Marriage in the Mineral World

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AN evening's conversation is generally of a desultory character at the beginning, and it is no misfortune that we break in upon this small company of three in the middle of the topic, and catch the words:

"Sheer waste of time! Positively criminal! That's what I call it", as they fall from the Professor's lips, and are followed by a moment's pause.

" What do *you* think about it all, Mr. Vincent ? " said the host." Do you agree that Science develops the mind better than the old machinery did?"

"Well, if I might venture to give an opinion, it would only be this, that I think Professor Merryweather does not quite do justice to poor Dr. Wordsworth and the public schools, whilst on the other hand he seems to me to do rather more than justice to Chemistry."

"In what way do you mean that I say too much for Chemistry?" inquired the Professor courteously. For he cared little what merits might be claimed to exist in other branches of learning, but felt it worth while to reply to a remark detracting from the honour of the Chair he filled.

"Why, I think that Chemistry, though nominally a science, is in reality not so much a science as an experience."

"I don't quite understand what you mean", rejoined the Professor, leaning with rather more attention towards his younger acquaintance, whom up to this moment he had believed to be quite outside the conversation and to be his fellow-guest merely as a privilege and a compliment. " Why do you think Chemistry is not a science ? "

" I may be taking rather an extreme view, but the study of Chemistry seems to me to teach people a quantity of desolate, unfruitful facts — a great quantity of them — as for instance the fact that such and such a mixture of things, when heated, will give off oxygen; that a certain substance won't dissolve in water, but will dissolve in ammonia. And we learn that the particles of nitrous oxide have *this* composition whilst the particles of nitric acid have *that* composition, and so on. But all the while there is very little system, very little principle in the matter."

"Ha! " said the Professor, turning aside to his host, " here's a good man for us at last!" And whilst the latter nodded and smiled, the Professor continued, with a frown that expressed not displeasure but a sense of personal importance. — "You're quite right, Mr.— — ", (enthusiasm had for the moment paralysed his memory) " you're perfectly **[Page 4]** right! There's nothing I regret more than the way in which the common throng of chemists ignore principle. Now in my young days — I was X.'s pupil — Professor X. laid the foundation of Chemistry in my mind with this great maxim, that a chemical union" — the frown here was quite terrific — "was not the mere adding together of A and B, but — " he continued, "the formation of an entirely new substance". And the Professor continued his harangue to some length, but the rest may be omitted, as it had no very important bearing on the conversation. But when it was over, the younger guest of the evening resumed the main topic: —

"Still I don't feel altogether satisfied with Chemistry even on that basis."

"What have you to find fault with? asked the Professor. "Perhaps you will let us hear what your own views are on the subject?"

"What I am thinking is this. Suppose we take the case of zinc and sulphuric acid, as when you prepare hydrogen. In such an instance, then, it is not the whole sulphuric acid that goes for the zinc, but only one half of it—one half of each particle, that is. We do not get a union of sulphuric acid with zinc, but there is a union made whereby one part of the sulphuric acid is turned adrift, I mean the hydrogen."

"Decidedly so! " replied the Professor; "very good indeed! Now I understand you better. Yes, it is not the case, as they used to think in the good days of Dualism, that sulphuric acid joins with oxide of zinc and forms sulphate of zinc, or more fully, sulphate of the oxide of zinc; but the hydrogen in the sulphuric acid is *replaced* by the zinc. What you would like, I conceive, is to hear a little more of the great Substitution Theory, in which we have been so much indebted to my friend Professor Wymer."

" That is somewhere near my meaning. May I venture to state the matter in the way I look at it myself? "

" Do, pray! " said the Professor, with a slightly ironical laugh; "there is nothing that would give us more delight, nothing that would entertain us more, than to hear your new theory of chemistry!" And he turned to the doctor to look for a responsive smile.

"No, I don't mean that", replied Mr. Vincent, a little abashed, but not overcome. " I don't think I have precisely any new theory of my own on chemistry, but I have a way of representing to myself explicitly what I think I find at every turn implied, and as it were between the lines. Although I do not remember to have anywhere seen the statement made in black and white, yet is it not supposed that every chemical compound is composed of *two halves*? It always strikes me, when I take up a text-book of chemistry and read a little of it, that the chemical substances spoken of — sodium-chloride, hydrogen-sulphate, silver-nitrate, potassium-chlorate and so on — are all a kind of insects, two halves —" **[Page 5]**

The two listeners were somewhat amused at the idea of "insects", but allowed him to proceed: —

" Two halves, as indeed the names themselves suggest. And what is more, it strikes me that the two halves are as it were of opposite kinds, and that in comparing any two chemicals, we can point out the corresponding halves in each.”

