THE EAST INDIA VILLAGE IN THE VIENNA ZOOLOGICAL GARDEN.

THE managers of the Zoological Garden in Vienna, who are constantly striving to present some interesting ethnographical novelty to the public, have this year imported about eighty people from Siam and the neighboring countries to constitute a village, and those who visited the garden this spring had the pleasure of seeing them put the finishing touches on the many-colored little structures scattered among the shrubbery which serve as their shelter for the summer. The men and women may now be seen sitting at the doors of these huts or on the hearths of the primitive kitchens, or they will be found wandering majestically or idly among the visitors, in white or colored burnouses, each according to his caste, while the children play noisily in canoes on the pond, sometimes running into a small Buddha temple standing in the water. Symbols of all kinds, mostly of a religious nature, are secured to the gables of the huts, before which the cabinet maker, the goldsmith, weaver, tailor and sculptor are busy at their trades.

The people in the village are not all Siamese. It is a well-known fact that the Siamese, on account of a vassalage which has lasted for hundreds of years, have become indolent and utterly lacking in energy, and the men as well as the women, although well proportioned, are small; their flat olive faces and the form of their skulls indicate neither the pure Mongolian nor the pure Malay type. They are good natured and patient, always playing a passive role. In one of our engravings we see some of them standing as spectators while two young men of the Sikhs race are wrestling.

These Sikhs, who are tall, powerful men with fiery eyes, are worthy of special attention. They belong to a peculiar religious sect and have played an important part in the history of India. In times of peace they cultivate the ground diligently, but in the Anglo-Indian army they make brave soldiers. They fought like heroes for their religion and their independence until 1849, when they were defeated and were incorporated in the British-Indian Empire; it seems strange that these men of Maccabean nature should become the hirelings of the Siamese. In the foreground of another of our engravings, in a group of East Indians from Siam, Madras and the Punjab, we see the gigantic figure of an old Sikh, who does good service in the village in the Zoological Garden as a sort of policeman. Several Hindoos also joined the troop who entertain the public, and apparently themselves, with musical productions, snake charming and the well-known fakir tricks.

The most numerous group in the village is composed of Telingas, who, like the Tamils, belong to the Dravida race. These represent the real working class in their native Farther India and in the Malay Archipelago. Most of the efficient workers in this village are Telingas; they made the picturesque structures out of bamboo and palm leaves. Among them there is a barber who shaves the foreparts of his compatriots' heads, but seldom shaves their thin beards; and they also boast of a tattooer who is always busy, for these people consider that certain characters tattooed in the skin are not only very decorative but also a protection from evil spirits. There are some "sensitives," who content themselves with having the figures simply painted on their brown skin.

The women are unattractive without being absolutely ugly; those of the Telinga and Dravida races are markedly different from the women of the other tribes. In these tribes the woman is not a slave, but an equal of the man. It is interesting to see how gallantly they are served by the men when they are cooking. They frequently wear rings in their nostrils such as European women wear in their ears. Here we may see how men ate before the invention of spoons and forks.

In the village there is a school for the children, who trace the characters of the Sanskrit alphabet on the sand that is spread over the floor, by means of little sticks.

Before and after the exhibitions given by the "artists" of the troop, the people walk about in single file, according to the Siamese fashion. There, when a family goes abroad, the father marches first; he is followed by the mother, and then come the children in order according to their size.

Among these men is one who speaks English and claims to be a friend of Prof. Hæckel's, whom he served as guide during a journey through India.—Ueber Land und Meer.

SPIDERS' MUSICAL ORGANS.

