THE

MATERIA MEDICA

IN ITS

SCIENTIFIC RELATIONS.

By
Wm W. Rodman

"Duæ viæ sunt atque esse possunt ad inquirendam et inveniendam veritatem."

Novum Organum, Aph. XIX.

NEW HAVEN, CONN.:
JUDD & WHITE, 240 CHAPEL STREET.
1868.

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To all who love the truth, this paper is earnestly inscribed. If its positions should not be accepted, its purpose will be fully served, if some one else is led to accomplish what it has aimed to do.

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W. W. Redman

THE Form of Dr. Bradford
Dec, 98
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THE MATERIA MEDICA IN ITS SCIENTIFIC RELATIONS

THE principles which give laws to the materia medica are those which are our guides in other studies. They are exact, determinate and universally applicable. However men may be at variance in regard to advanced positions, these fundamental principles are beyond dispute. The relations between abstract science and the materia medica are essential to the due development and to the thorough study of this important branch of knowledge.

The agents which constitute the materia medica have various powers and properties. Their chemical and physical properties stand related to several sciences. The powers by which they modify vital actions, give origin to certain medical branches. These modifications are chiefly two-fold, namely, disturbances from health and restorations towards it. The physiological and the remedial operations of medicines should be the physician's constant study.

Indeed, with him the great object of research, is to determine the remedial powers which medicines and some other agents possess. This is *Therapeutics*. To it, other branches are tributary and subordinate. But little time would be spent in studying the structure and the functions of the human organs, if they were not subject to disorder. Nor should we work hard to learn the operations of medicines, if these agents did not possess restorative as well as disturbing properties.

As is true of other branches of physical study, therapeutics is to be built up by a rigid adherence to the inductive processes. None of its positions can be deemed secure which are not in accordance with the elementary principles which give basis to modern science. Observation, experiment and comparison have the same essential places here as elsewhere. No evidence is to be taken as final which is not inductive or in the good sense empirical.

That a medicine cured or *seemed to cure* a case of disease is a pertinent fact in a question of therapeutics. That it is followed by the cure of similar cases, furnishes some evidence in favor of the

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medicine. That it cures many such cases, is still better—may perhaps be conclusive evidence of its efficacy and value. But nothing that can be furnished from other quarters, whether it be fact, presumption or "general principle," does furnish positive evidence or is entitled to be called proof.

But how is therapeutic evidence to be obtained? How are we to secure the necessary inductions? We cannot experiment with medicines indiscriminately. We cannot subject a sick man to experiment with one medicine after another and thus obtain our inductions. We must receive suggestions from other sources to guide the selection. In ways too numerous to follow now these suggestions are obtained. A great science has been built up, whose aim is to secure them. It is called the *materia medica. It is of course itself an inductive science.* The principles upon which other studies are based, are fundamental here. How can they be applied? *How can the materia medica be built up, as a science of observation?* is the question before us. This question has been mixed up with controverted topics. We need to avoid these and to discuss the subject independently of all questions which divide men into parties. The process must be a useful one, however dry and difficult it may be. Abstract and technical it must be of course. But the questions raised are of the greatest practical importance.

Let us then seek those principles which underlie the opinions of all medical men even though they may be unconscious of them, and starting from them secure advanced positions, to which men of different views can give assent. We begin with a passage, which was the key and is ever the embodiment of the inductive philosophy.

"There are two ways and can only be two, of seeking and finding truth. The one from sense and particulars, takes a flight to the most general axioms and from these principles and their truth settled once for all, invents and judges of intermediate axioms. The other method collects axioms from sense and particulars, ascending *continuously and by degrees*, so that in the end it arrives at the most general axioms: this latter method is the true one but hitherto untried."

The term materia medica has undergone changes or at least limitations in its meaning. It originated in the collecting and studying those material substances which became medicines. As the facts thus obtained increased in number and were classified, the

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name was given to the department of knowledge thus formed. As the facts became more numerous, division and sub-division were necessary. New departments were made and the name materia medica was restricted to one of them. At each period one branch stands representative for the others. Its object is to obtain material for therapeutic experiment. The other branches are in one way and another tributary to it. Thus the general term materia medica has included the history of medicines, their chemical, botanical, mineralogical and commercial relations, their operations on the animal economy in health and in disease and finally their uses. In due time the process of separation left their physiological and therapeutical operations to represent the science. For reasons that will come under our notice hereafter, these two classes of phenomena are being studied more and more as special departments. It is already obvious that what is sometimes called the *materia medica proper* is to crystallize as a distinct study. Such has been the history of other branches of knowledge. Two processes are continually going on, the collection of material and the distribution of it into groups. *Each group is to be studied by itself*, although it is only after considerable progress is made that its inductions can be rigidly separated.

As the statement of our subject implies, we use the term materia medica in its restricted or scientific sense. Accordingly it is to be distinguished, first from those sciences which in one way or another are the sources of medicines, as botany, chemistry, pharmacy, &c., and secondly from that which treats of the action and uses of medicines in the cure of disease, namely, therapeutics. If the terms materia medica and therapeutics are sometimes used interchangeably or at least as overlapping each other, such a course does not comport with the plan of this paper.

We make some extracts from recent standard authors bordering upon these distinctions.

