Mary the Copt or Mary prophetissa (Patai, 1994: 60-91). Zosimus from Panopolis, the first verified alchemical author, who lived in the third or fourth century AD, attributed some alchemical aphorisms and technical drawings to both. His texts are edited historically and critically by Michèle Mertens in the Greek original with French translation (Zosime, 2002; for selective English

translations, see: Patai, 1994). They contain instructions for the manufacture of ovens and distilling devices, as well as descriptions of techniques such as the double boiler, the oil bath, the wax bath, and the sand bath. Cleopatra and Mary are named as inventors of the art of distillation and of corresponding devices, which were central techniques for the practice of alchemy. The double boiler or "bain-marie", in Latin "balneum mariae", is named in many modern European languages after Mary, the Jewess.

In early Alexandrian alchemy the alchemical work was planned as a unification of the sexes: the production of new substances was compared to the ripening of the child in the womb. This view was handed down from the Hellenistic-Jewish to the Arab tradition, and is, for example, documented in the Arab book *Turba philosophorum* of the ninth century AD, where it was attributed to the older Ionian and Hellene philosophers.

The Alexandrian alchemical tradition knew only technical illustrations and illustrations of some particular symbols, such as the Ouroboros, an ancient Egyptian snake symbol in the form of a circle, which appeared in alchemical manuscripts in the first or second century AD as a symbol of the "prima materia", the first matter or matter of paradise (they are handed down to us in later manuscripts, cf. Figure 1). The Ouroboros can be generally considered as a symbol for unity. In a more concrete sense, it represented alchemical practices, such as the circular movement of the distilling process.

The erotic and sexual statements of Alexandrian alchemy, however, were illustrated neither in this nor in the later Arabic tradition: figures of alchemical "coitus", of "coniunctio" or "wedding" exist only in European books, which connected technical drawings with erotic decoration or represented alchemical work as common housework of men and women (cf. Warlick, 1998: 25-47), since the end of the fourteenth century.



Figure 1: Ouroboros, Ms. Grec. 2327, Paris, Bibliothèque Nationale, fourteenth century (cf. Priesner and Figala, 1998: 353).

Alchemical terminology shows an enacted fusion of the spiritual and the material, which was connected with the will of creation. The alchemists used their characters with magical intent, that is, in the hope of disabling the difference between words and things (cf. Foucault, 2002: 19-50). The alchemical practice of attributing things (as the desired "stone") as "philosophical" has to be considered an ambiguous professionalizing practice, alluding to and distinct from allegedly unprofessional or unlearned practices, such as female concerns. The terms "philosophical menstruum", "menstruum universalis" or "our menstruum", for instance, were used to denote solvents. Until the time when acids became producible, there

were a lot of different substances that were used as solvents, such as water from wells, distilled water, wine, tartar, spirits, urine, vinegar, ammonium carbonate, and vitriol. Substances such as pulverized metals were soaked in them prior to being distilled. "Prima materia" was manufactured in this way. According to the scientific opinion of those days, foetuses were nurtured by menstrual blood. The "menstruum universalis" should nurture, similarly, the "philosopher's stone". When alchemists called it "philosophical Menstruum" or "our menstruum", they appropriated female fertility as creativity; at the same time they demonstrated the technical reproducibility of "natural" processes (cf. Frietsch, 2013).

In the fifteenth century however, the al/chemical business of the distillation of spirits was often carried out by women of the middle class (cf. Moran, 2005). The frontispiece wood engraving of the first edited book on distilled waters, *Nützliche Materi von mancherley ausgeprannten Wassern*, written in 1476 by Michael Puff von Schrick, the Viennese university professor, affirms that the production of spirits was a typical female profession of this time (cf. Priesner and Figala, 1998: 301). Women practiced this trade in guilds in Germany until the late seventeenth century (cf. Szász, 1997: 90). From the fifteenth to the eighteenth century there were also noblewomen who practised alchemy.

In early modern times alchemy was significantly advanced by the international alchemical and theosophical movement of the Paracelsians who referred to Theophrastus Bombastus von Hohenheim, the Swiss physician and alchemist, also known as Paracelsus (1493/94-1541). I select this movement of the sixteenth and early seventeenth centuries for my short account because Paracelsus and the Paracelsians proved to be obsessed with generativity, even if they looked for a generativity that they could practise without the participation of women.