At the meeting of the British Association, Mr. R. J. Pocock read a paper on the subject of "Musical Organs in Spiders." He pointed out that the sound organs of spiders were in many cases constructed on exactly the same principles as a musical box; and after describing, with the aid of diagrams, the position of the sound organs and the means by which the sounds were produced, he went on to consider the use of these organs. The activities of any animal, he said, were directed toward one of four purposes—the procuring of food, the avoidance of enemies, the reproduction of the kind, or the protection of the young. The sounding organs of the spider fell into two categories. There were the cases in which the organs were equally well developed in both sexes, and appeared early in the life of the individual, and there were the cases in which the organs appeared only in the male, or were much more fully developed. The significance of the organs in the latter case was purely sexual, and the sounds might serve to assure the female of the identity of the male, for owing to the strength and voracity of the female, the period of courtship was full of risks for the male. As to the case where the organs were equally developed in both sexes, there was no reason to suppose that they had any sexual significance whatever. Their use was to warn approaching enemies, for when these spiders were attacked, it was their habit to rear up and stridulate. These large spiders were poisonous and inedible, and the stridulation was to prevent their being destroyed by enemies in ignorance of their distasteful qualities. The power to stridulate in these cases served the same purpose as the bright coloring which distinguished poisonous reptiles and insects. Where the sounding organs were equally developed in both sexes, there was no reason to believe that the spiders themselves heard the sounds which they produced.

ARTIFICIAL MINERAL WATERS.

By THOMAS WARWICK.

MINERAL waters, both natural and artificial, have been used from time out of mind. We have it on good authority that the old Romans made artificial mineral waters in imitation of the natural springs of Sicily, Gaul, and Iberia, while, during the middle ages, the alchemists made an endless number of such imitations. In fact, the origin of soda water is due to these attempts at reproducing the natural mineral waters, and the generic name of "seltzer" water, which is the common term employed to-day among the Latin races to designate "plain soda," and is not uncommon even in England and America, owed its adoption to the fact that one of the most popular of these artificial mineral waters was the imitation of the natural water obtained from the springs of Selters, near Frankfort. The virtues of these waters were soon found to be due mainly to the carbonic acid gas they contained, and the other ingredients were gradually dropped in the imitations; bicarbonate of soda was the last ingredient to be retained, and consequently the name "soda water" has persisted to the present time.

The sale of mineral waters by druggists is much larger than would be commonly believed, and as the profit on this class of goods is much greater than that on the sweetened drinks, it pays to push their sale, and as they are more refreshing in the long run than a siruped drink, it should not be a difficult matter largely to increase the custom for these goods.

ARTIFICIAL AND NATURAL WATERS CONTRASTED.

True, I have heard it urged that any mineral water if drunk in excess is likely to produce bad effects on the system, and this is undoubtedly the case with certain of the mineral waters, but I doubt very much if either plain soda or Vichy could ever be really harmful in the doses in which they are served up at the soda fountain. Even at the Saratoga Springs, where a customer is allowed for five cents all the mineral water he wishes to drink, I was unable to learn of any case of evil effects arising from the practice; and although I have personally known several soda water "topers," I never knew of one who suffered from his overindulgence, while I did know a number who experienced very beneficial results from the use of this beverage. The above remarks apply as well to the artificial waters as to the natural ones, for in spite of the assertions of the mineral spring owners to the contrary, the natural and the artificial waters are practically the same in their effects on the system. If anything, the artificial waters are more uniform in quality, and less likely to contain traces of injurious matters. Where the mineral spring obtains its great advantage is in the change of scene a trip thither necessitates and in the régime which has to be followed. When the choice is between a natural mineral water in bottles and a careful imitation of the same, the imitation is generally better than the natural water.

HOW ARTIFICIAL WATERS MUST BE MADE.

In making an artificial mineral water it must be remembered that it is seldom possible to reproduce the water by merely combining its chemical components. In other words, the analysis of the water cannot serve as a basis from which to prepare it, because even though all of the components were put together many would be found insoluble, and others would form new chemical combinations, so that the result would differ widely from the mineral water imitated.

For example, carbonate of magnesia and carbonate of lime, which are important ingredients in most mineral waters, will not make a clear solution unless freshly precipitated, hence when these are to be reproduced in a mineral water it is customary to employ other substances which will dissolve at once, and which will, upon combining, produce these salts. The order in which the salts are added is also a very important matter, for by dissolving the salts separately and then carefully combining them, solutions may be effected which would be impossible were all the salts added together to the water in the portable fountain.

