Alfred Bader fonds

Correspondence

Loschmidt - Chemistry in Britain 1993

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FILE 33

LOSCHMIDT - CHEM. IN BRIT.
CHEM & IND

Dr. Alfred R. Bader
2961 North Shepard Avenue
Milwaukee, Wisconsin 53211

May 12, 1993

Ms. Catherine O'Driscoll
Features Editor
Chemistry in Britain
Burlington House
Piccadilly
London W1V 0BN, England

Dear Ms. O'Driscoll:

Thank you for faxing me pages 396, 398, 401 and 492 of this months' Chemistry in Britain.

I am very concerned about one error that crept into our reply. Please look at my fax of March 31 and note that our quotation from Loschmidt referred to in the second last paragraph ends after the word "modifications."

When you sent me your corrections on April 2, I noted that you had included the words ortho and meta as part of the quotation.

In my fax to you of April 2, copy enclosed, I asked you to make certain that the quotation marks be placed correctly on line 20.

The words ortho and meta weren't used by Loschmidt or anyone else in 1861, and we could now be attacked quite sharply for including this in the quotation.

Would you consider printing a brief correction in your next issue? I plan to visit you on May 21 to discuss.

Best regards.

Sincerely,

Enclosure
c: Prof. Dr. Christian R. Noe

Dr. Alfred Bader
2961 North Shepard Avenue
Milwaukee, Wisconsin 53211

April 20, 1993

Ms. Catherine O'Driscoll
Features Editor
Chemistry in Britain
Royal Society of Chemistry
Builington House, Piccadilly
London W1V 0BN
England

Dear Ms. O'Driscoll:

Thank you for your fax telling me that you have made all the corrections in the response to Professor Rocke.

Originally, I understood that the two letters relating to Couper would appear in the April issue, but I presume that you have delayed their publication for inclusion with Professor Rocke's article and our reply.

Could you please let me know in which issue these will appear.

Sincerely,

FAX TRANSMITTAL SHEET

FROM: DR. ALFRED BADER

2961 North Shepard Ave.
Milwaukee, Wisconsin 53211

PHONE: (414) 962-5169

FAX: (414) 962-8322

TO:
Ms. Catherine O'Driscoll
Features Editor
Chemistry in Britain

DATE: March 31, 1993

FAX: 011 44 71 494 1134

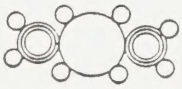
Dear Ms. O'Driscoll:

The following is our reply to Professor Rocke's article:

We believe that Professor Rocke misunderstands Kekulé's, Loschmidt's and our work.

When Loschmidt published his Chemische Studien I in 1861, Kekulé was working largely with his "rational formuli", stressing (on page pp. 175-8 of his 1861 textbook) that these were not "Constitutionsformeln", i.e., they do not show the position of atoms in molecules. He even doubted that one could learn anything about the constitution of compounds by studying their reactions! But to show the position of atoms in molecules was just what Loschmidt was so successful in doing, and Anschütz (p. 110, footnote 3) recognized the superiority of Loschmidt's structures. Discussing benzene, Anschütz wrote (p. 131, footnote 136) "...four years before Aug. Kekulé, Loschmidt considered the benzene nucleus as a structure containing the six carbon atoms in a ring (in ringförmiger Bildung)...".

When Loschmidt wrote "one might almost be tempted...to consider 182" he certainly did not mean that he considered 182 correct, and all his aromatic structures are based on 185, not 182. Consider just one, p-phenylenediamine, structure 229



where Loschmidt wrote: "Just looking at this scheme shows the possibility of isomeric modifications," i.e., ortho and meta.

Readers are urged to re-read Rocke's and our papers and to decide for themselves whose arguments are flawed.

Christian R. Noe

Alfred Bader

Best regards,

FAX TRANSMITTAL SHEET

FROM: DR. ALFRED BADER

2961 North Shepard Ave.
Milwaukee, Wisconsin 53211

PHONE: (414) 962-5169

FAX: (414) 962-8322

TO: Ms. Catherine O'Driscoll
Chemistry in Britain
FAX 011 44 71 494 1134

DATE: March 29, 1993

Dear Ms. O'Driscoll:

Professor Noe and I think it very important that our reply to Professor Rocke's paper be published in the same issue, and I very much hope to fax you our reply no later than Friday morning, April 2nd, so that you have it that afternoon London time.

Many thanks for all your help.

Sincerely,

Alfred Bader

Chemistry

c Noc

[illegible]

FAX TRANSMITTAL SHEET

FROM: DR. ALFRED BADER

2961 North Shepard Ave.
Milwaukee, Wisconsin 53211

PHONE: (414) 962-5169

FAX: (414) 962-8322

TO: Ms. Catherine O'Driscoll
Features Editor
Chemistry in Britain 011 44 71 494 1134

DATE: March 23, 1993

Dear Ms. O'Driscoll:

Professor Noe just telephoned me from Frankfurt. He will be travelling during the next few days, and I am on an American Chemical Society lecture tour until late Friday afternoon.

We hope to have our 200 word reply to Professor Rocke's paper no later than about April 10th, and we very much hope that you will be able to print our reply with Professor Rocke's paper.

Many thanks for your help.

Alfred Bader

Apr 7 deadline

Chemistry
IN BRITAIN

The Royal Society of Chemistry, Burlington House, Piccadilly
London W1V 0BN. Tel: 071-437 8656. Fax: 071-494 1134
Telecom Gold Box 84: BUR1

Dr A Bader
2961 North Shepard Ave
Milwaukee
Wisconsin 53211

18/3/93

Dear Dr Bader,

Thank you for your swift reply to my fax yesterday. As requested, I have enclosed a copy of the original article in the hope that this will be clearer than the fax-a copy has also been posted to Professor Noe. As I mentioned I am intending to print Professor Rocke's article in May and if your reply is to be printed below this, I shall need the copy by ~~Wednesday 24 March~~ at the latest. (This will allow me to return the edited copy to you the following day for checking, although I shall need the corrections back on the same day.)