In the concepts of the Paracelsians, generativity was connected to the Fall of Man: before the Fall, generativity should not have existed at all. The exclusion of women – and thereby of heterosexuality – from their own community, which was, among other methods, realised by dissociating themselves from alleged witchcraft, was therefore also used as a manoeuvre to enable an approach to Genesis as to the state before the Fall (cf. Frietsch, 2013). Women's exclusion was regarded as professional, articulated, for example, by judging the alchemical practices of adversaries as the old women's art of cooking (Paracelsus, 1996, vol. 10: 93). It was said in Paracelsian texts[1] that menstruating women would spoil spirits, wine, beer, mead, vinegar, and milk (ibid., vol. 11: 315, 328): hence they spoiled the philosophical menstruum. These statements implied that women were incapable of all professions that handled the corresponding substances and, therefore, especially of alchemy and medicine.

The Paracelsians of the sixteenth century were followers of the hippocratic-galenian doctrine of the two seeds. According to this, women generated a fertile seed similar to men. The matrix additionally attracted the seeds, whereby fertilization took place. Man and woman each possessed half a seed (ibid., vol. 1: 255-261). Generation of all things was likewise caused by one seed and one element. Seed and element, as well as seed and womb, were not differentiated clearly, although it was often mentioned that the seed was *in* an element. The order of priority of the traditional four elements and the three Paracelsian principles, sulphur, quicksilver and salt, remained contradictory (cf. for example: ibid., vol. 3: 32-35, 41; vol. 13: 134-136). The elements were often described as

1 A good English translation of some of the Paracelsian books has existed since 2008 (Paracelsus, 2008); it is not consulted here because of its incompleteness. I describe all the (Pseudo-) Paracelsian texts which are usually attributed to the alleged author Paracelsus as "Paracelsian".

mothers, who contain and receive the three principles as seeds (for further research on this topic, see: Cislo, 2010; Frietsch, 2013). In later Paracelsian texts, especially by the Paracelsian and German professor of medicine Daniel Sennert (1572-1637), these seeds were interpreted as atoms (cf. Newman, 2006).

These were some examples of gender-related images in the old alchemical tradition. In the following we will have a closer look at their reappearance in apparently non-gendered modern chemistry.

New notation systems and animistic allusions

Modern chemistry is represented by a new notation system that had its breakthrough in the nineteenth century. The preconditions for the establishment of this system were the measuring of weights and a general sense of quantification. In the terms of Thomas Kuhn, it was the old alchemical "hope for a sense-datum language" (Kuhn, 1974: 467), which was abandoned in chemistry in the eighteenth and nineteenth centuries: Instead of the claim of an *immediate* connection between symbolical terms and nature, which was represented by singular alchemical or magic signs and characters, a common writing system and general attribution rules were sought, for example, by Pierre Joseph Macquer (1718-1784), the French chemist, and by Torbern Olof Bergman (1735-1784), the Swedish chemist and mineralogist. The modernisation of chemical language was driven by the Swedish chemist Jöns Jakob Berzelius (1779-1848) and the British chemist John Dalton (1766-1844) who established the first relatively coherent and simple sign system of the chemical language (cf. Morris, 2003). These modern signs alluded no longer to the symbolic qualities of matter, to planets or to special devices. They were no longer animal or animistic, but formulas to represent molecular structures.

Nevertheless, there were certain preserved links between al-

chemy and chemistry in the eighteenth and nineteenth centuries. Johann Wolfgang von Goethe (1749-1832), the German author, built such a link. He himself was sincerely involved with alchemical experimental processes, before turning alchemy more poetically into literature. It is well known that he practised alchemy together with his relative Susanne von Klettenberg (1723-1774). Remembering these experiences, he was later capable of spiritualizing alchemy in some of his works, amongst them his well-known drama *Faust*, for which the personality and writings of Paracelsus served as a pattern. In Goethe's novel *Elective Affinities* (1809) again, the traditional *alchemical technique* of an analogy between substances and human beings is used to create a literary plot: We encounter four human protagonists, two men and two women; two of them form a married couple, while the two others are free. The male part of the couple shows an inclination to separate and to combine with the free female. To seduce his wife to combine with the free male, he makes allusion to the model of affinity, where the partners also change their bonds, following the *chemical* forces of attraction.