In this connection the following table given by Mr. C. H. Sulz in his excellent work on beverages will be found very useful:

GROUP 1.	
Ammonium carbonate.	Sodium chloride.
Ammonium chloride.	Sodium fluoride.
Sodium borate (borax).	Sodium iodide.
Potassium carbonate.	Sodium nitrate.
Potassium chloride.	Sodium phosphate.
Potassium nitrate.	Sodium pyrophosphate.
Potassium sulphate.	Sodium silicate.
Potassium bromide.	Sodium sulphate.
Sodium carbonate.	
GROUP 2.	
Lithium carbonate.	
GROUP 3.	
Aluminum chloride.	Magnesium chloride.
Barium chloride.	Magnesium nitrate.
Calcium bromide.	Strontium chloride.
Calcium chloride.	Lithium chloride.
Calcium nitrate.	
GROUP 4.	
Magnesium sulphate.	Alum (potassa or soda alum).
GROUP 5.	
Lime carbonate.	Lime sulphate precip.
Magnesium carbonate hydr.	
GROUP 6.	
Lithium carbonate.	Iron pyrophosphate.
Acid hydrochloric.	Iron sulphate.
Acid sulphuric.	Manganese chloride.
Iron chloride.	Manganese sulphate.
GROUP 7.	
Sodium arseniate, or sodium sulphide, or acid hydro-sulphuric.	

EXPLANATION OF GROUPS.

The explanation of the use of these groups is simple. When about to prepare an artificial mineral water, the

druggist should first ascertain from his formula which of the ingredients belong to group 1. These should be dissolved in water, and then be filtered and added to the distilled water in the fountain, and thoroughly agitated. Next the substance or substances belonging to group 2 should be dissolved in water, then be filtered and added to the fountain, which should again be agitated. And so the operation should proceed; whatever ingredients are required from each group should be taken in turn, a solution made, and this solution, after being filtered, should be separately added to the fountain, and the latter be well agitated before the following solution is added.

For groups 1, 3, and 4 the salts should be dissolved in five times their weight of boiling, or ten times their weight of cold, water. For group 2 (lithium carbonate), the proportions should be 1 part of lithium carbonate to about 130 parts of cold or boiling water. The substances mentioned in group 5 are added to the portable fountain in their solid state, and dissolve best when freshly precipitated. As carbonic acid gas aids their solution, it is best to charge the fountain after they are added, and agitate thoroughly, blowing off the charge afterward if necessary.

In group 5 the lithium carbonate is dissolved in the acids (see also group 2), the iron and manganese salts are dissolved in 5 parts of boiling or 10 parts of cold water, the solution quickly filtered, the acids added to it, and the whole mixture added to the fountain already charged with gas, the cap being quickly taken off, and the solution poured in. The iron and manganese salts easily oxidize and produce turbidity, therefore the atmospheric air should be carefully blown off under high pressure several times while charging the fountains. The substances mentioned in group 7 are never put into the fountain, except sometimes the arseniate of sodium in the case of Vichy water, which contains but a trifling amount of this compound.

Most of the solutions may be prepared beforehand and be used when required, thus saving considerable time.

Formulas for various waters will be given at the end of this article.

THE QUESTION OF PRICE.

Although manufacturers of mineral water salts and solutions are wont to charge fancy prices for their mixtures, so that many druggists swear they will always make their own salts, yet the sale of mineral waters is in most cases scarcely of sufficient importance to offset the economy effected by making the salts one's self. It is true that a package of mineral water salts which retails for one dollar will perhaps cost only five or ten cents when prepared in the pharmacy, but it is probable that more than a dollar's worth of time will be expended in preparing them.