Both the others listened attentively while he continued: —

“What I mean to say is, that as in comparing two magnets or compass-needles side by side, we can say, ‘This and this are the two north-poles, that and that are the two south-poles', so likewise in comparing the formulae of two chemicals, we can say, ‘This and this are the two *metal* halves, that and that are the two — what shall I say? — the two *acid* halves’."

Finding the Professor still inclined to listen, he continued: —

“Now what I want to ask, what I want to have a reason for, is this. What is the principle? I am going to take the example of hydrochloric acid poured on chalk, and for greater clearness perhaps you will let me call the two substances calcium-carbonate and hydrogen-chloride. On what principle does the acid half of the chloride dislodge the acid half of the carbonate and take possession of its dear calcium? "

“Because", answered the Professor, “the acid principle of chlorides, namely chlorine, is stronger than the acid principle of carbonates".

“Very well; but don't you feel that you imply something more besides the mere fact of one acid-principle being stronger than the other ? Don't you also imply that both the metal halves, the calcium on the one hand and the hydrogen on the other, are not found equally attractive by the acids ? For why should the stronger acid-principle seize the calcium and surrender the hydrogen unless it reckons the calcium the more desirable of the two? And for all we know the weaker acid-principle takes the same view, only being the weaker, it has to be content with the worse lot. In other words, don't you imply that the two acid-principles are bent upon the possession of something that cannot belong to both ? Don't you imply that they find the two metal halves not equally attractive, but have both of them a preference for the calcium ? The thought I am trying to convey is, that every acid-principle desires to be mated with some metal, and in fact cannot settle down in quiet existence except in that relation. Meanwhile, as in the animal world, so likewise in the inorganic world, these acid-principles have preferences with regard to their mates; they find — I cannot help speaking of them as if they were alive and endowed with animal instincts — they find that some metals possess greater attractions than others. And whenever there is an affray between two chemical compounds where the weaker acid-principle is in possession of the more attractive metal, then a forced exchange takes place; the stronger acid-principle **[Page 6]** seizes what it fancies better and leaves its own despised metal to fall to the lot of the weaker antagonist. And such I conceive to be the nature of every process that we commonly call a chemical reaction, or action, or union, or what you will."

"Are you going to turn out a Darwin for the mineral world ?" asked the doctor placidly. And then to the Professor: " I can't help comparing it with Darwin's constantly recurring phrases about the 'stronger male’ and the 'more attractive female' ".

"Yes", laughed the Professor; "I never heard such a curious idea. I doubt whether it will stand the test of facts; but at all events it is a very ingenious notion. Will you go on with your exposition ?"

"May I interrupt him just a moment longer ?" interposed the doctor. (To Mr. Vincent) "I should like to know what made you fix on the acid for the male and the metal for the female. Have you any reason for it ?"

"No", replied the theorist; "that is a difficulty I have often put to myself. I don't see any means of deciding which corresponds to the male and which to the female in the animal world. It would all work just the same if the greater strength lay in the metal, that is to say the calcium, and the greater attractiveness in the chlorine, instead of its being *vice versa*".

" Precisely so", replied the doctor, "that was the point I wanted to elicit; I wondered whether you had any reason one way or the other. Very well, go on; we want to hear you out".

"Then you see, I look upon every instance of chemical action as an exchange, not as a union taking place."

Both the listeners motioned an objection; the Professor prevailed, forsooth by some force latent in his large black beard and bushy eyebrows: "What do you say to this though? How about the action of sulphuric acid on zinc ? You can't get your exchange there; you have no fourth party. Ah! I suppose that is a *divorce* merely — divorce simple, instead of divorce compound".

" Try him with chlorine and hydrogen", suggested the doctor, advancing his own more pointed example.

" Well, he'll tell us that, that is a marriage", rejoined the Professor. "Only didn't he say — " (To Mr. Vincent:) "Didn't you say 'that substances could not exist otherwise than mated in pairs ?"

" I won't be too certain on that point. But you know it is held, is it not ? that hydrogen exists in pairs of atoms, being as it were, hydride of hydrogen. Don't chemists hold that the compound acid-principle Cyanogen exists in double atoms — I think you call it Di-cyanogen ? And I suppose Chlorine in the same way is chloride of chlorine — "

"Yes", interposed the Professor, "but where is your metal ? We **[Page 7]** have, I grant, good reasons for believing that chlorine in the free state exists with its atoms united in pairs, each pair forming one particle or molecule; but chlorine, I suppose you admit, is an acid principle, and if two acid atoms are in alliance, that hardly fulfils your idea of mating, does it ?"