Kekulé and the benzene formula: a case study

In the nineteenth century, when modern chemistry was established, the alchemical figures of the past were still used in belles lettres (as well as in the new esotericism): They could however also be used to popularize the new abstract knowledge in rather chemical comments. I will now give an example in greater detail.

In 1882 Hermann Franz Moritz Kopp (1817-1892), the German chemist, in his text *Aus der Molecular-Welt*, used some alchemical topoi from Johann Wolfgang von Goethe's novel *Elective Affinities*, to communicate new results of chemistry. Kopp compared atoms and molecules with creatures, especially with monkeys and human beings, and their compounds with sexual intercourse. (I

will come back to his parallels later.) These comparisons, which were meant to be funny and illustrative, inspired his colleague, Friedrich August Kekulé von Stradonitz (1829-1896), the German chemist, who is well known for his determining of the structure of benzene, to tell a famous story about this discovery.

Kekulé's dream

Kekulé published his discovery of benzene's circular structure on 27 January 1865, in the *Bulletin de la Société Chimique de Paris*. According to Kekulé, benzene was a six-membered hydrogen-carbon compound with three double bonds. The six carbon atoms weren't combined in a line, as thought, but as a ring (Kekulé, 1865: 98-111). The theoretical chemist's discovery contributed to the possibility of industrial mass production of this basic substance of chemical products (Wurster 1996: 79-93). It initiated an upturn of the dyeing industry. 15 years after his publication, in March 1890, Kekulé gave a lecture at a ceremony of the *Deutsche Chemische Gesellschaft*, held in his honour in the Berlin town hall. In the course of his lecture, Kekulé addressed only his male colleagues directly (Schultz, 1890: 1303). At that time women were not allowed to study chemistry in the German Empire. Nevertheless there were women, as well as representatives of the chemical industry in his audience (ibid.: 1266). Kekulé didn't neglect the supposed taste of this heterogeneous audience. That is why he communicated the results of his research in an entertaining easy-going manner, which he borrowed from Kopp as well as Goethe.

In his lecture, Kekulé explained that a dream had inspired him to create the scientific idea of his benzene formula (cf. ibid.: 1265-1312). He made an implicit allusion to the alchemical symbol of the Ouroboros in comparing the benzene molecule with the figure of a "Schlange" (German word for queue and snake). Kekulé thus

used one of the old Alexandrian animal symbols of alchemy, but he used it in a rather implicit way.

Kekulé showed modesty. He said that the benzene theory had not appeared like a meteor in the heavens; he had studied the history of chemistry as an amateur, and knew that the development of chemistry was continuous. All the earlier theories would have been integrated into the later construction, and his own opinions would have grown from the views of his predecessors as well. Looking at it that way, there was no absolute novelty in his discovery. However, he did not deny his own ingenuity. Kekulé quoted the view that the "genius" would think in leaps and recognize "truth" without knowing the evidence for it (ibid.: 1304-1305). He wanted to discover by "highly indiscreet announcements" of his "mental life" that he found some of his arguments dreaming rather than awake (ibid.: 1306).

The chemist gave a quite complex explanation for the genesis of his scientific discovery. His obsessive investigation about the manner in which atoms combine with each other, his studies about the history of science, and his over-fatigue combined together in a waking dream which resulted in a hypothesis. Kekulé gave a vivid account of this event in visualising two concrete situations for his audience: firstly a London bus trip and secondly a nap on a chair next to a fireplace in Ghent. He remembered his time as a private assistant in London, 1854-1855. After a long talk about chemistry with a friend he had taken the bus. While travelling through the streets of London he fell into a reverie:

> [...] and the atoms fluttered before my eyes. Whenever, hitherto, these diminutive beings had appeared to me, they had always been in motion; but up to that time I had never been able to discern the nature of their motion. Now, however, I saw how, frequently, two smaller atoms united to form

> a pair; how a larger one embraced two smaller ones; how still larger ones kept hold of three or even four of the smaller; whilst the whole kept whirling in a round dance. I saw how the larger ones formed a row, dragging the smaller ones after them, but only at the ends of the chain. I saw what the old master Kopp, my highly honoured teacher and friend, has depicted with such *charm* in his 'Molecularwelt'; *but I saw it long before him*. The cry of the conductor: 'Clapham road' awakened me from my dreaming; but I spent a part of the night in putting on paper at least sketches of these dream forms. This was the origin of the structure theory.' (ibid.: 1306, emphasis added.)[2]

According to Kekulé's statements, the structure theory was generated by means of sketches of dreamt shapes, written at night after friendly specialist talk and lived through during a trip on the open upper deck of a bus. Kekulé named the atoms "beings" and underlined that he always saw them in motion. What he first saw in his London dream, according to his portrayal, was the manner (or the structure) of their compound: They combined in whirling pairs or chains, depending on their size.

