

A REVERIE KEKULÉ AND HIS DREAM: AN INTERVIEW

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Editor's Note: A folded typescript of this interview on A4 paper was found in a copy of *The Kekulé Riddle*, which the editor of this manuscript purchased several years ago from a bookseller at abebooks.com. The interviewer (A²) has not been identified beyond information on the bookplate, which features an alembic and the symbol "A²" as the book owner. In addition to the typescript, there was also a single folded sheet of the same size paper with a handwritten letter, which is reproduced in the Postscript. —RER

Interviewer's Note: *Friedrich August Kekule von Stradonitz (1829-1896) was Professor of Chemistry at the University of Ghent from 1858 to 1867. From there he moved to the University of Bonn, where he remained for the rest of his life. He is best known for the hexagonal ring structure of benzene and for his other early contributions to structural organic chemistry. The following interview took place in a small parlor off the lobby of the Hotel Ouroboros at Berlin's Schlangeplatz on 11 March 1990, the 100th anniversary of the Benzolfest. The only restriction imposed by Kekulé was that no photographic or audio recording equipment could be used during the interview. Instead, a stenographer was present and provided a verbatim transcript from which this manuscript was prepared. Both of us spoke in English, and we sipped some well-aged Cognac as we conversed by the fireside.*

Interviewer (A²): Professor Kekulé, first let me express my appreciation to you for agreeing to this interview. I know you have been upset by the controversy that has arisen about your famous—some would say *infamous*—dream of the snake biting its own tail, but until now you have remained silent. Thus, all of us in the scientific community look forward to hearing what you have to say in response.

August Kekulé (AK): I thank you and the esteemed editor of this learned journal for the opportunity to express my views. I can tell you that I agreed to this interview because I could no longer tolerate all the nonsense and ridiculous *Halbwahrheiten* that have been bandied about concerning my dream and my remarks at the *Benzolfest* here in Berlin so many years ago.

A²: One hundred years ago today, to be exact.

AK: Yes. I wish that I could say that it seems like only yesterday, but it does not.

A²: With your permission, Professor Kekulé, I'll begin by summarizing the recent controversy about your dream and your speech at the *Benzolfest*.

AK: No, I do not care to dignify my critics and their silly pronouncements by refuting them point by point. Though I easily could. Instead, I wish to make known my views about science and the creative process. Most especially about my own creative process as it pertains to science.

A²: However you wish to proceed.

AK: Let me begin with the facts. That is indeed where science begins. But that is hardly where it ends. You know, it is not only the naive and gullible public that misunderstands science and thinks that the only currency we scientists deal in is facts. Even though nothing could be further from the truth, many scientists themselves also labor under this same illusion. According to this mistaken view, we scientists do not even need to think, let alone to dream. Instead, we march into the laboratory and single-mindedly gather facts.

A²: But you certainly wouldn't deny that scientists do need to gather facts?

AK: Of course not. Facts, facts, and more facts. They are an essential part of science, but at the same time they are perhaps the least interesting part of science.

A²: I'm sure that everyone would agree about their importance, Professor Kekulé, but what do you mean by "the least interesting"?

AK: Let me explain. What are facts? My friend Ernst Mach would say that a fact is a description of some immutable pattern in time and space. Something that all rational people can agree on. For instance, the sun rises each morning and sets each evening. Who could disagree? Man has observed such phenomena through time and space for eons.

A²: So you're suggesting that our familiarity with such facts makes them uninteresting?

AK: Not at all. Let me ask you this. Does the sun, in fact, rise each morning? There is no question that we see the same phenomenon every day. But to say that the sun "rises" means that we see it move relative to us, to the earth. It means that we have adopted a geocentric point of view. But in fact, we know that this diurnal movement of the sun is only apparent and actually results from the rotation of the earth on its axis. So even such a simple "fact" as the rising sun must be interpreted by the theory within which it is evoked.

A²: But isn't the "rising" of the sun merely an instance of our everyday language?

AK: Certainly, but I would not say "merely." After all, our everyday language has grown out of certain beliefs. In this case, out of the earlier belief that the earth is at the center of the universe. That particular theory was discarded centuries ago, but it lives on in our everyday language.

A²: But you're not saying that facts are whatever beliefs we happen to accept at the time.

AK: Of course not. Facts cannot be whatever we might want them to be. But neither does science consist only of objective facts within a vacuum. Facts provide us with evidence for our hypotheses, and they must be accounted for by our theories. There is a certain circularity between fact and theory.