My apologies that the deadline is so tight but I have only recently received the Rocke article myself and it seems sensible to publish this while Facts are better than dreams is still fresh in the reader's memory. Many thanks.

Yours sincerely,

Catherine O'Driscoll

Catherine O'Driscoll
(Features Editor)

April 2

Chemistry
IN BRITAIN

The Royal Society of Chemistry, Burlington House, Piccadilly
London W1V 0BN. Tel: 071 437 8656 Fax: 071-494 1134
Telecom Gold Box 84, BUR105

Dr A Bader
291 North Shepard Av.
Milwaukee
Wisconsin 53211
USA

17/3/93

Dear Dr Bader,

It seems that your article on the benzene ring structure has generated even more controversy! I thought you might like to reply to the following article which has been sent to me by Professor Rocke. I have decided to print this as a controversy article in our May issue and would like to invite your response (which will be included immediately below this article). I would appreciate if you could keep your reply to less than 200 words.

As for the other letters which Kathryn faxed to you earlier today, since these are mainly concerned with 'more legitimate rivals to Loschmidt', I am referring these to the letters page, where your reply will also be printed.

I would be grateful for a speedy response to the controversy article. Many thanks.

Yours sincerely,

Catherine O'Driscoll

Catherine O'Driscoll
(Features Editor)

Loschmidt's Aromatic Conjectures

Alan J. Rocke, Case Western Reserve University

In the February issue of Chemistry in Britain, Professor Christian Noe and Dr. Alfred Bader argue that the Austrian scientist Josef Loschmidt was the first to publish a correct cyclical structure for benzene, four full years before August Kekulé's famous paper proposing a cyclohexatriene structure. They note that Kekulé was aware of Loschmidt's earlier suggestion, thus implying plagiarism by the great German chemist.[1] Unfortunately, their arguments are deeply flawed.

As Noe and Bader correctly relate, Loschmidt privately published a pamphlet in 1861 with no fewer than 368 proposed structures for organic molecules. For this purpose he used a curious style of formula notation that takes some getting used to--and must have caused headaches for some of his contemporaries. Nonetheless, Loschmidt was perfectly consistent, and with a little practice one can translate the formulae without ambiguity into more conventional structural terms. When one does so it becomes clear that Loschmidt was applying the principles of Kekulé's structure theory, a theory which Kekulé had proposed three years earlier in the leading chemical journal of the day.

Loschmidt's Schema 68 was a proposal for the structure of propylene: a three-membered ring of carbon atoms, what we would today call cyclopropane. He added that such a structure was by no means improbable; indeed, "as we will see below regarding phenyl, it impresses one in many cases as the most acceptable supposition."[2] From this, Noe and Bader conclude that Loschmidt also thought of benzene as a simple ring of carbon atoms. Such, however, was not the case.

When Loschmidt came to the subject of benzene in his pamphlet, he first discussed a possible diallene structure for the carbon nucleus of the molecule,

but then argued against it, as diallene does not explain the nonexistence of intermediary substances between the aliphatic and aromatic series.

> Under these circumstances one might almost be tempted to explain the unsaturated character of this nucleus not through compression [*Verdichtung*, i.e., double bonds], but rather through layering [*Schichtung*] of the carbon atoms, and to assign to the nucleus C_6 something like Schema 182.

Schema 182 depicts six adjacent small circles (i.e., carbon atoms) in two close-packed layers of three circles each. He discussed what the analogous formula for naphthalene would look like under this supposition, and then added:

> However, in the present state of our knowledge it is not possible to come to a definitive result in this matter, and we are all the more justified in suspending judgement, as our constitutions [structure proposals] are fully independent of the question. We assume for the nucleus C_6 the symbol Schema 184 [a large unembellished circle], and treat the nucleus exactly as if it were a hexavalent element. Benzene C_6H_6, Schema 185, is in the phenyl series what methane CH_4 is in the methyl series. Just as the latter must be viewed as methyl hydride, so the former is phenyl hydride.[3]

What does all this mean? Loschmidt obviously believed that the most probable structure for benzene was a formula constructed from multiple fused cyclopropyl rings, using only single bonds: if one abstracts three hydrogen atoms from each of two cyclopropane molecules, then connects the two cyclopropanes with three carbon-carbon single bonds between four adjacent carbons, one arrives at the correct (indeed, the only possible) modern translation of Loschmidt's Schema 182. This is what Loschmidt meant when he said earlier that propylene (regarded as cyclopropane) was relevant for benzene.

4

Significantly, however, Loschmidt provided no empirical justification for this structure (beyond the quotations I have just reproduced), and declared the issue still open. Although he clearly favored the multiple fused-ring structure, he proposed to treat the benzene nucleus explicitly as structurally indeterminate; his large circle (Schema 184) was simply intended to signify this structural indeterminacy—C_6 as a "hexavalent element." In short, Noe and Bader's crucial Schema 184 was not a proposal for cyclohexatriene, nor even for any sort of ring structure for benzene. Loschmidt clearly stated that it was not any sort of structure at all—that was his very point![4]

As Noe and Bader correctly state, Kekulé had received and read a copy of Loschmidt's pamphlet by 1862. Kekulé evidently understood and rejected the "layered" structure for benzene that Loschmidt so clearly favored but refused to defend. Loschmidt's cyclopropyl structures for both propylene and benzene might indeed have had some effect, possibly subconsciously, in getting Kekulé to think in terms of cyclical structures (A. S. Couper, a more legitimate rival to Kekulé, also had suggested some cyclical structures even before 1861). However, the fact that Kekulé himself did not recognize Loschmidt as a predecessor for benzene structure is indicated by the circumstance that he cited Loschmidt's benzene proposal in his first paper on the subject. If Kekulé had consciously gotten the idea for benzene from this highly obscure source, or regarded the Loschmidt structure as similar to his own, the last thing he would have wanted to do was to draw everyone's attention to it.