A question which arises in preparing mineral waters is: "What is the best pressure at which to charge them?" As a general rule, they are charged to a lower pressure than plain soda, and I have even known good authorities to recommend charging certain mineral waters as low as 30 pounds pressure to the square inch, but this seems to me much too low a pressure for the dispensing counter. From 50 to 120 pounds pressure would be a good limit, while plain soda may be served out as high as 180 pounds. There must be enough pressure completely to empty the fountain, while enabling sufficient gas to be retained by the water to give it a thorough pungency. Moreover, a high pressure to the mineral water enables a druggist at a pinch (and I have known of several such cases), when he runs out of plain soda, to use his Vichy water, instead, with the siruped drinks. The taste of the Vichy is not very perceptible when covered by the sirup, and most customers will not notice it.

THE DISPENSING OF MINERAL WATERS.

Mineral waters should not be cooled as much as soda water, and I knew the case of one druggist who had so many complaints that his mineral waters were too cold that he went to the expense of inserting a special pipe in his apparatus, so as to be able to draw his plain soda either cool or cold at will, one pipe from the fountain passing through his regular cooler, and the other passing straight through the ice box, so that the water would not remain long in contact with the ice. As most mineral waters are drawn from portable fountains, a smaller cooler than that used for the soda water is generally employed, so that these drinks need not be served up either too hot or too cold.

Special tumblers should always be used for mineral waters. A man cannot drink as much mineral water as he can sweetened soda water, and even if he could, he would prefer to be helped twice in a small, thin tumbler, rather than once in a large, coarse tumbler. Even at the mineral springs, where a customer is allowed as much mineral water as he can drink, a small tumbler of very thin glass, holding from 7 to 8 fluid ounces, is used, and greatly adds to the pleasure of the draught. The profits on mineral waters are so great—especially on plain soda—that I have often wondered why druggists do not seek to push the sale of these. A glass of plain soda costs the druggist one-fifth of a cent. Why then would it not be a good plan for him to imitate the practice which has proved so popular at the mineral springs, namely, of allowing each customer who comes for plain soda to drink as many glassfuls at he wishes at a sitting without extra charge? The scheme at least seems to be worth trying.

As to those druggists, and they are not a few, who persist in asking ten cents for a glass of plain soda, it is difficult to understand how they can keep this price up. The only regular customers that can be obtained at this price are among the fashionable classes, and even men of means will look twice at a cent nowadays before spending it. It is not only the pauper and the millionaire who are willing to walk a mile to save five cents, but the middle classes as well know the difference between a dime and a nickel.

WHICH WATERS ARE MOST POPULAR?

Before concluding this article, a word in answer to the question as to what are the most popular mineral waters will be in order. The number of natural mineral waters is almost infinite, as are also their artificial reproductions. There are, moreover, a few specially prepared medicinal waters, compounded not in imitation of any natural water, but merely to obtain certain medicinal effects. Now it is impossible for the drug-

gist to keep many of these in stock; in fact, it seldom pays him to keep in fountains more than two mineral waters in addition to his plain soda. Vichy is, of course, the great standby. Geyser, Selters, and Kissingen are also frequently called for, but the demand varies so much according to locality that each druggist is obliged to be governed by his individual circumstances. It is seldom wise to try anything but Vichy water in portable fountains until assured that there is a real demand for any other mineral water.

FORMULAS.

The formulas given below are for making 10 gallons of mineral water—i. e., a sufficient quantity to charge the ordinary 10-gallon portable fountain. For the sake of convenience the different groups of substances in the formulas are separated by dashes. All the components above the first dash must be mixed together as directed in the first part of this article, and must then be added to the 10 gallons of water in the portable fountain, rocking the fountain all the while to secure a thorough mixture. The ingredients above the second dash must afterward be combined together and added to the fountain; and so on with each of the other groups in turn. The formulas given are designed to produce a very close imitation of the natural waters. Less elaborate formulas, which merely approximate the principal ingredients in the natural waters, are frequently used, and a few of these are given at the end of this article.

APOLLINARIS.

	Grains.
Sodium carbonate.....	2,835.27
Sodium sulphate.....	335.2
Sodium silicate.....	10.0

Magnesium chloride.....	198.1
Calcium chloride.....	40.2

Potassa alum	57.1
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Magnesium carbonate, hydr	158.5
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Iron sulphate.....	21.3
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DEEP ROCK.