Kopp's *Molecular-Welt* and the priority of discovery

Kekulé thereby outlined *en passant* that he saw atoms in this way long before his colleague and former teacher Hermann Kopp, the German chemist and historian of chemistry. Kopp had described atoms in his aforementioned publication *Aus der Molecular-Welt* of more than 100 pages as little beings in an aerarium who connected with each other; he illustrated the connections as hands (Kopp, 1882). The chemist varied this pattern by calling the atoms monkeys (ibid.: 6), girls (ibid.: 7), or little ladies (ibid.: 43), and their compound political (ibid.: 39) or sexual intercourse (ibid.: 15) of

2 The English translation of Kekulé's two dreams is quoted after Rothenberg (1993: 291-295).

male and female (ibid.: 93) as well as a "struggle for existence" (ibid.: 102). Kopp's description alluded in multiple ways to prostitution and polygamy. He wrote this essay in 1876 and published it after the manuscript, firstly in 1882, to give it as a birthday present to his friend Robert Wilhelm Bunsen (ibid.: III-VIII). The author explicated his wish to be generally understood (ibid.: 16) and oriented himself on the language superiority of the humanities (ibid.: 75). He bowed to Goethe's *Elective Affinities* (ibid.: 52). In this way, Kopp popularized some of the results of the research on atomic compounds that he himself, Kekulé, and some other chemists had achieved in the nineteenth century.

If Kekulé in 1890 had wanted to mark the priority of his discovery, the mention of "old master Kopp" was nevertheless misleading. Kopp's essay could have been an example for him in respect of its affable style. In a *scientific* respect, he could have named another colleague, Archibald Scott Couper (1831-1892). This Scottish chemist postulated in the 1850s the chain and quadrivalence of carbon, as Kekulé did (cf. Wotiz, 1993). Kekulé did not name him in his lecture.

However, Kekulé's lecture and statements should not have been totally surprising to his colleagues. Kekulé had already taken his position for speculative research "also in the so-called exact sciences" in a lecture in 1878, on the occasion of accepting the vice-chancellor's office of the Rhenish Friedrich-Wilhelm-University in Bonn (Kekulé, 1878: 27), where he had worked as a professor since 1867. The nature of matter would be beyond any direct study and should therefore be revealed in the way of hypotheses, he articulated at that time. The hypotheses should then be developed logically, with calculations, and be compared with the observable facts (ibid.: 26-27). Adolph Wilhelm Hermann Kolbe (1818-1884), the chemist whose abusive (nationalistic, for example) objections

against mysticism, empty formulas, thoughtless hypotheses, and unscientific doodles were feared by chemists, accused Kekulé consequently of a lack of logic (Kolbe, 1878: 139). What Kekulé was proposing would not be "exact research about nature", but "a gross monster of philosophy of nature" (ibid.: 140) and a "chemical dream" (ibid.: 151). In describing so vividly his reverie, Kekulé turned this branding into a characteristic virtue.

He continued his Berlin lecture without a break and took his audience for the second narrative from the streets of London to a dark workroom in the town of Ghent at night. He had taken his first chair as a tenured professor for inorganic and organic chemistry at the Belgian State University in 1858. At this time he wanted to have another waking dream. Kekulé remembered:

> It was similar with the benzene theory. During my stay in Ghent in Belgium I lived in elegant bachelor quarters on the main street. My workroom was along a narrow side street and was without light during the daytime. […] I sat there writing my textbook, but it was not going well […]. I turned the chair to the fireplace and sank into half-sleep. Again the atoms played before my eyes. […] My mental eye, sharpened as a result of repeated visions of a similar kind, now discerned larger structures of manifold formation. Long rows, often put together more closely; everything in motion, winding and turning like snakes. And behold: what was this? One of the snakes seized its own tale, and the entire structure swirled mockingly before my eyes. As if in a flash of lightning I awoke; this time, too, I spent the rest of the night working out the implications of the hypothesis.
>
> Let us learn to dream, gentlemen; then we shall perhaps find the truth [...]. But let us be on guard against publishing our dreams before they have been examined by waking reason. (Schultz, 1890: 1306-1307; cf. Rothenberg, 1993: 291-295)

According to this the chemist sank half-asleep at his desk, working on his *Lehrbuch* (Kekulé, 1859-1887). He dreamt a "hypothesis" the "consequences" of which he later worked into the benzene theory: the atoms moved themselves in queues or chains. One of these connected with itself and produced a circle.

Kekulé's dream was definitely motivated by the daily action of his work. His textbook had an explorative and not only recapitulating character: in it he wanted to systematize the organic chemistry of his time. He thereby rested explicitly on the theory of types of Charles Gerhardt (1816-1856), the French chemist, who deduced organic compounds from inorganic basic types, and he additionally interpreted types as atomy combinations of compounds. With his staff, he experimented with the aim of exploration. He was thereby especially interested in benzene, isolated by Michael Faraday (1791-1867), the English physicist and chemist, in 1825. Benzene seemed to contradict his theories. According to Kekulé's opinion, the benzene molecule possessed six carbon atoms that were under all circumstances quadrivalent, and six constantly monovalent hydrogen atoms. If this was true, it could not build a stable chain, because it seemed to lack eight hydrogen atoms for being saturated. But it nevertheless rarely entered into addition reactions. To him it appeared as totally incomprehensible that it had only one and not three derivatives in substitution reactions (Wizinger-Aust, 1966: 16). The dream figure showed the solution: the open line or chain closed itself into a ring. The carbon atom combined with the hydrogen atom as well as with itself. Benzene, therefore, obviously had only one derivative. No matter to which carbon atom the substituent was attached, the same entity always resulted (ibid.: 17).

Loschmidt's circular representation of benzene

It is undisputed in research that Kekulé saw benzene as a ring in 1861-1862. It is however doubtful where he saw it in this shape. When Kekulé experimented with benzene and, according to his statements, started to dream in 1861, the monograph *Chemische Studien* by Joseph Loschmidt (1821-1895), the Austrian physicist and chemist, was published. In this book benzene is represented as a circle. Kekulé knew this. However he judged the representations in a disparaging letter as "Confusion's" – instead of constitution's – "formula" in 1862 (Noe and Bader, 1993: 223, 240). In his publication of 1865, which is considered the official document of the discovery of the benzene ring, he mentioned the name Loschmidt only in a footnote, and distinguished himself anew generally from his representations.

Structurally considered, a ring is nothing other than a circle. Loschmidt's circle symbol for the benzene molecule must have impressed Kekulé, therefore, in the same manner that he claimed for the dream figure of his snake/queue and ring. Gillis, the Belgian science historian, therefore supposes an influence on Kekulé's "subconscious" (Gillis, 1966: 42). Kekulé himself never articulated it. The de-naming of Loschmidt's performance by Kekulé is criticized in research today (Noe and Bader, 1993: 221-245).[3]

The Ouroboros

The narrative of the discovery of the benzene ring was further developed after the celebration of the *Deutsche Chemische Gesellschaft*. Richard Anschütz, Kekulé's longstanding employee and

3 Disputes on priority with regard to *other* colleagues appear instead to be rather unclear. They were controversially discussed in Wotiz (1993). The objections of nationalism and general scientific misbehaviour, which were articulated in the central contribution against Kekulé (cf. Wotiz and Rudofsky, 1993: 247-275), however, seem rather excessive and unfair.

later biographer, for example, took the view that a finger-ring with the shape of an Ouroboros inspired Kekulé to adopt the ring symbol for this carbon compound. Anschütz told the following story. In 1847, the high school student Kekulé had observed a fire in the neighbouring building during which a countess met her death. In 1850, legal proceedings were conducted. Not only was Kekulé, a student of chemistry, now heard as a witness, but Justus von Liebig (1803-1873), the German chemist and later professor of Kekulé, was also consulted as an expert. This was in order to clarify whether the death of the countess was a result of "human self-combustion", as popular belief and some physicists thought. Liebig denied this. The guilty person was found by chemical expertise: a suspect servant of the countess had tried to sell a ring that had allegedly been in the possession of his family since 1805. The count, however, insisted that this ring had been in the possession of his wife since 1823. The ring consisted of a snake of gold and a snake of platinum. With that information, the servant was convicted, because platinum could only have been obtained sufficiently pure form to be made into jewellery since 1819. He had robbed and murdered the countess (Anschütz, 1929: 18).