" I have thought of that", replied the other. "I imagine it to be that one atom of chlorine plays the part of a metal in relation to the other. I always compare it in my own mind to practising a step for a dance, when you say to another man, ‘You be a lady a moment, will you ? I want just to try if I've got this right.' What I

imagine is, that chlorine is just capable of the functions of a metal, though of course of all unattractives the least attractive in this capacity. And in the same way I imagine hydrogen is capable of assuming an acid function so as to mate with another hydrogen atom, the latter behaving as a metal, according to its proper nature."

The Professor here made a sudden transition: "John ! What should you say if we were to see old Berzelius rise from the dead, and his dualistic theory once more prevailing? Does not this suggest Berzelius to your mind ?"

The doctor answered: "As often as I read a page of Berzelius", and he turned his face towards his book-shelves, " I've got a French edition of him — I never can help rather admiring him. He did so well with such ideas as he inherited. I often think we are hasty in throwing overboard great ideas just because we do not at first see how they are to be reconciled with some newly discovered evidence of our own later times. Poor Berzelius ! He got hopelessly beaten by the Frenchmen. He constructed his lines too wide; he should have made the circle of his defences narrower; his theory was pushed forth too definitely. A few 'somehows' would have made that electro-chemical theory of his impregnable; and living in those days, it was folly in him to pretend he knew more than 'somehow'. Of course it is a very good thing to make *suggestions* as to how the dual nature of electricity has some corresponding duality in the sister science of chemistry, but he should not have pledged himself so hastily as to what the precise connection was — and straightway he maintained that chemical affinity was nothing but electrical attraction! And I can't think why he did not see that there was a dualism in chemical energy, corresponding to electrical dualism and interchangeable with it (as one form of energy is interchangeable with another) but not identical with it."

" Was your theory suggested to you by Berzelius' views ?" asked the Professor. And Mr. Vincent answered: “To tell you the truth, I was not aware till this evening that it *was* ‘my’ theory specially and not everybody's theory — so far as they thought about the matter at all. Certainly I was much struck with Berzelius' ideas of dualism, though his theories, I **[Page 8]** think, represent molecules as composed in a different way from what we believe nowadays. Still, I should not say that I got the idea from Berzelius; it was more that I read it between the lines of the chemistry text-books that I used. And now that reminds me of a strange instance of confusion and mistake which came from over-looking this half-and-half structure in molecules. I once attended a chemistry class in order to get a little practical work as well as some teaching. The lecturer, following his text-book, pointed out that the valency of nitrogen was variable; though commonly the valency was *three*, it was occasionally *five* (he said). And after reminding his pupils that the valency of an element was its capability of engaging in partnership with other atoms, and that the term tri-valency, applied to nitrogen, meant that a nitrogen-atom joined itself with a set of *three* atoms of hydrogen (the latter being mono-valent), — after this brief explanation, I say, the lecturer cited ammonium-chloride as an instance of the fivefold valency, pointing out that a single nitrogen-atom was there found to be combined with four hydrogen-atoms and one chlorine-atom — that is to say, with five monovalent atoms in all". **[** " In Ammonia, NH3, nitrogen is trivalent, but in ammonic chloride, NH4, Cl, the nitrogen is in combination with four atoms of hydrogen and one of chlorine; it is therefore pentavalent, *i.e*. FIVE valent." (*An Introduction to Scientific Chemistry*, by F. S. Barff, M.A., Chap. XI, po 260.) There is, I believe, just a similar statement in *The New Chemistry* by Professor Josiah P. Cooke, of Harvard University, but I have lost the reference to it.— E. A. W. **]**

“One day", Mr. Vincent continued, “I stayed after lecture, wishing to offer an objection on this point and to

hear the lecturer's reply. I suggested that ammonium-chloride was not a compound of nitrogen with sundry other things, but that a monovalent compound-radical called ammonium was united with a single chlorine atom, also monovalent. At first the lecturer tried to answer me by taking me out of my depth into some question about chloride of ethyl **[** Ethyl is a half-particle or "radical" composed of two carbon-atoms and five hydrogen-atoms. It cannot exist alone as a physical particle, but only as chloride of ethyl, hydrate of ethyl, *etc.* **]** (a thing I had never heard of then), but when, by the aid of his own explanations about ethyl, I was enabled to show him that it was not correct to regard the carbon-atoms of the ethyl separately, and that all the seven atoms of carbon and hydrogen together ought to be taken as forming one monovalent radical, he felt persuaded to let me deal with the nitrogen and other atoms of the ammonium-radical likewise collectively. There was a moment's pause, and then the lecturer exclaimed, “Well, I always thought, myself, that nitrogen was a triad; but Professor So-and-so, under whom I studied, taught that it was a pentad'. I would rather not mention Professor So-and-so's name, because I think it was a real disgrace to him, considering the position he held, to have gone astray in so elementary a point of chemical science. It all came of not **[Page 9]** recognising that ammonium-chloride was a compound of a certain metal-half with a certain acid-half, the metal-principle being supplied by the nitrogen-atom in association with four hydrogen-atoms, whilst the single chlorine-atom stood for the acid-principle."