	Grains.
Sodium chloride ..	1,504.8
Potassium chloride.....	1,490.8
Sodium silicate.....	1,458.0
Sodium carbonate.....	521.1

Magnesium chloride.....	102.5
Calcium chloride.....	202.0
Hydrochloric acid.....	257.4

KISSINGEN.

	Grains.
Sodium phosphate.....	3.6
Sodium silicate.....	16.1
Sodium chloride.....	2,776.4
Potassium chloride.....	176.2
Sodium bromide.....	5.0
Sodium nitrate.....	57.0
Ammonium carbonate.....	1.6
Sodium carbonate.....	1,986.7

Lithium chloride.....	12.2
Calcium chloride.....	960.0
Magnesium chloride ..	14.9

Magnesium sulphate	1,213.8
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Iron sulphate.....	46.1
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SARATOGA VICHY.

	Grains.
Sodium carbonate.....	4,249.8
Sodium chloride.....	112.2
Potassium chloride.....	141.1
Sodium bromide.....	9.9
Sodium silicate.....	15.4

Lithium carbonate.....	11.0
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Calcium chloride.....	736.3
Magnesium chloride.....	307.9
Barium chloride.....	6.2
Aluminum chloride.....	12.5

Iron chloride.....	0.39
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The foregoing formulas are designed to give imitations as closely as possible to the analyses of the natural water, the analyses of the best chemists having been taken in every case. As in many cases the composition of the waters of the mineral springs differs at different seasons of the year, the mean or average of several analyses has to be taken as a standard.

In cases where a close reproduction of the natural waters is not required, much simpler formulas may be used, as for example in the three formulas given below:

VICHY.

Sodium chloride.....	6 drachms.
Sodium bicarbonate.....	5.25 ounces.
Ammonium carbonate.....	10 grains.
Sodium phosphate.....	25 grains.
Sodium sulphate.....	4 scruples.
Potassium sulphate.....	2 drachms.

Mix in half a gallon of water, and filter after standing twelve hours.

This solution may be kept a certain length of time, and when required be added to 10 gallons of water in the portable fountain and charged to 150 pounds pressure.

KISSINGEN.

Sodium bicarbonate.....	1 drachm.
Sodium chloride.....	.8 ounces.
Ammonium chloride.....	.4 grains.
Sodium sulphate.....	2 drs. 2 scr.
Magnesium sulphate.....	2 ounces.
Magnesium carbonate.....	4 drs. 1 scr.
Water	2½ pints.

Add to 10 gallons of water in a portable fountain and charge to 150 pounds.

SELTERS.

Calcium chloride	0.27 gm.
Magnesium chloride.....	0.8 "
Sea salt.....	0.23 "
Sodium phosphate.....	0.27 "
Iron sulphate.....	0.013 "
Sodium sulphate.....	0.4 "
Water.....	605.0 "

Charge to 150 pounds pressure.

N. B.—In the case of these last three mineral water solutions it is desirable to shake the solution thoroughly before adding it to the water in the portable fountain.—Bulletin of Pharmacy.

THE NATURE OF VALENCE.*

By F. P. VENABLE.

THE term "valence" is variously defined as the "combining capacity," "capacity of saturation," "quantitative combining power," or "chemical value of the atom." It is well known that the introduction of this idea into chemistry was due to the development of the type theory, a system which had at first a purely empirical basis. Sixty years ago there was still some hesitation as to the acceptance of the atomic theory or the need for such a theory. Much use was made of the term equivalent, which had been Wollaston's expedient for avoiding the difficulties arising from the full adoption of the theory of atoms.

Wallaston had been himself very far from consistent in the use of the term. The numbers called by him "equivalent weights" were not infrequently atomic and molecular weights and fully as hypothetical as the so-called atomic weights of Dalton. In the later use of the term it signified solely the numbers obtained by analysis without the introduction of any theoretical considerations. Thus, on analyzing ammonia, the ratio

$$N : H :: 4.6 : 1$$

is gotten, and therefore the equivalent of nitrogen is 4.6. Strange to say, the equivalent given by Wollaston corresponds with the present atomic weight, whereas the atomic weight given by Dalton corresponds with what would be the equivalent.