Even had Loschmidt suggested a cyclical benzene structure in 1861, I would be prepared to argue for the non-significance of the proposal, simply because no empirical evidence could then be adduced to support the idea. Everyone was then convinced that there existed two isomers of benzoic acid (the second one was called "salylic acid"), and that there were likewise two isomers of each

disubstituted benzene. Under such circumstances cyclohexatriene would not only be unsupported, it would have to be regarded as contra-factual. Only in 1863 and 1864 did it gradually become clear that "salylic acid" was nothing but impure benzoic acid, and that <u>three</u> isomers of every disubstituted benzene exist. Loschmidt could not have made a case for cyclical benzene in 1861--nor did he even try to argue empirically for his multiple fused-ring structure. It was, as he quite openly admitted, a bald speculation.

According to Kekulé's famous dream anecdote, he got the idea of cyclohexatriene in Ghent (probably early in 1862), but only published it in early 1865. The delay has been suggested as a reason to disbelieve the anecdote. However, as we see from the previous paragraph, Kekulé published the theory immediately after it first became possible (by newly emerging empirical data) to really make a case for the structure. His own experimental work during the years 1865-68 then firmly established the new theory.[5] I cannot assert unequivocally that the dream story is true, but I can say that it fits all the available evidence, and that there is no reason to disbelieve what Kekulé himself related to friends and colleagues.

Noe and Bader believe that "facts are better than dreams." Whether this is true or not, one must make certain that one's facts are correct, and in the field of history that means understanding the <u>context</u> out of which important advances arise. Kekulé knew the facts; that was why he refused to publish in 1862 and proceeded only in 1865. It was Loschmidt, not Kekulé, who never progressed from beautiful dreams to hard arguments backed up by data and new experiments.[6]

1. C. R. Noe and A. Bader, Chem. Br., 1993, **29**, 126.

2. All of my references to Loschmidt's Chemische Studien I (Vienna, 1861) will be to the more accessible treatment in Richard Anschütz, August Kekulé (Berlin: Verlag Chemie, 1929), vol. 1, pp. 296-305. Anschütz quotes liberally directly from Loschmidt's pamphlet. The cited quote is on p. 302.

3. Ibid., pp. 303-304.

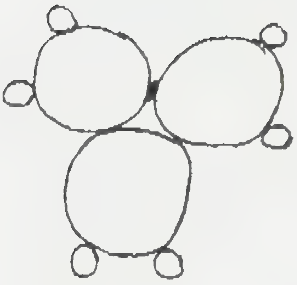
4. Similar arguments regarding Loschmidt's benzene proposal, arrived at independently, have been expressed by Günter Schiemenz (University of Kiel).

5. This is argued in detail in A. Rocke, Annals of Science, 1985, **42**, 355. See also Rocke, The Quiet Revolution: Hermann Kolbe and the Science of Organic Chemistry (Berkeley: University of California Press, 1993).

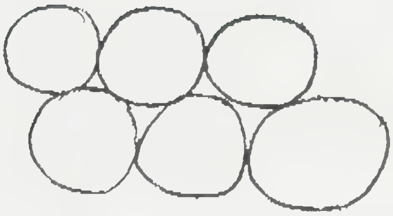
6. Here, of course, I am speaking only of Loschmidt's work in organic chemistry; Loschmidt was also a distinguished physicist. It is not true, as Noe and Bader believe, that Loschmidt's work is unappreciated today. In the definitive Dictionary of Scientific Biography, more space is devoted to Loschmidt than to Kekulé.

Chem Brit
A/W

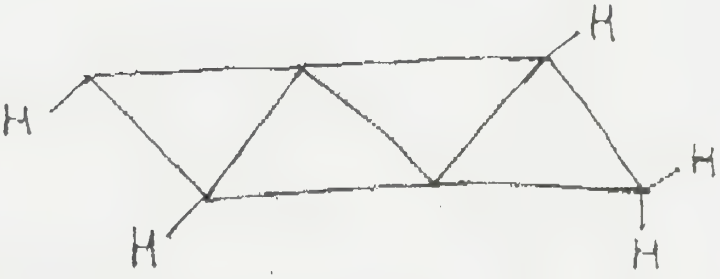
Rocke
Bosc



Schema 68



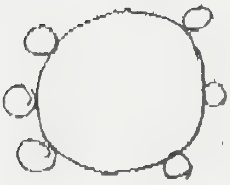
Schema 182



Modern equivalent of
Schema 182

Author: please confirm that these two circles should be lager than those above?

Schema 184



Schema 185

28¼

Chemistry
IN BRITAIN

25 February 1993

Dr Alfred Bader
2961 North Shepard Avenue
Milwaukee
Wisconsin 53211
U.S.A.

Dear Dr Bader

We have received the enclosed letter to the editor for publication. If you would like to comment on any of the points Dr Donald Lee makes, we will be happy to publish your reply. Your text should be no more than 150 words.

Copy deadline for the next letters page is 22 March: if you want to reply and this date creates a problem for you, please let me know.

Yours sincerely

Kathryn Sims

Kathryn Sims
Editorial Secretary

Enc.

FAX TRANSMITTAL SHEET

FROM: DR. ALFRED BADER

2961 North Shepard Ave.
Milwaukee, Wisconsin 53211

PHONE: (414) 962-5169

FAX: (414) 962-8322

TO:
Catherine O'Driscoll
Chemistry in Britain
Fax 011 44 71 494 1134

DATE: January 5, 1993

RE LOSCHMIDT

Extempim 2/63

Thank you for your fax of January 5th.