" Yes; it is a good thing to make that clear, of course", remarked the Professor, to whom in reality it was a perfectly new thought. And then, turning to Mr. Vincent, he added in a tone of contempt, "but your lecturer must have been a very stupid man; he was not fit to teach chemistry".

" Well, I can only say he had worked under the guidance of a biggish man; and he taught everything else very well and clearly. No; I did not despise him for his mistake. And on the other hand I very much admired his honesty and candour in admitting that I was right and that he himself had been led astray."

"Yes", interposed the doctor knowingly; "the longer you live, the better you will know that that characteristic made him one man out of a thousand! "

"Now, if I am not wearying you", resumed Mr. Vincent, "there is another thing which strikes me as an instance of how unscientific our chemistry teaching is — and all for want of a clear understanding about this mating of acids and metals. Look at the case of testing. A student is taught — as a matter for his memory — that the test for sulphates is barium-chloride, and he is shown that it causes a white precipitate in the liquid to which it is added, if sulphate-of-something should happen to be there. But whoever encourages him to ask, — 'Why barium-chloride? ' "

" I don't quite understand what you're driving at", said the Professor.

"Why, I mean this. Why do we choose chloride of barium, among all things, for our means of detecting a sulphate in the glass ?"

"Because barium-chloride, when it finds out a sulphate, will form the barium-sulphate precipitate", answered the Professor categorically.

"Well, but *lead* as a sulphate is also insoluble; why don't we employ lead-acetate and form a *lead*-sulphate precipitate ? "

"Because in many cases it would not catch the thief; it would answer for hydrogen-sulphate, but it would fail to detect any of the sulphates of the alkalies or alkaline earths, because in their case the lead would remain lead-acetate."

"Precisely so; now we are getting at the point. Why is a Barium salt the right one to choose if we wish always to catch the sulphate ? Why, because Barium is the one metal which the acid-principle of sulphates finds more attractive than any other. Given sulphate of anything-you-like, it would rather become Sulphate of Barium, the acid-principle forsaking its former mate. But not so with regard to Lead. Take sulphate of sodium and offer it Lead in the place of the Sodium, and it will answer, No thank **[Page 10]** you. But when a Barium compound meets a sulphate, there is sure to be an exchange, because the strongest acid-principle is brought into the presence of the metal it finds most attractive. Just think what a much more intelligent study testing becomes when viewed in this light."

“It is very pretty in this instance", replied the Professor, "but we could not explain the working of all tests in this way. For instance, silver-nitrate will detect any chloride by the white precipitate of silver chloride that is formed. And yet you cannot argue that the Chlorine has acquired the Silver by *force majeure.*"

“Quite so; there, the change is accomplished on an opposite principle. The *force majeure* resides with the Nitrate, for undoubtedly the nitric acid-principle is stronger than chlorine. The Chlorine gets hold of the Silver simply because it is deprived of what it had before, and therefore is willing to take whatever it can get. And if you ask, 'How is the Chlorine deprived of its own metal?' it happens in this way. The acid-principle of the Nitrate finds no charms in the metal Silver with which it is mated, but on the contrary is simply bored by its unattractive companionship, and holds that any substitute would be preferable. Accordingly being a trifle stronger than Chlorine (the acid-principle of the chloride) it pounces on whatever metal it finds accompanying the Chlorine. I mean that if you bring (say) chloride of *iron* within reach of nitrate of silver, there is at once a change to *nitrate* of iron."

“Then you don't think the change takes place", asked the Professor, “in virtue of any affinity between the chlorine and the silver?"

“Well, no; that is to say, I cannot for a moment suppose, taking Sodium-chloride as a strong instance, that Chlorine forsakes an alkaline metal like Sodium in favour of Silver."

"Then these Acid-principles of yours don't care to marry money; only beauty. Eh ?" observed the Professor .

"And that beauty, of the earth earthy! " added the doctor.

“Yes", continued Mr. Vincent, "it is very curious that gold and silver are just the things these acid-principles despise, and that what they most esteem would be such things as the ashes of a burnt-out and gutted edifice, as they are washed away in the dirty flood of the hydrant. However, as to the relation between Chlorine and Silver, I have just a suspicion that Chlorine sets rather a better value on Silver than the other acid-principles do which regard it as such an utter bore. Why now,I'll tell you another acid-principle that does not at all despise Silver — Sulphur. Sulphur has a decided fancy for Silver; and so has the compound principle Cyanogen."