It is manifest that the idea of equivalents needed something more than the simple theory of atoms to make it clear and tenable. It embodied two distinct conceptions, and if we hold to an atomic theory we must introduce a further explanatory theory of the saturation capacity of these atoms. This is the theory of valence, or quantivalence, or atomicity, and without it the equivalents are purely empirical, and it is most difficult if not impossible to clear up the confusion connected with their use.

Returning now to the derivation of this idea of valence from the type theory, according to Wurtz,† the conception of valence was introduced into the science in three steps. First there was the discovery of polyatomic compounds. This term was first used by Berzelius in 1827,‡ he applying it to such elements as chlorine or fluorine where he thought several atoms of these elements united with a single atom of another element. The term was later applied by Graham, Williamson, and others to compounds.

The second step was the reference of this polyatomicity to what was called the state of saturation of the radicals contained in these compounds. This was largely through the work of Williamson and Gerhardt.

Thirdly, this conception of saturation was extended to the elements themselves. This was chiefly due to the work of Frankland upon the organo-metallic compounds. And so valence has come to refer to the number of atoms with which a single atom of any element will combine.

This conception has then been one of slow growth, gradually incorporating itself into the science as the necessity arose of devising a suitable explanation for accumulated observations. It was a logical outcome of and was evolved from knowledge acquired step by step. It was no mere speculation or hypothesis, such as that of Prout, evolved by the brilliant fancy or imagination of one man and suddenly appearing with scarcely a claim to foundation upon observed fact.

This conception enters into the chemical theory of to-day almost as fundamentally as the atomic theory itself. Its application is of everyday occurrence and of the most varied character, and yet chemists admit that the nature of valence is one of their chief puzzles and they have advanced but little toward its solution during the past half century. It is quite possible that the ideas to be advanced in the further discussion of this subject in this paper will meet with antagonism. Certainly they should be fully and freely discussed if they are worthy of it. I believe that they form a step toward the clearing up of the mystery of valence.

It is necessary, however, first to trace somewhat further the development of the original conception. One of its earliest and most important applications was to the study of the constitution of the compounds of carbon. Here Kekulé assumed for carbon a constant valence of four, and this idea is still dominant in theories relating to the constitution of these bodies. It was quite natural, then, that the first belief should have been in a constant valence. It was speedily found, however, that in certain cases, as in the compounds of nitrogen and phosphorus, this belief was scarcely tenable. There were efforts at making it hold good, as, for instance, a distinction was drawn between atomic and molecular compounds, but all of these suggestions have been proved unsatisfactory.

We unquestionably have to account for the existence of a compound with three atoms and another with five atoms in the cases of nitrogen and phosphorus and there are many similar anomalies. Here the valence seems to vary toward one and the same element. Cases might be multiplied to show also that it varies often toward different elements. Thus it frequently happens that the valence of an element toward hydrogen seems to be quite different from that exhibited toward oxygen. For a long time there was

* Address, as chairman, delivered before the North Carolina Section of the American Chemical Society. Reprinted from the Journal.

† Histoire des doctrines chimiques, p. 89.

‡ J. Chem. Soc., 7, 89.

much straining to consider the valence of an element always the same, but this effort is, in large measure, abandoned now as unavailing, and chemists admit that valence is not constant but variable, and may even vary toward one and the same element.

The doctrine of valence has had much added to it about bonds, affinities, and linkage, the necessity for which one may well question. Certainly the misuse of the word affinity here, seeing its other and greater use, should be earnestly discountenanced. I am inclined to think that the other terms bring in false and misleading ideas which should be carefully guarded against. At any rate, all hypothetical talk about strong bonds and weak bonds, double bonds and triple is to be avoided.

If, then, valence varies, can it be an inherent property of the unchanging atoms? Experiments have shown that it varies with the nature of the combining element, that it varies with the temperature and with other conditions. It is not dependent upon the atomic weight in the same sense as other properties are dependent upon it. Thus in the same group the valence remains the same, whether the atoms weigh nine times as much as hydrogen or two hundred times as much.