I think it is important that you state the publisher of the table, i.e. "Fig. 3. An extract from a chronological table published by . . .showing . . . ." Unfortunately, I left the table in Bexhill, but I think that the name of the publisher is ECOMED.

Best wishes for 1993,

Alfred Bader

[illegible]

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[illegible]	[illegible]	[illegible]
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FAX: (414) 962-8322

3 pages

TO: CHEMISTRY & INDUSTRY
VIA FAX 011 44 71 235 9410
Confirmation by air mail

DATE: April 27, 1993

Thank you for sending me the 2-page galley of the article on Loschmidt.

Please consider changing the title from "Out of the shadows" to "Out of the Shadow."

Please also make the corrections as marked.

Column 2 Please change the italicized word to "Confusionsformeln" (i.e., please add an s).

Column 3 Please change the date of Loschmidt's best-known paper from 1866 to 1865. This was my mistake in the original manuscript.

Please add Professor's Noe's initial; he prefers to be called either Christian R. Noe or C. R. Noe.

The Cache River Press is in a small town in the state of Illinois--Vienna, Illinois.

Many thanks for your help.

Alfred Bader

economics to antisemitism, and include plans for a hovercraft.

Loschmidt was the son of a poor farmer in Bohemia. His village priest encouraged him to go to high school and then to the university in Prague. After further studies in Vienna and practical experience with several chemical companies, he became a high school teacher in chemistry and physics. During his teaching years he published *Chemische Studien* and his best known paper of 186~~1~~, calculating the Loschmidt/Avogadro number, the number of molecules in a mole of an ideal gas. Friends in the department of physics in the university recognised his ability as a physicist and persuaded the university to appoint him to their faculty.

1865

~~What if?~~ What if Kekulé and his contemporaries had understood or even acknowledged Loschmidt's work as worthy of further consideration? Molecular modelling ~~as we know it today~~ would have come to us many decades earlier – we have all been losers.

+6

What if Loschmidt had not been so shy and self-effacing, but had pointed to his earlier work when Kekulé was being honoured for his benzene structure supposedly based on a dream? He would surely have done more in chemistry, his *Chemische Studien* would have been followed by *Chemische Studien II* – again, we have been the losers.

And ⓦ

What should we think of Kekulé today? There is no question that he can be called the father of aromatic chemistry and of the German chemical industry. Kekulé's dream was surely based on Loschmidt's structures, but Loschmidt did no practical work to corroborate his theories. Kekulé had a photographic memory, and so cannot have forgotten Loschmidt's name, although he may not have understood Loschmidt's work in 1861.

Had it not been for Anschütz, we would know none of this. John F Kennedy said that one man can make a difference and every man should try. It would be hard to find a more apt example among historians of chemistry than Richard Anschütz.

Alfred Bader is the former chairman of Sigma-Aldrich. He and C~~hristian~~ Noe reviewed Loschmidt's life and work in chapter 16 of 'The Kekulé Riddle' (Ed J H Wotiz, Illinois: Cache River Press 1993).

C. R. Noe

+6 H. Wotiz, Vienna, Illinois

~~*Was Loschmidt at the centre of Kekulé's snake dream?*~~

Really. There is a Vienna in Illinois!

SCI issue date: 17/5/93
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correction date:
Corrected by:
on Station no:

Fax to 44 71 235 9410

Out of the shadows

In 1911, Richard Anschütz, a 59-year-old chemist at the University of Bonn, was working on a biography of his mentor, August Kekulé. His attention was caught by a footnote in Kekulé's most important paper, describing the structure of benzene, that was to undermine his subject's claim to one of the most famous discoveries in the history of science.

The aromatic ring structure of benzene had first come to him in a dream, Kekulé claimed years later. The footnote, however, led Anschütz to a modest Viennese high school teacher, Josef Loschmidt, who was the first to suggest the circular structure of benzene.

Was Kekulé's dream triggered by Loschmidt's structure? Or was his famous vision of six snakes biting each other's tails a genuinely original insight? But for the tenacious research of Anschütz, ~~Kekulé's student, secretary and successor in Bonn,~~ these questions might never have been asked.

tb

In the footnote in that famous paper of 1865, Kekulé had stated that he preferred his own structures to those of Loschmidt and Crum Brown. This puzzled Anschütz. He knew of the Scottish chemist Alexander Crum Brown, but who was Loschmidt? He eventually found a reference elsewhere to *Chemische Studien I*, a book published by Loschmidt in 1861, but it was not in Kekulé's library, nor in the university libraries he consulted.

Most historians might have given up and forgotten about the footnote – not Anschütz. He kept looking, and finally an antiquarian bookstore in Vienna sent him a copy. As he later wrote, Anschütz expected little from the tiny pamphlet, and had a shock when he opened it. There, he discovered the first depiction of double and triple bonds, simple molecules like acetic acid and acetone shown correctly, and – incredibly – many aromatic structures including benzene, toluene, phenol and anisole. Cinnamic acid was even shown with the *trans* double bond! And all this had been published four years before Kekulé's paper.

Loschmidt's book consists of two essays: one giving some 368 graphic formulae, the other dealing with gas laws. His purpose, he wrote, was 'to provide a deeper insight into the constitution of matter.' And here he first depicted ozone as O_3, predicted the existence of cyclopropane ~~twenty~~ years before it was made, and first drew the structure of a sugar correctly.