“Then you hold that the acid-principles, as you call them, do not all agree with one another in their estimates of a metal's attractions ? " asked the Professor. **[Page 11]**

“No, just so; tastes differ in the chemical world no less than in our own sphere."

A moment's pause followed, and then the Professor observed: “And so you think, Mr. Vincent, that some change is called for in the way, in which analysis is taught, you think the study might be rendered more intelligent ? "

“Well, yes, perhaps", replied Mr. Vincent, but in a tone which showed that the Professor's summing-up did not satisfactorily represent his own state of mind. The doctor too was equally sensible of the position, and he endeavoured to mend it:—

“I think our friend means to give to his remarks an application somewhat wider than the mere illustrations themselves."

“Oh, quite so! " rejoined the Professor.

“Do you know, Mr. Vincent has led me to a curious reflection — "

“Well, John! let's have it! "

“Then first of all, you will agree with me, I am sure, that he has produced some very interesting scientific thoughts. Confirm them as true, and they are as genuine a contribution to science as anything that was ever hit upon — "

"Undoubtedly!”, said the Professor. "Oh! I have been very much interested indeed".

“And yet", resumed the doctor, "he has not been making any experiments or researches. And what is more, even those experimental facts which he implicitly appeals to, are of the simplest and most familiar kind; they are neither of a complicated nature nor of very recent discovery. For my part I feel persuaded

that there are treasures upon treasures of knowledge to be unearthed in the most elementary topics of science. Whilst your German experimentalist is proudly examining the thermo-electric relations of Zirconium and Yttrium or something of that sort, dealing with substances so rare, that beyond the fact of their individuality there is really no interest attaching to them, — "

“You, see, John, we must do something *new*; all the relations of the well-known metals have been examined by experimentalists again and again.

“Yes", said the doctor, “but why should they work in that department at all ? As for observation of phenomena, our knowledge is not halting for want of that; the mind of man is the Laboratory in which the great discoveries are now to be made."

“Undoubtedly!" replied the Professor; “if we could only have a few more good intellects! " And the doctor: —

“What I feel so strongly is that we do not really want *new* experiments; we have never yet sucked the juice out of the old ones — not even **[Page 12]** out of the simplest and most elementary among them. I feel that there is in the science of chemistry — and I would say exactly the same of medicine and several other sciences — a whole mine of knowledge wrapped up in the elementary chapters. No experiments, no microscopes or other such instruments, will reveal to us the existence of marriages and divorces in the mineral world with all the complicated play of superior attractions, greater strength to seize what is desired, individual or tribal preferences, and so on. To find out that the mineral world is as busy and alive as our own, we must use that faculty which our friend" (turning to Mr. Vincent) "describes, very aptly I think, as ‘reading between the lines'. For after all, this theory of his is not in opposition to any theory of yours or mine; Mr. Vincent takes and accepts the very same facts which you and I do at present the only alternative, the only rival to such a theory is — a blank of ignorance. And this blank of ignorance will never be filled in with the lineaments of truth by means of all the experiments and observations in the world, such as are now being made. Men must cultivate thought and perception; mere information is of very little good; indeed it almost seems to do harm in large quantities? as if it were a heap blocking up the channel of perception and intellectual insight."

"Oh yes, yes! " said the Professor, who was always equal to the occasion, though in this instance he failed to comprehend or sympathize with the remarks which were being made. "Why that is what I am always telling our young men; it is no good their merely reading, they must think and understand".

Presently the party rose, and the Professor stretched himself. Mr. Vincent took leave of his friends and departed, whilst the Professor proceeded to invest himself with a colossal overcoat, meanwhile observing with emphasis: —

" What a wonderful discovery this is of Dr. Koch's! "

"Yes", replied the doctor placidly; “it seems to have caused much excitement". And then the Professor:

"A nice fellow that Vincent; I thought his ideas extremely interesting.”

"Oh, a very promising man — so I think him."

And the Doctor continued:

" It's what I am always saying about our men, Harry; you know that quotation of mine ? "

" What quotation? " asked the Professor puzzled.

"Why, you know; from the Latin Grammar — adapted to the occasion —

‘*Satis scientiae; intelligentiae parum* '. 'Seas of science, but a want of wits'. "

" Oh yes, yes! " replied the Professor; " I follow you now." (Though in truth he did not.) "Yes; the Lord deliver us from small men! Goodnight, John ! "