These proceedings must have impressed Kekulé. Anschütz comments that they made the later work of Kekulé's "creative fantasy" "unconsciously" easier (ibid.). In the nineteenth century, however, many editions of alchemical texts were published which show the image of the Alexandrian symbol, which consists only of one snake (cf. Figure 1). Kekulé, who called himself an amateur of the history of chemistry, must have seen this symbol of the (pre-) history of his discipline multiple times. He probably intended his audience to identify the queue of his dream as an Ouroboros. Qualified as mocking, it had to be understood as an animal symbol and not as a bare queue shape. In only alluding to the alchemical

symbol instead of naming it, Kekulé invited psychological interpretations of his ring as an allegedly eternal and, therefore, ingenious symbol. In the face of this supposedly surprising recognition, the work of Kekulé's colleagues would be totally forgotten and the discovery entirely identified with his name (for this argument, cf. Wotiz and Rudolfsky, 1993).

Monkeys and ballets

In fact there were rather recent proofs which could persuade Kekulé, that alchemical snake-dreams were socially acceptable for a chemist's anecdotes: In 1886, four years before Kekulé's lecture, an anonymous satire based on his models had been organized on the occasion of a beer evening of the *Deutsche Chemische Gesellschaft* in the context of the fifty-ninth meeting of the *Gesellschaft Deutscher Naturforscher und Ärzte* in Berlin. The members received an imitation of their journal titled "Reports of the thirsty chemical society", which contained, among other things, caricatures of the carbon compound and the benzene ring as monkeys, which linked themselves by paws and tails, depending on the alternating single and double bonds (cf. Figure 2). This idea of the young chemist Otto Nikolaus Witt was certainly prompted by Kopp's essay *Molecular-Welt* (1882).

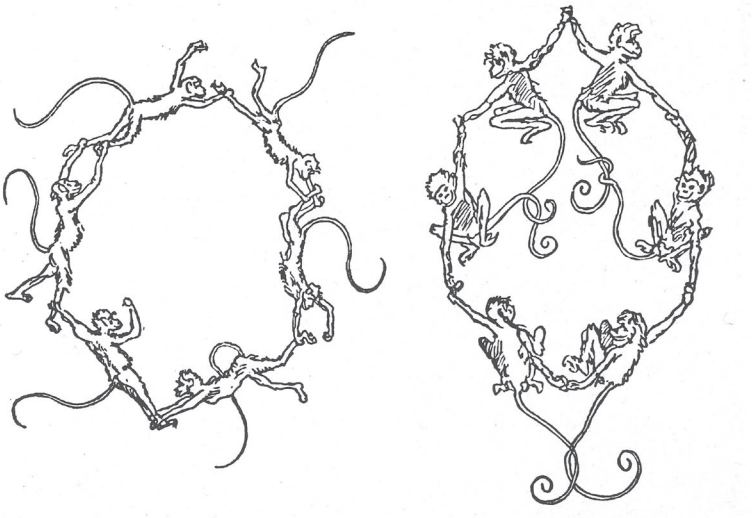

Figure 2: Satirical representations of the carbon compound and the benzene ring (Witt, 1886: 3536).

At the sixty-first meeting of the *Deutsche Naturforscher und Ärzte* in Cologne in 1888, and two years before Kekulé's lecture, this 'translation' was driven only a bit further and became 'charming' anew (just as in Goethe's times or in Kopp's essay). Under the chairmanship of the chemist August Wilhelm Hofmann, an atom-ballet appeared "in which individual ladies as representatives of the chemical symbols illustrated in appropriate clothes the different positions of the compounds" (Anonymous, 1888: 1296). The ballet dancers appeared as benzene, among others. Which clothes and postures were appropriate for it has not come down to us.