"MATERIA MEDICA or PHARMACOLOGY treats of the natural history and the preparation of medicines and of their operation on the animal economy. It strictly includes PHARMACY, or the art of selecting, preparing and compounding medicines, but this which belongs to the apothecary as his special business, should occupy only a subordinate position in a treatise which is addressed to the physician and the student of medicine.

"THERAPEUTICS treats of the *action* and *uses* of medicines in the cure of disease."—(*Stillé*).

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"It (the materia medica) includes two distinct departments, viz: First, *Materia Medica proper*, embracing simply an account of the history and properties, physical and chemical, of medicinal agents, and of their effects on the system in health. Second, Therapeutics, that which relates to the effects of these agents in their applications to the managemant of disease."—(*Beck.*)

Although Dr. Beck includes the physical and chemical properties, and the natural history of medicines, in the materia medica proper, they are excluded from the present inquiry as plainly belonging to other branches. It would seem that this limitation of the science must ere long receive the assent of all men. It is certainly proper to limit the subject of investigation as definitely as possible. If, however, the distinctions above stated are observed, it is comparatively unimportant whether the subjects are avowedly considered as separate sciences, or are held as branches of one science. But it is essential to exact inquiry, that their inductions be kept apart.

An ambiguity exists in the word medicine, according as it is taken in its relations to science or to use. In therapeutics, a medicine is a substance used for the cure or mitigation of disease. In the materia medica, considered as an independent science, it is a substance which has certain powers and properties which make it likely to be thus useful, even though it may never have been applied to actual use. The ambiguity is avoided by some, by using the term *drug* to designate an agent known to have medicinal properties without regard to therapeutic applications. There is no way of avoiding the difficulty in regard to the meaning of the terms employed, that is entirely free from objection. It is necessary to use them as scientific terms, in order to bring the subject within the range of logical investigation. And if it is necessary to use one term in two senses, we should be careful not to base arguments on one signification which apply only to the other.

The materia medica has complex relations. In common with some other physical sciences, it has not always been based exclusively upon a rigid observation of natural phenomena. A stage of crude deductions from imperfect data seems necessary as a preparatory process. Even now the effort is a common one, to deduce the properties of medicines by processes of reasoning. And doubtless it is destined to continue as a deductive science, as well as an inductive one. It also has relations to the other medical branches. Induction, though not usually the first to attract attention, is the

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initial process preparatory and fundamental to all others. This paper will be restricted to these elementary processes, though frequent allusion will be made incidentally to the different aspect in which the materia medica is placed.

Various positions are held on this subject. It is taken for granted by some, that the materia medica, as taught by standard authors, comprises such a body of exact and enduring knowledge as fully entitles it to rank as a science. Others maintain that there are intrinsic difficulties in ascertaining the properties of medicines which prevent the inductive process being duly followed and consequently that the materia medica cannot take any other than a very subordinate place. Most physicians, however, have contented themselves without raising the question. They have gathered from various sources what could be learned of the therapeutic powers of remedial agents, without taking the view, that the materia medica itself should be studied separately and inductively.

If the question were asked, whether any attempt has ever been made, to apply the strict principles of science to the development of the materia medica, we might at least assume that no such attempt dates far back in medical history, or has been so successful as to preclude further effort.

Whatever estimate men may put upon the progress already made, no one surely who compares this with the other physical sciences, can doubt that much remains to be done. Those who worthily claim to be "physicians" or students of nature, must desire the perfecting all the branches tributary to the practice of medicine.

To accomplish this, the several departments must be constantly advancing in improvement. The improvement must take place in each separately, and also in the relations of each branch to the others.

To perfect each individual branch it is requisite,

1. That it be placed on a well defined basis.

2. That its phenomena be determined by observation and experiment.

3. That the phenomena thus obtained be systematized.

While each particular study is thus in process of development, the relations of the results obtained, to each other and to the other medical branches, are to be determined. We gain in this way, new facilities for further improving the several branches. Thus, through endless ramifications, all are advancing by this mutual interchange of good offices.

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For example, Anatomy must be studied as a distinct branch of science in order to perfect it. Its phenomena must be gathered separately, arduously, systematically. It must also be studied in its relations to physiology, to surgery, to therapeutics. The applications of anatomy, to these and to other branches, will open new avenues for the further prosecution of anatomy itself. If, with utility as the aim, anatomy had advanced only in connection with the other sciences, its own progress would have been retarded, and they in consequence would also have suffered. Our object is to treat of the materia medica as an independent science.

The subject has many and tangled relations. There are intrinsic difficulties and others which have been needlessly added. To clear it up as much as possible, we desire to include in this introductory matter, some additional considerations bearing upon it. We must return to some of them again and again, as is required by the logical unfolding of the several topics. It will be necessary to dwell, more than might be wished, upon the principles and the processes involved, owing to the perplexity which has arisen from the frequent disregard of them.

The materia medica, *considered as a science*, is that branch of knowledge which determines and teaches the properties of medicines. The properties thus taught, include all the effects which they produce on the human system *in its normal state.* Not, to any great degree, effects which occur under exceptional circumstances, as disease for example, where there is no uniformity of action or of intensity, but such as occur regularly or usually and whose repetition can be secured by experiment, an unlimited number of times. When accurately determined and naturally grouped, these phenomena constitute the *materia medica proper* a science of observation and induction. Taken deductively and put to practical use, the results are tributary to therapeutics. The phenomena which make therapeutics an inductive science are the remedial and curative operations of the agents which the materia medica and some other sources furnish to us.