We seem shut up to the conclusion that valence is not one of the primitive inherent properties of the atom but is relative. It is rather to be regarded as the resultant of the mutual influence of the atoms of the combining elements. The clear grasping of this idea is an important step forward. Unfortunately the distinction is not always made nor consistently adhered to.

It may not be amiss to cite here the utterances of Lothar Meyer in regard to the question of a constant or variable valence.*

"Since the aim of all scientific investigation is to exhibit the most variable phenomena as dependent upon certain active invariable factors taking part in them and in such a manner that each phenomenon appears to be the necessary result of the properties and reciprocal action of these factors, then it is clear that chemical investigation would be considerably advanced were it possible to prove that the composition of chemical compounds is essentially determined by the valency of the atoms and the external conditions under which these atoms react upon one another. The first necessary step in this direction has been made in the attempt to explain the regularities observed in the composition of chemical compounds, by the assumption of a constant power of saturation or an invariable valency of the atom. The opposite and equally hypothetical assumption that the valency is variable leads to no advancement.

"The first step toward progress in this matter would be made if some hypothesis as to the cause of this variability were proposed. This difference between the two attitudes has seldom been properly realized. While some chemists, accepting the constant valency of atoms, have attempted to deduce the varying atomic linking from one distinct point of view, others have considered it sufficient to have assigned to the atom of a particular element in one compound one valency, and in another compound a different valency, according as this or that value appeared the most suitable, and thus to have given a so-called explanation of the composition of the compounds in question. In this way the fact has been overlooked, that an arbitrary interpretation, carried out by means of chosen hypotheses, cannot be regarded as an attempt at a scientific explanation, but is nothing more than an expression of our ignorance of the causal connection of the phenomena. An explanation would require that the different valencies assigned to one and the same element in different compounds should be traced to a distinct cause. If, for instance, it is stated that carbon in carbon dioxide possesses double the valency which it possesses in carbon monoxide, such a statement is no explanation of the fact that an atom of carbon in the former compound is combined with twice as much oxygen as in the latter, for such a statement is merely a paraphrase which hides its incompetency by assuming the form of an explanation. Although this may be perceived without further remark, still it has frequently occurred during the past few years that similar paraphrases have not only been proposed but also accepted as real explanations of such phenomena. Just as it was formerly supposed that the assumption of a vital force dispensed with a more complete investigation of the phenomena of animal life, so many chemists have of late thought that they possessed in 'variable valency' a means of explaining the varying stoichiometric relationship which would satisfy all claims. Such deceptions can only retard the advance of the science, since they prevent an earnest and thorough investigation of the question, whether each atom is endowed with a property determining and limiting the number of atoms with which it can combine, dependent upon the intrinsic nature of the atom and like it invariable; or whether this ability is variable and with it the nature of the atom itself."

It is not strange that this line of reasoning should lead Lothar Meyer to doubt the unvarying nature of the atom itself, and thus losing his grasp upon one invariable to make sure of another. He says: "It is by no means impossible that the magnitudes which we now style atoms, may be variable in their nature."

It will be an unfortunate day for chemists when the belief in the unchanging atom is given up. Chaos will indeed enter into all of our theories when this, the foundation rock, is left at the mercy of every shifting tide of opinion and can be shaken by all manner of unfounded hypotheses.

The case cannot be so hopeless as to necessitate calling to our aid so dangerous a doctrine. Before turning to such an expedient, let us first make all possible use of our atomic theory as it stands. The extension of this theory teaches that the atoms are endowed with motion, and this motion probably varies in velocity and phases with the different elements. So too when the atoms unite, the resulting molecule has a certain motion peculiar to it, while the atoms composing it have an intra-molecular motion in which their original motions are probably modified by their influence upon one another. It is quite manifest then that a molecule, in order to exist, must maintain a certain equilibrium.

* Modern Theories of Chemistry, Eng. trans., p. 308.