20

Did Kekulé know of Loschmidt's book? Anschütz knew this question would be a difficult one to ask. The whole chemical world had celebrated the Benzolfest of the German Chemical Society in 1890, honoring Kekulé for his depiction of benzene ~~25 years earlier~~. ~~Many lesser chemists and historian might have let the matter drop quietly – but not Anschütz.~~ At first ~~he~~ thought that Kekulé could not have seen the book but must only have heard about it ~~secondhand~~. However, Anschütz later found a letter sent by Kekulé to his friend Professor Erlenmeyer in 1862, just months after Loschmidt's book was published, in which he referred to Loschmidt's 'Confusionformeln' or formulae of confusion. In his biography of Kekulé, Anschütz acknowledged that Kekulé must have known the book.

Anschütz

itals

tb

In 1913, Anschütz republished Loschmidt's first essay in a format which is much easier to read, including a biography with many footnotes. He bemoaned the fact that Loschmidt had originally printed it privately, paying for it personally. Anschütz felt that it would have attracted much interest if only it had been published in a well-known journal. However, which journal of 1861 would have accepted the theoretical essays of a Viennese high school teacher?

Who was this modest scientist? The many accounts of Loschmidt (1821-1895) speak of his gentle, unmaterialistic nature, the love his students and friends felt for him, and his rise from school teacher to professor of physics at the University of Vienna. His unpublished manuscripts cover an enormous variety of interests, from Greek literature and

Confusionsformeln

add s

FAX TRANSMITTAL SHEET

FROM: DR. ALFRED BADER

2961 North Shepard Ave.
Milwaukee, Wisconsin 53211

PHONE: (414) 962-5169

FAX: (414) 962-8322

TO: CHEMISTRY & INDUSTRY
VIA FAX 011 44 71 235 9410
Confirmation by air mail

DATE: April 27, 1993

Thank you for sending me the 2-page galley of the article on Loschmidt.

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on Station no:

Out of the shadows

In 1911, Richard Anschütz, a 59-year-old chemist at the University of Bonn, was working on a biography of his mentor, August Kekulé. His attention was caught by a footnote in Kekulé's most important paper, describing the structure of benzene, that was to undermine his subject's claim to one of the most famous discoveries in the history of science.

The aromatic ring structure of benzene had first come to him in a dream, Kekulé claimed years later. The footnote, however, led Anschütz to a modest Viennese high school teacher, Josef Loschmidt, who was the first to suggest the circular structure of benzene.

Was Kekulé's dream triggered by Loschmidt's structure? Or was his famous vision of six snakes biting each other's tails a genuinely original insight? But for the tenacious research of Anschütz, ~~Kekulé's student, secretary and successor in Bonn~~ these questions might never have been asked. 5/b

In the footnote in that famous paper of 1865, Kekulé had stated that he preferred his own structures to those of Loschmidt and Crum Brown. This puzzled Anschütz. He knew of the Scottish chemist Alexander Crum Brown, but who was Loschmidt? He eventually found a reference elsewhere to *Chemische Studien I*, a book published by Loschmidt in 1861, but it was not in Kekulé's library, nor in the university libraries he consulted.

Most historians might have given up and forgotten about the footnote – not Anschütz. He kept looking, and finally an antiquarian bookstore in Vienna sent him a copy. As he later wrote, Anschütz expected little from the tiny pamphlet, and had a shock when he opened it. There, he discovered the first depiction of double and triple bonds, simple molecules like acetic acid and acetone shown correctly, and – incredibly – many aromatic structures including benzene, toluene, phenol and anisole. Cinnamic acid was even shown with the *trans* double bond! And all this had been published four years before Kekulé's paper.

Loschmidt's book consists of two essays: one giving some 368 graphic formulae, the other dealing with gas laws. His purpose, he wrote, was 'to provide a deeper insight into the constitution of matter.' And here he first depicted ozone as O_3, predicted the existence of cyclopropane ~~Aughty~~ years before it was made, 20 and first drew the structure of a sugar correctly.

Did Kekulé know of Loschmidt's book? Anschütz knew this question would be a difficult one to ask. The whole chemical world had celebrated the Benzolfest of the German Chemical Society in 1890, honoring Kekulé for his depiction of benzene ~~25 years earlier. Many fewer chemists and historian might have let the matter drop quietly – but not Anschutz.~~ At first ~~Ak~~ Anschütz thought that Kekulé could not have seen the book but must only have heard about it ~~secondhand~~. However, Anschütz later found a letter sent by Kekulé to his friend Professor Erlenmeyer in 1862, just months after Loschmidt's book was published, in which he referred to Loschmidt's '*Confusionformeln*' or formulae of confusion. In his biography of Kekulé, Anschutz acknowledged that Kekulé must have known the book. 5/b

itals

Confusionsformeln

add s

In 1913, Anschütz republished Loschmidt's first essay in a format which is much easier to read, including a biography with many footnotes. He bemoaned the fact that Loschmidt had originally printed it privately, paying for it personally. Anschütz felt that it would have attracted much interest if only it had been published in a well-known journal. However, which journal of 1861 would have accepted the theoretical essays of a Viennese high school teacher?

Who was this modest scientist? The many accounts of Loschmidt (1821-1895) speak of his gentle, unmaterialistic nature, the love his students and friends felt for him, and his rise from school teacher to professor of physics at the University of Vienna. His unpublished manuscripts cover an enormous variety of interests, from Greek literature and economics to antisemitism, and include plans for a hovercraft.

Loschmidt was the son of a poor farmer in Bohemia. His village priest encouraged him to go to high school and then to the university in Prague. After further studies in Vienna and practical experience with several chemical companies, he became a high school teacher in chemistry and physics. During his teaching years he published *Chemische Studien* and his best known paper of 186~~6~~, calculating the Loschmidt/Avogadro number, the number of molecules in a mole of an ideal gas. Friends in the department of physics in the university recognised his ability as a physicist and persuaded the university to appoint him to their faculty.