It is requisite for due discrimination and the most successful progress that the study of the two sciences be kept apart, at least in their inductions. Even if they are considered as branches of one and the same science, the principle is unaltered. The phenomena, on which their conclusions are based, are distinct and cannot logically be grouped together. The questions to be answered are different. In the one case it is what effects will the given medi-

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cine produce. The question in the other instance is, what will cure the disease before us, or it may be, what will alleviate the group of morbid symptoms. As scientific questions, they are to be answered from evidence independently of each other.

The application of one science to the improvement of the other, or in other words the relation of the materia medica to therapeutics is a still different matter and is not within the range of this paper. To introduce it would be to raise issues that men are not yet agreed upon. It may however be said, that it gives opportunity for the exercise of all the knowledge which can be brought from the various branches of medical study. That application may be either particular or general. It may aid us to learn what contributes to the best treatment of the particular case before us, or aid us in determining principles applicable to a class of cases, or even open to us laws for several classes. The most profound sagacity, the highest inventive genius, with which the human faculties are ever gifted, may here find scope for their exercise.

At the outset of any inquiry, one of the most common difficulties arises from the bias we suffer from preconceived opinions. Our pride, our habits of thought and study, our friendships and our personal history are identified with them. Reason tells us that we may be led astray, even if we are unable to realize it. The world has not yet produced men so wise, on any scientific subject, as not to have found limits to the extent and often to the certainty of their knowledge. The wisest philosophers, the most eminent discoverers have reached such limits and there rejected truths, offered to them, whose possibility they were unable to accept.

How then can we be sure of our own position? How can we know that our most trusted opinions are not distorted by influences similar to those which have misled others. Unless we can claim infallibility, or are indifferent on the subject of moral responsibility, we must sometimes ask ourselves these questions.

The inquirer after truth need not wander hopelessly in the dark. In the physical sciences there are certain principles which admit of definite statement, conformity to which, *as fast and as far as it can be maintained*, gives security. The principles of Experimental Philosophy have placed one after another of these sciences on a firm basis. To this test each of them brings its tenets. A science that lacks conformity to its methodical system of rules and processes stands insecurely. There can be no certainty that its doctrines of to-day may not give place to other positions to-morrow.

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The application of these principles has difficulties and is subject to some modifications in the different sciences, according to the nature of the subjects of inquiry. But it is found in each of them, that whenever a way is opened, by which a more strict adherence to these principles is secured, corresponding advancement in the science results.

If a scientific materia medica now exists, it must be in accord with these principles. If such a science is yet to be built up, it must be by conforming, as strictly as is possible in the circumstances, to that philosophy which has done so much for other branches of knowledge. The relation between principles on the one side and investigation on the other is a fixed one. Whenever a subject can be mentally separated from other topics, all questions in regard to it are to be referred, singly and as directly as possible, to the observation of natural phenomena.

To apply the principles heretofore appealed to, to the development and to the study of the materia medica, the following things must be done.

1. The subject must be placed on a scientific basis. In other words the investigation must be restricted within definite limits.

2. The phenomena obtainable by observation and experiment must be determined.

3. The phenomena thus obtained must be compared and classified in their natural relations, considering the end in view.

When these things are done, the application of the knowledge thus obtained, to the other branches of medicine, will deductively open new channels of investigation, by which the materia medica can be further developed.

1. To bring any investigation into accord with the demands of science, it is essential that the steps be taken within certain well defined limits. These limitations will be considered under the following heads. The development and the study of the science must be by processes which are (1) inductive; (2) separate; (3) without regard to practical utility; and (4) definite.

(1.) It is to be borne in mind that *induction* is the essential part of the process and that it must be as direct as is possible. Nothing must be omitted that will add to the accuracy, to the completeness and to the availability of the inductions. Nothing must be admitted as a substitute for them. There are other things necessary to complete success, but in each of them deficiencies may

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occur or mistakes be made without involving failure as a matter of course. Logicians tell us justly of the importance of hypothesis, of observation, of generalization and of various other processes. Yet in either of them single errors may occur and yet not be fatal in our search for truth. Theoretical deductions often occupy an important place. Their anticipations are often the first suggestions of facts afterwards more rigidly proved. But the scientific value of such deductions entirely depends on the accuracy of the inductions. Probably every science which has been built up deductively and afterwards been made the subject of rigid inductions, has had its positions materially altered or completely revolutionized.

To illustrate: A man may find that a teaspoonful of a new medicine taken into the stomach is followed by vomiting. This observation may be the starting point in the investigation. If the same phenomenon occurs in repeated instances, with different individuals, we obtain the generalization that the article experimented with, vomited a dozen persons. If due caution is used to exclude other agencies, after a while the inference would become indubitable, that the substance had a tendency to vomit any healthy person. This is an induction. It is knowledge not included in the direct observation, for we cannot experiment with every body, nor is it part of the generalization, for that included only a limited number. It is drawn from the facts by a mental operation, the inductive process. In the development of a science at any given stage, if the induction is not secure, every other inquiry, suggestion and process, is impertinent and misleading.