Unconscious inhibitions and easy solutions

The conception of benzene as a ring seems to be an "easy solution" for chemists of our days (Wizinger-Aust, 1966: 20). For Kekulé and

the chemists of his time, however, it was not at all evident. The circle was the symbol for the indivisible, and thus the atom. Wizinger-Aust explains that an "unconscious inhibition of thinking" therefore had firstly to be outgrown in order to symbolize chemical compounds as a ring (ibid.). This applies perhaps as much to Kekulé's scientific community as to himself.

Kekulé's work as a theorist consisted primarily in clarifying chemical terminology. He was fundamentally involved in the differentiation of an atom as a chemically indivisible entity from a molecule as a compound of atoms (Kekulé, 1878). To use a circle or a ring to represent the constitution of the benzene molecule, therefore, must have been spontaneously abhorrent to his chemical perception.

Kekulé's model, however, enabled him to elaborate new formulas for a number of organic substances. His colleagues analogized his achievement with the substitution of the hieroglyphs (the old theory of types) by the Greek alphabet (Rimbach, 1904: 15). Kekulé had hence initiated a change in paradigm with the dimensions of a new chemical writing system.

Conclusion: The 'scientific unconscious' of the modern scientist

In his well-known *Foreword* to the English and German edition of *The Order of Things*, published first in 1970/71, Michel Foucault created the non-individualized concept of a "positive" – that is to say: a non-repressed – "unconscious of knowledge: a level that eludes the consciousness of the scientist and yet is part of scientific discourse" (Foucault, 2002: xi-xii). It's true that Kekulé's dream makes its contribution to a scientific discourse, but nevertheless it is an open question whether his dream exemplifies this *positively*

unconscious order.[4] According to Kekulé, his discovery was motivated by inspirations, dreams, hypotheses, speculations, and a "right" or "scientific seeing" (cf. Kekulé, 1929: 929). Gillis spokes of Kekulé's "subconscious" (Gillis, 1966: 42), Anschütz thought that Kekulé's "creative fantasy" was "unconsciously" supported (Anschütz 1929: 18), and Wizinger-Aust believed that an "unconscious inhibition" had to be overcome (Wizinger-Aust, 1966: 20). Current research, however, judges Kekulé's dream rather *negatively*, in proposing that it was either motivated by his ambition to push similar ideas by his colleagues Couper and Loschwitz out of memory (cf. Wotiz and Rudolfsky, 1993), or that it was a marketing strategy to popularise his own discovery by using some of the 'charming' patterns already created by the scientific community (cf. Schiemenz, 1993), by Kopp, Witt, and the Chemical Celebration of 1888. According to them there was no subconscious or unconscious of the researcher's performance, but an active will to repress or to appropriate the achievements of his colleagues.

In reflecting on all these positions, I come to the conclusion that 1) the function of the alchemical symbol as pattern or running joke in Kekulé's community as well as 2) the competition between the sciences and humanities were crucial components in the famous dream story. The joke intensified the sense of community and so the cohesion around the new invention. The competition with the humanities in turn was a topos in the reflections of natural scientists at that time: As Kopp did, Kekulé also mentioned this competition several times, using lectures on his pedagogical ideas as a platform to discuss it (cf. Kekulé, 1878; Kekulé, 1929: 919-921, 929-934). At the end of the nineteenth century, the well-

4 Foucault coined the concept of an "unconscious of knowledge" without reference to this case, as a more general term for the social generation of knowledge. In the research on Kekulé this concept is not discussed.

established subjects of the humanities had a greater reputation than a new discipline like chemistry. To allude to the humanities' learned knowledge – as to Goethe's novel – thus was a good strategy to both underline the importance of his own work and communicate new scientific models. Alchemy, with its animal – and, for purposes of 'charming', sexualised – symbols, functioned as a bridge between the scientist and a wider, rather humanities-oriented public, which ensured the chemist's fame.

The humanities were the place where gender-related images could still flourish as inner or serious parts of the disciplines; in a science like chemistry, on the other hand, their use seemed instead to be decorative. This situation hasn't really changed up to now. It's however true, that humanities – as for example history of knowledge and cultural theory – have the capacity to analyse and to deconstruct these gender-related images by historical research, whereas sciences simply use them in a manner which is more discreet and silent than trivial.

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