A²: Ah, there's an appropriate figure of speech for you.

AK: But, as you know, facts do not produce theories by themselves. The human mind does that.

A²: So you're saying that science results from the interplay between facts and the human mind.

AK: Broadly speaking, yes. That was certainly the case with me, but I am hardly unique in this regard. Science has always arisen from this interplay ever since there has been scientific observation and thinking. The first instance we know of is in the 6th century B.C., when Thales developed his theory that water represents the ultimate reality of the material universe. Of course, some people today point to this as an indication of the misdirection of Ancient Greek science. I point to it as an indication of the interplay of facts—the ubiquity and importance of water—with the human mind.

A²: And you would claim this to be a hallmark of science ever since.

AK: Consider some examples. Copernicus and his heliocentric universe. Newton and his inverse square law. Lavoisier and his oxygen. Dalton and his atom. Mendeleev and his periodic table. Watson and Crick and their double helix. And may I be so bold as to add myself to this most impressive list, Kekulé and his benzene ring.

A²: These are truly some of the greatest achievements of science.

AK: And you will notice that each of them is a creation of the human mind, consistent *with* the known facts and also predictive of new facts, but none of them consists *only* of facts. The inverse square law, the benzene ring, the double helix, these things do not exist in the world as scientific entities for us to behold and examine like a flower growing in the field or the sun rising in the morning.

A²: I find it curious, Professor Kekulé, that you include the DNA double helix since that discovery occurred half a century after your death.

AK: I do not know Watson and Crick—they are both still alive, of course—but this is an episode about which I do have some personal knowledge.

A²: You do?

AK: No doubt you have read *The Double Helix*, Watson's striking account of his and Crick's discovery of the helical structure of DNA. This story particularly interests me because it bears certain similarities to my own discovery of the ring structure of benzene. In the case of DNA there were essentially two groups of investigators looking for the structure. I purposely omit Linus Pauling as he is irrelevant to my point.

A²: Maurice Wilkins and Rosalind Franklin at King's College London, as well as Watson and Crick at the Cavendish in Cambridge.

AK: Exactly. And I hope you are aware that Miss Franklin was a most excellent scientific worker. I have had many fascinating discussions with her about x-ray diffraction, in which she was an expert. This technique did not exist in my day of course, but it is interesting that Wilhelm Röntgen discovered x-rays at Würzburg shortly before my death. In fact, his first public lecture on x-rays was in January 1896, only a few months before I died.

A²: But Rosalind Franklin was born nearly a quarter century after that.

AK: She was, but we all try to pass the time pleasantly in eternity with interesting discussions. It is possible to tolerate only so much shuffleboard and bridge.

A²: That sounds like a topic for another time.

AK: Miss Franklin is a lovely woman, and I can tell you that Watson's unflattering portrait of her in his memoir is very inaccurate, very biased, very shallow. He tried to get himself off the hook with that pathetic apology at the end of the book, but it fails utterly.

A²: So there were two groups looking for the DNA structure.

AK: Yes, a lovely girl, and first-rate in the laboratory. But . . . what I mean to say is . . . she and Wilkins both lacked a certain creativity . . . the imaginative impulse, even playfulness, which Watson and Crick possessed to an extraordinary degree. In some way, Miss Franklin seemed to expect the DNA structure to leap out at her from the x-ray data that she accumulated.

A²: So you're saying that facts are not enough.

AK: I am saying that they are definitely not. They were not enough for Miss Franklin. They were not enough for Watson and Crick. What were Watson and Crick doing at the Cavendish? That is, besides terrorizing Bragg and the rest of the old guard waiting to retire. I believe that I am not breaking any confidences if I tell you that Bragg still complains about Crick and his booming voice. Poor Bragg, he fears the day when Crick . . .

A²: You asked what Watson and Crick were doing at the Cavendish.

AK: Exactly. Watson knew nothing about x-ray diffraction. He knew no structural chemistry, as he himself admits. No, no, as he himself *brags*. It is your 20th-century custom of running yourself down, so that when you succeed, everyone finds your success all the more amazing. And should you not succeed. Well, then you have already explained the reason for your failure.

A²: One thing Watson and Crick were doing was building models.

AK: Yes, they were doing that, but more importantly they were daydreaming. They were thinking of other things. Crick of foreign films, Watson of Cambridge popsies, as he termed them. These were the surface events in their lives, but their work on DNA continued unabated underneath.