If, now, it is already known by other evidence, that is, by another class of inductions, that the process of vomiting has been useful, the inference may be drawn that the new drug would include those uses within its powers. This inference is less direct. It might be true or it might not be, without raising a question as to the emetic properties of the drug. But if either of the two inductions be false or untrustworthy, the conclusion must share its weakness. If it be said that that conclusion might itself become an induction from trials on the sick, we concede the claim. But this is an induction of another science, therapeutics, and has no place in a scientific materia medica. That a medicinal agent has the power to produce a certain effect on a healthy man may be an induction of the materia medica. That it will produce a similar effect on a sick man, may be a therapeutic induction, or, as some would say, it

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may be an induction of the materia medica, using that term in a broader sense than that now advocated. In either case, to infer one of the facts from the existence of the other is not an induction, for the circumstances in the two cases are different. To establish it, would require that experiments be made in disease and indeed in each particular disease, and thus the inquiry is removed from the domain of the materia medica proper.

To return to the supposed trial of a new medicine. We have seen how a preliminary induction may be obtained, namely, the emetic power. If the drug is capable of producing another effect, that also should be ascertained. The process should be continued, according to methods and subject to cautions, which will claim our notice presently. It is essential that all the effects of the medicine should be ascertained. If the article in question has been made the subject of investigation during the whole history of medicine, the process is not complete as long as new facts can be determined by applying the principle of induction to the results of observation and experiment. If more exactness or completeness can be pointed out than that secured, the whole science, must if need be, be held subject to reconstruction. Moreover while one substance is thus treated, it is to be presumed that other medicines are being subjected to the same process and the inductive principle is to be applied to them jointly, to the extent that two or more substances may elicit like results.

These remarks have been extended in order to bring before the mind the important place which induction holds amid the processes concerned in determining scientific truth. The principle under consideration is violated whenever speculations, theories or indirect deductions take the place of rigid inductions. Science should be based on the latter. The former have other uses.

Tested by this principle, it will be seen doubtless, that all the works on the materia medica, except quite recent ones, are entirely deductive in their character and make no attempt to determine the properties of medicines by inductive processes. These properties have been ascertained chiefly by processes of reasoning from limited data. It was long maintained that "the faculty or power of medicines, depends chiefly upon their general qualities of heat and cold, dryness and moisture. This doctrine, however, unfounded and erroneous, was implicitly followed by all the physcians of Greece who succeeded Galen, as well as by all the physicians of Asia, Africa and Europe for at least fifteen hundred years." "Medicines

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were every where explained by the *cardinal qualities* and their different degrees, with very little reference to anything acquired by experience."* Cullen's "Treatise of the Materia Medica" is the best exposition of the state of science at the close of the last century. Cullen and his disciples taught as follows. "In general, the means by which the remedial or medicinal character of different substances are determined at the present day, are their own sensible qualities, their botanical affinity, their chemical analysis and general experience." By *experience* was meant the knowledge obtained by the use of medicines in disease. He gives the results of a few experiments on brutes, some facts elicited by accidental poisoning, but there is no allusion to the methods of experimentation now deemed essential to success. In short, the idea of a scientific materia medica, as we now use the term, had no existence.

A few years later, Dr. John Bostock wrote as follows, showing his perception of the error of previous methods and his failure to see the true process. "That all the attempts which were made to ascertain the properties of the materia medica from hypothetical principles were of no effect; that experience ought to be the sole guide; and that the only method which promised any success, was to collect from the best sources of information, the most authentic facts and to arrange the facts thus obtained in a scientific form."

We find about this period, the first traces of a science of observation and induction. Many of the most characteristic operations of medicine were still unknown and inferences were drawn from imperfect data, which often led to positive error. But medicines were now for the first time made the subjects of direct experiment. Gradually, different explorers reached the true method. The doctrine as taught by them, and the practical results gained in accordance with it, will be noticed at subsequent stages of this inquiry.

(2.) To place any branch of knowledge upon a scientific basis, the science itself and each of its particulars must be investigated singly. This isolation includes the end aimed at, the processes followed and the material collected.

A science has its own *aim* to which its processes are to be subordinate and its material is to be tributary. In the case before us the aim is to ascertain the operations of individual medicines. If any other end is *prominent*, the mind will be turned aside. Thus for example, to seek a presumptive explanation of some well known

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* Rees' Cyclopedia.

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remedial action, is tempting and instructive. It may open facts pertaining to the materia medica and of course be useful to us. But it is not coincident with the precise thing to be aimed at, and *by itself* might lead to distorted results. Search for the *modus operandi* of medicines has many times led to error. Again, to make the development of the materia medica to consist in finding agents that will meet the wants of exceptional cases, or in other words, to identify it with therapeutics, is to turn it aside from its direct aim which demands at least, approximate uniformity and exactness. A chief reason why the materia medica has had so little of a scientific character, is that it has lacked singleness of aim.

Again, the *methods of investigation* are to be those which experience shows to be best adapted to secure the result aimed at. They must be distinctly appropriate to the end in view. They grow up gradually, with each science, inspired by those fundamental principles and processes which give basis to the other sciences of observation. Some of these processes as applicable to the materia medica, will come under our consideration hereafter.