1865

~~What if?~~ What if Kekulé and his contemporaries had understood or even acknowledged Loschmidt's work as worthy of further consideration? Molecular modelling ~~as we know it today~~ would have come to us many decades earlier – we have all been losers.

+b

What if Loschmidt had not been so shy and self-effacing, but had pointed to his earlier work when Kekulé was being honoured for his benzene structure supposedly based on a dream? He would surely have done more in chemistry, his *Chemische Studien* would have been followed by *Chemische Studien II* – again, we have been the losers.

What should we think of Kekulé today? There is no question that he can be called the father of aromatic chemistry and of the German chemical industry. Kekulé's dream was surely based on Loschmidt's structures, but Loschmidt did no practical work to corroborate his theories. Kekulé had a photographic memory, and so cannot have forgotten Loschmidt's name, although he may not have understood Loschmidt's work in 1861.

And w

Had it not been for Anschütz, we would know none of this. John F Kennedy said that one man can make a difference and every man should try. It would be hard to find a more apt example among historians of chemistry than Richard Anschütz.

Alfred Bader is the former chairman of Sigma-Aldrich. He and C~~hristian~~ Noe reviewed Loschmidt's life and work in chapter 16 of 'The Kekulé Riddle' (Ed J H Wotiz, Illinois: Cache River Press 1993)

δ - C. R. Noe

+b - H. Wotiz, Vienna, Illinois

~~Was Loschmidt at the centre of Kekulé's snake dream~~

[illegible] Here is

Dr. Alfred Bader
2961 North Shepard Avenue
Milwaukee, Wisconsin 53211

February 23, 1993

Mr. Andrew Miller
Editor
Chemistry & Industry
14/15 Belgrave Square
London SW1X 8PS
England

Dear Mr. Miller:

Because of my recent involvement with the purchase of Herstmonceux Castle for my university in Canada and a number of trips, my reply to your interesting and helpful letter of December 4, 1992 has been so delayed.

First of all, to answer the four questions:

1. In 1861 when Loschmidt's book was published, he was a high school teacher in Vienna, teaching chemistry and physics. He did not become a Privatdozent, the equivalent of our assistant professor, until 1866.

2. Kekule's reference must be to that little book as there was no earlier paper by Loschmidt. We don't know in which month of 1861 the book was published, but Kekule's damning letter is dated January 4, 1862.

3. Anschütz didn't find Kekule's footnote in the 1865 paper until about 1911, years after Kekule had died. Hence, Anschütz never had a chance to discuss this with Kekule. However, Anschütz did know Kekule's library very well and believed that Loschmidt's book was not in the library. Perhaps Kekule had thrown the small book away, or Anschütz overlooked it. If you look at the copy of Loschmidt's book in the British Library, you will see how easily such a pamphlet might be overlooked.

4. I do believe that Loschmidt is getting to be better known. Anschütz certainly did his best, but even his reprint of 1913 has become quite rare. Dr. Wiswesser's article was published in 1989 in the Aldrichimica Acta which went to over 200,000 chemists. I, myself, have given dozens of lectures--so, for instance, a Friday evening discourse at the Royal Institution--and Christmas lectures at Imperial College and University College. Copy of the Chemistry in Britain paper is enclosed.

   In 1995, there will be a large symposium and exhibition honoring Loschmidt, in Vienna at the time of the hundredth anniversary of his death. That, I believe, will add substantially to our knowledge of Loschmidt.

I enclose my rewritten manuscript. You will note that I have followed many of your suggestions, for which I thank you.

Please consider alternate titles--"The Case of the Modest Scientist" or "Better Late Than Never."

I also enclose a photograph of Loschmidt and some of his formulae. You may wish to use one, some or all of them. The photograph of Loschmidt should be credited to Gerlinde Fritz in Vienna; it is of an unpublished painting owned by the Department of Physics of the University of Vienna. Because of that photo, I am sending this by registered mail. Please do return the photo to me.

I understand that you do not like to use archival material, but please do print the footnote to the title.

Best regards.

Sincerely,

Enclosures

JOSEF LOSCHMIDT[*]

Out of the Shadow

In 1911, Richard Anschütz (1852-1937), a 59 year old chemist at the University of Bonn, was working on a biography of his mentor, August Kekulé (1829-1826). His attention was caught by a footnote in Kekulé's most important paper, that was to undermine his subject's claim to one of the most famous discoveries in the history of science.

The aromatic ring structure of benzene had first come to him in a dream, Kekulé claimed years later. The footnote, however, led Anschütz to a modest Viennese high school teacher who was the first to posit the circular structure of benzene.

Was Kekulé's dream triggered by Loschmidt's structure? Or was his famous vision of six snakes in a ring biting each other's tails a genuinely original insight? But for the tenacious research of Anschütz, Kekulé's student, secretary and successor in Bonn, these questions might never have been asked.

In the footnote in that famous paper of 1865 describing the cyclic structure of benzene, Kekulé had stated that he preferred his own structures to those of Loschmidt and Crum Brown. This puzzled Anschütz. He knew of the Scottish chemist Alexander Crum Brown, but who was

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[*] For a thorough review of Loschmidt's life and work, see C. R. Noe and A. Bader, Chapter 16 in The Kekulé Riddle, J. H. Wotiz, Editor, Cache River Press, Vienna, Illinois, 1993.

Loschmidt? He found a reference to *Chemische Studien I*, a book published by Loschmidt in 1861, but it was not in Kekulé's library, nor in the university libraries he consulted.

Most historians might have given up and forgotten about the footnote--not Anschütz. He kept looking, and finally an antiquarian bookstore in Vienna sent him a copy. As he later wrote, Anschütz expected little from the tiny pamphlet, and had a shock when he opened it.