A²: In the unconscious.

AK: Please. Do not get me started with that kind of terminology. Sigmund Freud is an excellent bridge partner, but we do not discuss science even though he still mistakenly regards himself as a man of science.

A²: You were saying, under all the surface events of their lives.

AK: And the answer eventually came to the surface through the models they constructed. After Watson had been wrong more than once, he had that flash of insight—prepared for by a structural chemist, I might add, in addition to his own daydreaming—in which he saw the pairing of the bases and the way they fit together between the sugar-phosphate chains. There was his true creative genius.

A²: In seeing the relationships.

AK: Exactly. The facts were essential, but rather uninteresting. They were there to be seen by anyone. Various distances extracted from the x-ray patterns. The amount of water present in the sample. The structure had to be consistent with them, of course. But what those

facts implied was of paramount importance, not the facts themselves. So it was with me and benzene as well.

A²: The problem simmering under the surface.

AK: I was engaged in many activities on the surface—my laboratory work, my teaching. I was writing my *Lehrbuch*. I was courting my Stephanie.

A²: Your *Lehrbuch der organischen Chemie*.

AK: But underneath those surface events there was always benzene. That clear, odorous liquid from the London gas lines. The great Michael Faraday himself sent me a sample, which I kept in a glass vial on my mantelpiece.

A²: Where you could see it every day.

AK: Where it plagued me every day. Especially as I worked in my rooms in the evening. Whenever I looked up, there it was, hiding its structure like the unseen skeleton of a skyscraper under its outer skin. Many chemists thought that the molecule had a linear diallene structure, but how could that be? The known facts about benzene did not fit such a structure.

A²: Such as the equivalence of all six hydrogens.

AK: That particular evening I was having some trouble making progress on my *Lehrbuch*. What it was, I do not remember anymore. I poured myself some brandy. I lit myself a cigar. And I sat in front of the dying fire and stared at the benzene. Simple. It *had* to be simple.

A²: I need to ask you, Professor Kekulé, whether you actually dozed off or were merely daydreaming? The German word you used was *Halbschlaf*. Literally, that means “half-sleep” in English, but the exact translation isn’t clear.

AK: No translation is ever exact. However, your inexact meaning of the German word is sufficiently correct to describe the state I was in. My landlady had prepared a most excellent meal for me. I had a good cigar and a little too much brandy. A very comfortable armchair. The warmth of the fire. The fingers of leaping flame played on my imagination. I passed into that state between sleeping and waking, and it was there that I saw the snake grasp its own tail in its mouth.

A²: Did you make the connection of this snake to the ring structure of benzene as soon as you woke up?

AK: Even before. The flash of insight occurred to me as I saw the snake whirl before my eyes. But I would tell everyone, including my critics, so they understand,

that I also knew this to be my fancy, my reverie, while in the *Halbschlaf*. The comparison—or analogy—of two things does not make them the same thing. My fancy was not science. The science of chemistry does not permit the theory of whirling snakes. [*laughs*]

A²: How then did the snake in your dream, in your reverie, become science?

AK: It is extremely important to distinguish between science as it is done and science as it exists. The former is the creative impulse of the individual scientist, and it must be unique to each scientist, just as each individual is unique in his own thoughts and ideas and knowledge and way of doing things. But the simple addition of all these individual contributions is not science. If they were, science would be as muddled as sociology or—God forbid—Freudian psychiatry.

A²: Luckily, not many social scientists are likely to read this interview.

AK: In fact, we can appeal to a famous social scientist—the economist Adam Smith—for a way of seeing how these contributions do become science. Science as it exists—as a structure that is always *becoming*—consists of the essences of those individual contributions, stripped of the idiosyncrasies that accompanied or even enabled their discovery.

A²: The economist Adam Smith?

AK: The unseen hand that directs and coordinates all these contributions as no individual or group of individuals could. The free market of ideas where the fruitful contributions survive and the barren ones perish.

A²: Are you suggesting that an “unseen hand” transformed your snake into the benzene ring?

AK: Of course not. I did that myself. I saw the analogy even before I awoke. But then when I did awake, I quickly realized the scientific consequence of the snake biting its own tail. Joining the linear molecule’s terminal carbon atoms together eliminated the problem of the two extra valences. They simply vanished. With that realization, I wondered how I did not see it before. How Couper, Loschmidt, all of them did not see it before.

A²: So you actively transformed the snake into a carbon ring structure.