The *material* to be gathered, consists of the phenomena which are applicable to the inductions of this study, that is, those which bear directly upon the end in view. All other things have a subordinate place. The phenomena of other sciences may indeed be useful in two ways, suggestively and instrumentally. Knowledge gained from other sources is often useful to the explorer, by suggesting new avenues of inquiry, by opening new methods of investigation and by rendering various preparatory aids and cautions. Such knowledge may also help us instrumentally by aiding our conceptions and giving us clear, exact and appropriate ideas on subjects which come under our cognizance. But no phenomena are to be admitted to the inductions of a study except those elicited by its own processes or at least those which pertain to its own province. The facts pertaining to a natural secretion in a healthy person are phenomena of one science. The suppression of that secretion by natural disease, appertains to another science. Its restoration, if by remedial power, belongs to a third. Whatever effects are produced by the action of drugs upon the secreting organs and functions of persons in health, are the province of still another science. The phenomena of any one of these branches may throw light upon the others. But its own questions are to be finally settled in each instance by the facts of its own department. The generalizations of one science are never to determine the inductions of

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another. Instead of being useful, they may be mischievous by diverting the mind away. Each science is to be studied separately by all means, and then relatively also if possible.

In studying the materia medica as such, the facts of chemistry have only a subordinate place. That two substances have similar chemical relations, is not to be introduced as a fact of the materia medica, nor are any inferences to be drawn from it, for such agents may have quite different medical properties. Nor are the facts of Botany or Pharmacy to receive an unquestioned admission, but are only to be used as suggestions or as instruments like those of Anatomy and Physiology. Even the phenomena of Therapeutics have no proper place in such a materia medica. That lime will check some of the natural secretions, is a fact of the materia medica. That it will correct or modify a morbid secretion, is a therapeutic fact. To allow these two facts to stand side by side may be useful to the practical physician. But if he is studying a science as such, it is indispensable that its phenomena should be studied separately from those of every other science and when classified, that each be classed with its kind.

The process of separating the inductions is to be continued indefinitely. Not only must the sciences be studied apart, but each topic must be separated from every other. New facts continually call for further analysis. At every stage of the investigation, the analysis of the phenomena is to be carried to its utmost limits before the process of synthesis is begun. In order that the experiments be worth anything, each drug must be studied by itself and while its properties are being determined, all other influences should as far as possible be excluded.

In other sciences, this principle receives an unquestioning assent. If the works on the materia medica which are held as standard authorities ignore it, if the properties of medicines as determined by observation and experiment are intermingled with those which belong to other branches, if their authors make no claims to separate the materia medica from therapeutics, if their works are so constructed as avowedly and inevitably to unite the two studies, if their aims, their processes and their material are linked together in a tangled web, then the claim to scientific method cannot be sustained.

(3.) It is to be noted still further, that at this period, or during the stage of scientific inquiry, no questions are to be raised as to the final use to be made of the facts elicited. Such questions pre-

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occupy the mind, they distort our conclusions. "At the beginning and for a time we seek experiments that may afford light, not profit." We must study a science for its own sake and not merely for what it promises to pay. If it is urged that in medicine, utility is the very object of all our research, we admit it. To the practical physician, therapeutics or the cure of disease has certainly a more important place than even the materia medica has. But the perfection of the one depends on the full development of the other, and the materia medica cannot be developed in its fullness and purity except by the methods of pure science. To object, as is sometimes done, to an asserted fact as unimportant or irrelevant, is to renounce all claim to scientific method. We cannot measure in advance the importance of natural phenomena. No fact is unimportant to the scientific inquirer. However trifling it may seem, it may open to us one of nature's secrets. She punishes those who despise her little things. All attempts at premature application are sure to destroy the purity and the accuracy of science and thus inevitably to impair its ultimate usefulness.

(4.) While the phenomena to be observed or sought, are not to be weighed or measured as to their supposed practical importance, those only are useful in science which have definite relations to each other and to the subject of inquiry and which can be re-produced by experiment, if their verification requires it. Uniformity and exactness must be aimed at and secured. The problem is, to obtain the normal or uniform effects which are produced by medicinal agents on the living human organism. There are some facts which will *provisionally* aid this inquiry, though they are not the phenomena sought. The operation of medicines on brutes are at times of this character. But sometimes these effects are entirely different from the effects produced on man, and hence the former should be excluded altogether or made to take a subordinate place. Experiments on any animals may be useful suggestively. But the precision essential to science cannot be secured, if facts of such a character are admitted to its inductions. Anatomy suffered because dissections were for ages chiefly restricted to brutes. The materia medica still suffers from a similar cause.

It is just so in regard to the effects which medicines produce in disease. These effects are two fold, (1), remedial, and (2), disturbing. The remedial effects of medicines and of some other agents, give basis to the science of therapeutics. They occur when morbid phenomena, processes and results are removed by medicines.