There, he discovered the first depiction of double and triple bonds, simple molecules like acetic acid and acetone shown correctly, and--incredibly--many aromatic structures including benzene, toluene, phenol and anisole. Cinnamic acid was even shown with the *trans* double bond! And all this was published four years before Kekeulé's paper.

Loschmidt's book consists of two essays: one giving some 368 graphic formulae, the other dealing with gas laws. His purpose, he wrote, was "to provide a deeper insight into the constitution of matter." And here he first depicted ozone as O_3, predicted the existence of cyclopropane twenty years before it was made, and first drew the structure of a sugar correctly.

Did Kekulé know of Loschmidt's book? Anschütz knew this question would be a difficult one to ask. The whole chemical world had celebrated the Benzolfest of the German Chemical Society in 1890, honoring Kekulé for his depiction of benzene 25 years earlier. Many lesser chemists and historians might have let the matter drop quietly.

Not Anschütz--at first he thought that Kekulé could not have seen the book but must only have heard about it secondhand. However, Anschütz later found ~~that~~ a letter sent by Kekulé to his friend Professor Erlenmeyer in 1862, just months after Loschmidt's book was published, in which he referred to Loschmidt's "Confusionformeln" or formulae of confusion. In his biography of Kekulé, Anschütz acknowledged that Kekulé must have known the book.

In 1913, Anschütz republished Loschmidt's first essay in a format which is much easier to read, including a biography with many footnotes. He bemoaned the fact that Loschmidt had originally printed it privately, paying for it personally. Anschütz felt that it would have attracted much interest if only it had been published in a well-known journal. However, which journal of 1861 would have accepted the theoretical essays of a Viennese high school teacher? Both the original and the reformatted versions are available in reprints from the Aldrich Chemical Company.

Who was this modest scientist? The many accounts of Loschmidt's life (1821-1895) speak of his gentle, unmaterialistic nature, the love his students and friends felt for him, and his rise from school teacher to professor of physics at the University of Vienna. His unpublished manuscripts cover an enormous variety of interests, from Greek literature and economics to antisemitism and plans for a hovercraft.

Loschmidt was the son of a poor farmer in Bohemia. His village priest encouraged him to go to high school and then to the university in Prague. After further studies in Vienna and practical experience with several chemical companies, he became a high school teacher in chemistry and

physics. During his years teaching high school he published his 1861 Chemische Studien and his best known paper of 1866, calculating the Loschmidt/Avogadro number, the number of molecules in an ideal gas. In 1811 Avogadro had predicted that some day that number would be calculated; Loschmidt made the calculation which gave the size of the molecule. The Chemische Studien had given the shape of many.

Friends in the department of physics in the university recognized his ability as a physicist and persuaded the university to appoint him to their faculty.

What if? What if Kekulé and his contemporaries had understood or even acknowledged Loschmidt's work as worthy of further consideration? Molecular modelling as we know it today would have come to us many decades earlier--we have all been losers.

What if Loschmidt had not been so shy and self-effacing a man, but had pointed to his earlier work when Kekulé was being honored for his benzene structure supposedly based on a dream? He would surely have done more in chemistry, his Chemische Studien I would have been followed by Chemische Studien II--again, we have been the losers.

What do we think of Kekulé today? There is no question that he can be called the father of aromatic chemistry and of the German chemical industry. Kekulé's dream was surely based on Loschmidt's structures, but Loschmidt did no practical work to corroborate his theories. We know that Kekulé had a wonderful, a photographic memory, and so cannot have forgotten

Loschmidt's name, although he may not have understood Loschmidt's work in 1861.

Had it not been for Anschütz, we would know none of this. John F. Kennedy said that one man can make a difference and every man should try. It would be hard to find a more apt example among historians of chemistry than Richard Anschütz.

... old

A more intriguing title?

The case of the ~~shy~~ scientist

In [illegible], a young chemist at the University of Bonn working on a biography of his mentor, August Kekulé – one of the most respected German chemists of his time – stumbled across an obscure footnote that was to undermine his subject's claim to one of the most famous visions in the history of science.

The noted chemist was August Kekulé, who claimed to have first intuited the aromatic ring structure of benzene in a dream. His biographer, Richard Anschuetz, found that the first person to posit such a structure was not Kekulé but a shy Viennese schoolteacher, Josef Loschmidt.

Anschütz?

Did Kekule steal Loschmidt's ideas? Or was his famous vision of six snakes swallowing each others tales in a ring a genuinely original insight? But for the tenacious research of Anschuetz, Kekulé's student and admirer, these questions might never have been asked.

Do I have this right? or was it children holding hands?

Anschuetz studied with Kekulé at Bonn, became his secretary and eventually succeeded him as professor of organic chemistry in ?. When he set out to write his two-volume biography he came across a curious footnote in Kekulé's most famous paper of 1865, describing the cyclic structure of benzene. In this, Kekulé stated that he preferred his own structure to those of Loschmidt and Crum Brown.

This puzzled Anschuetz. He knew the Scottish chemist, Brown, but who was Loschmidt? After further investigation he discovered that Loschmidt had published a small book in 1861, Chemische Studien I, but it was not in Kekulé's library, nor in the university libraries he consulted.

Most historians might have given up and forgotten about the footnote - not Anschuetz. He kept looking and finally an antiquarian bookstore in Vienna sent him a copy. As he later wrote, Anschuetz expected little from the tiny pamphlet: and had a shock when he opened it.

(A)

There, he discovered the first depiction of double and triple bonds, simple molecules like acetic acid and acetone shown correctly, and - incredibly - many aromatic structures including benzene, toluene, phenol and anisole. Cinnamic acid was even shown with the trans double bond! And all this was published four years before Kekule's ~~contributions.~~ paper.