AK: I actively transformed my reverie into a scientific description devoid of fancy, a description that could compete on its own merit in that free market of scientific ideas. And other scientists determined my idea to be

sound. Once I dressed my idea up in suitable scientific garb, it mattered nothing to science that the idea had originated from a whirling snake. Though it has obviously mattered to some scientists of your time.

A²: You're suggesting that your critics have a fundamental misunderstanding of how science operates.

AK: I know they have when they say that science consists only of going into the laboratory and gathering facts. Facts by themselves have little or no meaning. Their meaning arises only in connection with some hypothesis or theory from the human mind. The illustrious Sir Francis Bacon himself collected hundreds of facts about heat, but they never progressed beyond "natural history," as he termed his work, because he had no theory to recast all those facts into something more than just individual bits and pieces.

A²: We've covered a lot of ground, Professor Kekulé, from Thales to DNA, then to the benzene ring, and now to Francis Bacon and heat. We are just about out of time. But before we conclude this interview, is there some final point you'd like to make?

AK: By all means. My critics make one charge that I would like to address directly. They have impugned my honesty by saying that I did not mention my dream of the snake in my speech at the *Benzolfest*, that I added it afterwards in the published account. There is no credible evidence to support such a charge because it is not true. I would add that I believe this whole episode reveals more about my critics than about me though I will leave it to others to make that judgment. The honesty of each scientist in his work and in reporting his work to others is crucial to the success of science as a worldwide enterprise. If scientists do not trust each other in what they say and do, the structure of science will collapse. I know that it has become fashionable toward the end of your century to try to find the feet of clay of every person of stature and accomplishment. It was not so in my time. We respected people then for their great deeds in science or politics or art or whatever field of endeavor in which they excelled, and for that I am glad not to be living in your time. I do not hesitate to place my honor behind what I have said, both publicly and privately, as well as behind the science I have tried to do.

A²: [*stands and shakes Kekulé's hand*] Professor Kekulé, on behalf of all scientists and readers of this journal, I thank you for granting this exclusive interview and for setting the record straight.

AK: [*also stands*] I am extremely grateful for the opportunity to do so. Especially since I am not able to publish on my own anymore.

Postscript

My dear Maura,

In all the years you have been my editor (nearly 25!), I have never been more mystified and disappointed than I was by your recent rejection of my interview with Professor Kekulé. You seem to have 2—perhaps 3—major objections: the topic is too narrow, the 'facts' have already been thoroughly discussed, and this interview brings nothing new to the discussion. I must disagree with each of these.

It is true that the 'facts' about his dream of the snake have been laid out more than once though there is not necessarily agreement on what they actually are. In Professor Kekulé's own words (translated from the German), it appears that his 'dream' was more of a daydream or a reverie in that state between waking and sleeping. (I believe that the technical term for this state is 'hypnagogia'.) He specifically mentions the vision of atoms in his 'mind's eye,' suggesting that he was partly awake, not sleeping. But his harshest critics deny the existence of any (day)dream of a snake seizing its own tail because none of the contemporaneous newspaper accounts of his speech at the *Benzolfest* mentions such a vision, so therefore he must not have mentioned it himself. Such an argument would seem to have little merit. Presumably, none of the newspaper accounts mentioned his waistcoat either; is that omission evidence that he wasn't wearing one?

Thus his critics leap to accuse him of scientific fraud, claiming that he later invented the story of the snake to avoid having to share any credit with earlier scientists who had made vague proposals toward some kind of ring structure for benzene. Professor Kekulé's structure went far beyond those earlier proposals, and yet he graciously admitted in his speech that his views had 'grown out of those of my predecessors and are based on them. There is no such thing as absolute novelty in the matter.' Tellingly, none of those predecessors that he referred to ever disputed his claim of priority to the benzene structure.

At the very least, an exclusive interview with the very individual at the center of this controversy is an incredible coup for the magazine. Nowhere else has Professor Kekulé ever taken on his critics, not directly by arguing point by point, but by doing exactly what he discussed in the interview, i.e., placing the facts within

the context of his own imaginative processes. That is surely the addition of something new to the discussion.