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On the side of utility, these effects may fully rank with those furnished by the *materia medica proper*. But the two classes of phenomena occur under circumstances so different in character, that they cannot be made the subjects of the same scientific classification. This is also true of phenomena which occur incidentally, when medicines are taken by the sick, under the form of more or less disturbance of the organs and functions. Unless these phenomena are known to be identical with what would occur in health, they are not to receive an unqualified acceptance into the materia medica proper. They may be useful as clues, they may suggest channels of inquiry, there is a sense in which they may be said to belong to the materia medica, but until confirmed by experiments in health, they cannot be trusted as guides to a true science. The action of medicines in disease, does not always agree with the results of experiments on healthy persons. Morbid processes modify the operations of medicines. The infinitely varying phases which human maladies present, make the modifications innumerable. Moreover, the morbid operations will be mingled with those of the medicines and cannot be distinguished therefrom. So that, however useful to therapeutics, are the operations which medicines produce in disease, they are out of place in the generalizations of the materia medica.

Having thus determined the fundamental principles according to which the materia medica is to be cultivated, we turn to consider briefly what attitude has from time to time been taken in regard to them.

The first suggestion of a scientific materia medica is attributed to *Haller*. In the preface to his Pharmacopæia, about one hundred years ago, he taught that a medicine should be made the subject of experiment on persons in health. That the operations thus elicited should be carefully noted and that afterwards the effect on the sick should be determined. It does not appear that the suggestion of Haller attacted attention, or that he instituted any experiments in accordance with it or that it led to any practical result.

About twenty-five years later, Samuel Hahnemann taught the same doctrine with great earnestness. He instituted a series of experiments on his own person and secured the coöperation of his friends in the process. I quote his words on the subject.

"It is neccessary to have recourse to pure experiments made with care for the purpose of developing the properties that belong to medicines and the true effects which they produce on healthy in-

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dividuals." "There is no safer or more natural method of discovering the effects of medicines, than by trying them separately and singly in moderate doses upon *healthy* individuals and observing what changes they create in the moral and physical state; that is to say, what elements of disease these substances are capable of producing."

Henceforth, this method became a subject of discussion. Opinions as to its merits were divided. Some looked upon it as untrustworthy. Gradually the profession has reached, at least theoretically, the position indicated by the following extracts.

Pereira says of it, (vol. i, p. 119), "The study of the effects of medicines in the healthy state, is the only way of ascertaining the pure or pathogenetic effects of medicines—since when we administer our remedies to invalids, the symptoms of the natural disease then existing, mingling with those which the medicinal agents are capable of producing, the latter can rarely be distinguished with any clearness or precision."

In the year 1840, George B. Wood addressed the medical students of the University of Pennsylvania in the following language.

"Having selected the subject of experiment, you are first to ascertain its effects upon the human system in health. Try it upon yourselves, upon your friends, upon persons of different sex, age and temperament, beginning with doses which you know to be safe and gradually ascending till its activity or inertness is evinced. Ascertain its influence upon the brain and nervous system, upon the stomach and bowels, upon the heart as indicated by the pulse, upon the temperature of the body, upon the secretions, and in fine upon all the healthy functions. Note all these effects carefully, as you observe them, but at the same time be very cautious not to confound those changes in the system which may result from mental influence, or form the operation of ordinary or accidental causes, with those which are the genuine product of the medicine. Do not be satisfied with a single trial in each case, but repeat it with varying circumstances till there can no longer be a doubt of the actual effect produced."—(*Introduct. Lect.*, Phil., 1840.)

Dr. Wood's "Pharmacology" has the following passage,—(vol. 1, p. 31):

"The only certain means therefore, of judging of the effects of medicines, is to observe carefully their operation in man; and even in this mode, multiplied observations under diversified circumstances and a most cautious comparison of results, are necessary to

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arrive at the truth. From the want of these precautions many errors have been handed down from writer to writer for many years; and even at the present time there are medicines which have been long in use, upon the precise virtues of which opinion is yet unsettled."

Prof. Alfred Stillé—(*op. cit.*, vol. 1, p. 32) has the following passage.

"The uniform action of a medicine upon healthy structure or function is its physiological operation; its curative action or function is called its therapeutical operation. To determine the former is comparatively easy, for as compared with the abnormal, the normal action of the system may be viewed as constant and uniform. But the latter involves infinite difficulty, for we are required to determine the influence of an agent upon functional and structural conditions, with the natural termination and tendencies, of which we are only imperfectly or not at all acquainted. Whatever else they may do, experiments upon the healthy organism can never fully reveal the manner in which medicines cure disease, because in the latter case an element is involved which does not exist in the former. But if we are ever to acquire a distinct idea of the curative operation of medicines, that is, of their operation upon the tissues, organs and functions when they have departed from their normal condition, we must possess a standard with which to compare the effects that medicines produce; and however imperfect it may be, no other standard is available than the operation of the same medicines upon the healthy economy."

John Stuart Mill—(*Logic*, p. 266, New York ed.), has the following. "Besides natural pathological facts we can produce pathological facts artificially; we can try experiments even in the popular sense of the term, by subjecting the living being to some external agent. As this experimentation is not intended to obtain a direct solution of any practical question, but to discover general laws from which afterwards the conditions of any particular effect may be obtained by deduction; the best cases to select are those of which the circumstances can be best ascertained; and such are generally not those in which there is any practical object in view. The experiments are best tried, not in a state of disease, which is essentially a changeable, but in a condition of health, comparatively a fixed state. In the one, unusual agencies are at work, the results of which we have no means of predicting; in the other, the course of the accustomed physiological phenomena would, it may gener-

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ally be presumed, remain undisturbed, were it not for the disturbing cause which we introduce."