(B)

Loschmidt's book consists of two essays: one giving some 368 graphic formulae, the other dealing with gas laws. His purpose, he wrote in it, was 'to provide a deeper insight into the consitution of matter'. And in it, he first depicted ozone as ~~O3~~ O_3, predicted the existence of cyclopropan~~e~~e twenty years before it was made, and first drew the structure of a sugar correctly.

Did Kekulé know of Loschmidt's book? Anschuetz knew this question would be a difficult one to ask. The whole chemical world had celebrated the Benzolfest of the German Chemical Society in 1890, honouring Kekulé for his depiction of benzene, twenty five years earlier. Many lesser chemists and historians might have let the matter drop quietly.

Not Anschuetz - ~~he bravely put the question to Kekulé, who denied it categoric~~ally. at first he thought that Kekulé could not have seen the book, but had only heard about it second hand. However, Anschuetz ~~also~~ later found that

Kekulé, in a letter to his friend ~~in~~ Professor Erlenmeyer in 1862, just months after Loschmidt's book was published, had referred to 'Loschmidt's 'Confusionformeln', or formulae of confusion. In his biography of Kekulé, Anschuetz acknowledged that Kekulé must have known the book.

In 1913, Anscheutz republished Loschmidt's first essay. He bemoaned the fact that Loschmidt had originally printed it privately, paying for it personally. It would have attracted much interest if only it had been published in a well-known journal. However, ~~no~~ what journal of 1861 would have accepted the theoretical essays of a Viennese high school teacher? X X

Was he still a school teacher when book was published — or already a physics professor?

Who was this ~~shy~~ modest scientist? The many accounts of Loschmidt's life (18__-1895) speak of his gentle, unmaterialistic nature, the love for him of his students and friends, and his rise from school teacher to professor of physics at the University of Vienna. His unpublished manuscripts cover an enormous variety of interests, from Greek literature and economics to antisemitism and plans for a hovercraft. end of ¶ (*)

Another paragraph on Loschmidt would be interesting. Birth place? Parents? His principal area of physics research?

Why did Loschmidt not point to his own work when Kekulé was feted for his dream vision? How different would the history of chemistry be if had succeeded in publicising his ideas more widely? And what judgement can be made of Kekulé: did he deliberately plagiarise Loschmidt's work or unconsciously borrow it? Finally, why was Anschuetz so persistent, faced with the prospect of embarrassing a highly respected chemist and personal colleague? These questions, sadly, may never be answered.

This could probably be improved on. For one thing, what is your judgement of Kekulé now? (This is important, it seems to me) And why don't people acknowledge Loschmidt even today — or do they?

THE TEXT IS ABOUT 700 WORDS
YOU COULD ADD UP TO ANOTHER 100 WORDS
IF YOU WISH.

CHEMISTRY
& INDUSTRY

Published by SCI

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4 December 1992

Dr Alfred R Bader
52 Wickham Avenue
Bexhill-on-Sea
East Sussex TN39 3ER

Dear Dr Bader,

Stuart Nathan passed your draft manuscript on to me. I found the subject extremely interesting, but the article needs to be written in a style that will draw the general reader into it more readily. It is a fascinating tale and I would hate to see it weighed down, in such a brief account, by too much archival detail.

I've drafted a rough version of what I'm thinking of - only to show the sort of style, not to put words in your mouth! It needs a few gaps filled, and perhaps a better ending. It doesn't need footnotes: we will point any interested readers, who want to dig deeper, in your direction.

I would like to use the original illustrations of benzene by Loschmidt and Kekule, if you can send us copies of them. I think we could fit these in, <u>and</u> a picture of Loschmidt, if there is one available.

Finally, I am intrigued about a few points, and you may wish to clarify these by amending the text:

(1) Was Loschmidt already a physics professor in 1861, when his book was published?

(2) Is it possible that Kekule's reference to 'confusion of formulae' is to an earlier paper by Loschmidt?

(3) If not, since Kekule publicly refers to Loschmidt's structures in a footnote in his paper, why should Anschuetz need to ask Kekule if he's seen the book? How can we believe Anschuetz' assertion that Kekule denied having seen it, when Kekule had already referred to Loschmidt's structures in print?

(4) Is Loschmidt's role in this still not acknowledged today?

I've also noted a few points on the draft version. I look forward to receiving your revised manuscript. Many thanks for your cooperation.

Yours sincerely

Mr Andrew Miller
Editor

Enc

Dr. Alfred R. Bader
2961 North Shepard Avenue
Milwaukee, Wisconsin 53211

September 8, 1992

Mr. Stuart Nathan
Chemistry & Industry
14/15 Belgrave Square
London SW1X 8PS
England

Dear Mr. Nathan:

I will be happy to write another paper Loschmidt, within the next few months.

In the meantime, could you please send some examples of your recent chemical history papers to my English address:

52 Wickham Avenue
Bexhill-on-Sea
East Sussex TN39 3ER

where I will be between November 15th and December 22nd of this year. If I have any questions, I will call you in London during that time.

Best regards.

Sincerely,

Alfred Bader

CHEMISTRY
& INDUSTRY

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Dr Alfred Bader,
2961 North Shepard Avenue,
Milwaukee,
Wisconsin 53211,
US

19/8/92

Dear Dr Bader,

Thank you for your letter of the 10th August. It's very flattering to be addressed as Dr, but I'm afraid I'm actually only a BSc; I couldn't quite manage the results to scale the dizzy heights of a PhD - and I kept breaking glassware in the lab, anyway!

As far as we are concerned, there is no problem with you contributing an article on Loschmidt, as long as it is different from the papers you are contributing to other journals. Our Chemical History papers are usually much shorter than **Chemistry in Britain**'s, so there shouldn't be too much of a problem.

Please contact me if there are any problems. I look forward to hearing from you and reading your paper.

Yours sincerely,

Mr Stuart Nathan, BSc