Nor does he stop with the interplay of facts and imagination in the case of his discovery of the benzene ring structure. He expands his ideas to the discovery of the DNA helical structure and discusses the x-ray data of Rosalind Franklin (whom he knows in the hereafter) in connection with the model building of Watson and Crick. Her x-ray data was critical to revealing the helical structure, but would it have ever been enough by itself? Not without some kind of imaginative leap, just the sort of leap that Watson and Crick made. Thus, Professor Kekulé broadly considers the interaction of facts and creativity, providing insight into his own attitudes about the nature of the scientific method. Contrary to the statement of one of his critics that chemists do not ‘operate by dreaming up things,’ Professor Kekulé would assert that indeed they do, though not in a vacuum, but rather in conjunction with known facts.

I feel certain that today’s historians of science would find all of Professor Kekulé’s statements in complete agreement with the currently accepted historical record of these events.

It is unfathomable that you would pass up such an interview, but since you have made it absolutely clear that you will not publish it and that you will not change your mind, I shall seek its publication elsewhere, a necessity that I very much regret.

I assure you that I remain yours sincerely, etc.

Editor’s Note: Unfortunately, the letter bears neither a signature nor date. —RER

Further Reading

- F. Bacon, *Novum Organum*, 1620; excerpt on the nature of heat from Book II. Available online at <http://web.lemoyne.edu/giunta/bacon.html> (accessed 1/18/2016).
- O. B. Ramsay and A. J. Rocke, “Kekulé’s Dreams: Separating the Fiction from the Facts,” *Chem. Br.*, **1984**, *20*, 1093-1094.
- A. J. Rocke, “Hypothesis and Experiment in the Early Development of Kekulé’s Benzene Theory,” *Ann. Sci.*, **1985**, *42*, 355-381.
- A. J. Rocke, *Image and Reality: Kekulé, Kopp, and the Scientific Imagination*, University of Chicago Press, Chicago, 2010; esp. Chap. 10, “Kekulé’s ‘Dreams,’” pp 293-323.
- A. J. Rocke, “It Began with a Daydream: The 150th Anniversary of the Kekulé Benzene Structure,” *Angew. Chem., Int. Ed.*, **2015**, *54*, 46-50.
- A. Rothenberg, “Creative Cognitive Processes in Kekulé’s Discovery of the Structure of the Benzene Molecule,” *Am. J. Psychol.*, **1995**, *108*, 419-438.
- S. F. Rudofsky and J. H. Wotiz, “Psychologists and the Dream Accounts of August Kekulé,” *Ambix*, **1988**, *35*, 31-38.
- A. Sayre, *Rosalind Franklin and DNA*, W. W. Norton, New York, 1975.
- S. Schaffer, “Making Up Discovery,” in M. A. Boden, Ed., *Dimensions of Creativity*, MIT Press, Cambridge, 1994, pp 13-51, esp. pp 23-29.
- G. P. Schiemenz, “A Heretical Look at the Benzolfest,” *Br. J. Hist. Sci.*, **1993**, *26*, 195-205.
- R. J. Seltzer, “Influence of Kekulé Dream on Benzene Structure Disputed,” *Chem. Eng. News*, Nov. 4, 1985, pp 22-23.
- F. Strunz, “Preconscious Mental Activity and Scientific Problem-Solving: A Critique of the Kekulé Dream Controversy,” *Dreaming: Journal of the Association for the Study of Dreams*, **1993**, *3*, 281-294.
- D. Theodore, “Was Kekulé’s Mind Brainbound? The Historiography of Chemistry and the Philosophy of Extended Cognition,” *Spontaneous Generations: A Journal for the History and Philosophy of Science*, **2009**, *3*, 158-177. Available online at <http://spontaneousgenerations.library.utoronto.ca/index.php/SpontaneousGenerations/article/view/6125/8198> (accessed 1/18/2016).
- J. D. Watson, *The Double Helix: A Personal Account of the Discovery of the Structure of DNA*, G. S. Stent, Ed., Norton Critical Edition, W. W. Norton, New York, 1980. This edition contains other perspectives, book reviews, and original papers on DNA from the 1950s.
- J. H. Wotiz, Ed., *The Kekulé Riddle: A Challenge for Chemists and Psychologists*, Cache River Press, Vienna, IL, 1993.
- J. H. Wotiz and S. Rudofsky, “The Unknown Kekulé,” in J. G. Traynham, Ed., *Essays on the History of Organic Chemistry*, Louisiana State University Press, Baton Rouge, 1987, pp 21-34.
- J. H. Wotiz and S. Rudofsky, “Kekulé’s Dreams: Fact or Fiction?” *Chem. Br.*, **1984**, *20*, 720-723.

About the Author

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