Another extract from Stillé may be made. "The results of clinical observation cannot in general be legitimately invoked to demonstrate or even to illustrate the physiological mode of action of a medicine."—(*Vol.* 2, p. 62.)

It must be obvious that a source of knowledge or method of investigation until recently unrecognized, now takes precedence in importance of all others. To what extent the operations of medicines have been actually determined in accordance with it and consequently are available to the strict study of the materia medica, will be noted hereafter. It is sufficient to observe for the present, that the process hitherto advocated has received the highest sanction which is possible short of the confirmations of experience.

In developing the materia medica there are some other restrictions to be noted, that will more properly come under subsequent topics.

To sum up the principles on which the investigation is to be based. We should conduct our inquiries independently of the phenomena and processes not concerned in the subject of inquiry. The inductions should be as rigidly distinct as our mental conceptions will make possible. It may be added moreover that the peculiarities of speculative inquiry, the dogmas of schools and systems and the bearing of the results reached, upon the practice of medicine should be conscientiously excluded.

2. Having determined the limits within which the investigation is to be conducted, the next thing to be done, is to gather the phenomena. To obtain the phenomena of the materia medica, as the other sciences of observation do theirs, is the problem before us.

(1.) Observation and experiment are to be resorted to, under the restrictions stated and with a single end in view. A medicine or drug is to be made the subject of experiment, the one object being to determine what effects it will produce on the human organism in its normal state. All the effects short of suspension of function or serious injury to tissue need to be known. We are to learn what functions it will stimulate or depress, or in any way modify. What organic changes it will produce. What are the characteristics of such activities and their varied relations, direct and sympathetic. What relations may be determined with reference to time, to intensity, to permanency, to periodicity. What mutual

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relations the phenomena have to each other, as of alternation, correlation, substitution, &c. We are not to overlook the distinction between effects that are primary, secondary and ultimate. It is of the utmost importance to learn what order of succession, phenomena tend to assume. Causes and effects make an endless chain, or a network of which the meshes are unlimited. We are to be continually adding to our knowledge by obtaining new links. But we are to count as our sure possessions, only ascertained facts and not those hypotheses by aid of which some of the facts may be obtained.

The medicine should be made the subject of experiment under every possible variety of dose and circumstance. As to dose the entire range should be canvassed, between inertness on the one side and the limits of safety on the other. The experiments should include every variety of constitution, age and sex. In each instance they should be continued as long as new facts can be got thereby.

The facts of sensation are the starting points of all science. The effects which the drug is capable of producing, which can be seen or felt or perceived by any of the senses, should be learned with as much particularity as the human mind is capable of. Thus, in such a record pain will have a prominent place. The observations should include its various locations, its kinds and its modifications and every positive fact appertaining thereto. The great thing in science is to obtain these particular facts. As to generalization, effects should be grouped according to their degrees of likeness and to their relations to the end in view. But generalizations should be no faster than this grouping makes inevitable.

In conducting the experiments the utmost precision and accuracy are called for. The precision relates chiefly to the degree with which the minute characteristics of individual medicines are determined. Accuracy requires the excluding doubtful phenomena and securing all those which are duly accredited. If the degree, in which these qualities are secured, falls short of what the mind is able to conceive, we should not feel satisfied. Unexpected facts are to be admitted on sufficient evidence. On the other hand, phenomena which there is reason to anticipate, are to be looked for and secured. In this way the operations of medicines *in disease* will suggest new avenues of inquiry.

The experiments call for the coöperation of many observers. They should be repeated as often as may be necessary. The inductions are not to be considered as complete, as long as obtainable evidence can modify or strengthen them.

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No source of knowledge is to be neglected, which will furnish trustworthy facts. We should avail ourselves of individual and voluntary experiment and of accident as in cases of poisoning, &c. The testimony of witnesses, oral and historical, should be taken, weighed, compared, collated and used or rejected according to the strictest rules of evidence. What use shall be made of the material accumulated by others, is an important question. It is embarrassed by the fact that there are differences of opinion as to the degree of credibility of what is offered. The principles by which his own investigations are guided would be a test of the merits of what others teach. But the physician is often debarred from using that test, by the presumption, conclusive to his own mind, that what is offered to him is unworthy of investigation or even of notice.

Experience will elicit methods and cautions which cannot here be discussed. The preparation of the agents to be experimented with, the size of doses and their repetition, the particular methods to be followed by the persons experimenting, and manifold other points are to be attended to. Of course the building up a science is not an easy process. Each has its own difficulties. In determining the special characteristics of a single medicinal agent, there are many circumstances to be taken into account. But a great point is gained, when the process is once brought under scientific rules.

We have already seen that this method of studying the materia medica was not recognized until recently. We have also seen that it has already received very high sanction. From the limited period since its reception by the profession, we should expect that the practical results gathered by it would be meagre. This we shall find to be the case, especially if we compare this science with those in which the inductive principle has been applied for a long period. No accurate detail of these operations can be gathered from the earlier writers, except in the case of a few substances, which having poisonous properties became known through accidental experiments.

Cullen's materia medica begins with a brief history of the science. This is followed by an account of several hundred medicines. Neither in the historical sketch nor in the work itself does there appear to be any trace of the directly inductive methods of study and consequently there is no material for such a science. Whatever facts were gathered in regard to a medicine are usually referred

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to generic propositions which are more or less speculative. That it is a tonic, or sedative, or diuretic, &c., was made to include not merely the ascertained phenomena of the medicine, but also theoretical views as to its mode of action.

Prof. Eberle's work doubtless fairly represents the state of the science fifty years ago. What has been said of Cullen is nearly true of Eberle. Less importance is attached to certain theoretical deductions and more to others. Therapeutic experience is held as the chief source of the knowledge of medicines. A few scattered allusions are made to experiments made in health. But the properties of most medicines are given without any notice of such experiments. It is nowhere recognized that this is the true way to secure a trustworthy materia medica, or that a knowledge of the action of medicines upon the sound organism is requisite if we would understand their curative operation in disease.

Some twenty years still later, Pereira's great work was published. Now we find the effects of medicines in health have assumed an important place. Many such facts are given by Pereira. Each subsequent work on the materia medica brings us greatly increased material for its scientific study. But very much remains to be done. Even now the operations of medicines as taught by the latest standard authors are with few exceptions either the effects elicited in disease or inferences from processes of reasoning, not inductions from physical phenomena. The aim is to obtain generic facts rather than to make the most of the particular phenomena on which the generalizations are based. But it is one thing to make a medicine the subject of experiment in order to elicit a class of facts or to confirm certain therapeutic deductions. It is a vastly different thing to institute and to complete a series of experiments, whose aim shall be, to learn patiently, arduously, conscientiously all that can be known of the physiological action of a medicine, even in directions which seem the most trifling. Is there any work on the subject which occupies a place which in other sciences would be deemed creditable, such for example, as Miller's Chemistry, or Gray's Botany, or Wilson's Anatomy? Is there a record of the operations of any single medicine, on the various organs and functions of a healthy man, which can be offered as tolerably thorough and complete? These questions will not be likely to find an easy or a flattering answer.

The subject might be indefinitely illustrated. If rhubarb is capable of producing any effects on the pulse, on the breathing, on

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the brain and nervous system, on the temper even, science calls for their determination and formal statement. To detail only the effects of rhubarb on the bowels and the secretions, and then to turn to the uses of that agent is less than we might expect to be done.

Phosphorus has the power of causing a painful affection of the jaws with necrosis of the bone. There will be disorder of the digestive organs and inflammatory fever. The disease may extend and involve the soft and hard parts in gangrenous destruction, and finally cause hectic fever and death. A scientific materia medica will recognize these evidences of power, and make such an agent the subject of elaborate experiment. It will endeavor to obtain all the symptoms caused by phosphorus. Questions of practical utility will be kept in abeyance.

Lime is known to have useful properties in affections of the skin, the mucous membranes and the urinary organs. It is an important constituent of the living tissues. Many questions might be asked in regard to its action in health. Who can tell what effects it produces on the operations of the mind? It would seem to be of the highest importance to determine accurately and precisely, its action on the human system in its normal state. Any work on the materia medica which lacks such a record, is incomplete.

Carbonate of potassa is a substance of which similar remarks might be made. The time will come when the medical historian will inquire and record to whom the world may be indebted for minute accounts of the properties of such agents.

Sulphur is known to modify profoundly certain vital actions. A record of its operations worthy to be called scientific, it would cost some labor to find.

Suppose it were asked, what are the changes which will be wrought upon the blood, upon the nervous system, upon the skin, upon the muscular and osseous tissues, by the repeated administration of magnesia to a healthy person. Doubtless some effects would be produced. Where is there a scientific statement of them unmingled with other matter? The mineralogist and the chemist would expect to be able to give the relations of magnesia which pertain to to their sciences. Except the laxative and the antacid properties of magnesia, there is hardly a physiological effect of this substance given by any standard author whose works we have seen.

If the chemist were asked what is the difference between the relations of gold and of mercury to oxygen, he would feel that the credit of his science suffered, if an answer could not be given. If

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the question were asked, in what does the action of these substances differ as related to sleep, or to the action of the mind, or to the functions of the several organs, if prompt and satisfactory answers could not be given, the science of the materia medica admits of improvement.

(2.) We have stated the principles and the methods, which should guide us in obtaining the facts. The next step is to bring our knowledge into the form of language.

The facts are to be embodied in words and recorded with the same principles in view, as those which guided us in their determination. The utmost exactness and precision of thought and language are needed. Most of the mistakes made and of the controversies which exist, are caused or aggravated by the ambiguity of terms.

The records of different sciences and the inductions of different topics, are all to be kept distinct. None of the purposes of a science can be secured unless this is done. If we had no statement of the properties of a mineral except such as were intermixed with its chemical properties, its geological relations and its practical uses, mineralogy could not claim a very exalted place among the sciences. But if many a record of the properties of a medicine were sifted of all details as to its uses and of its relations to other branches, it would hardly consist of as many lines as it now occupies pages.

The phenomena should be recorded in terms free from speculations about their causes. Other sciences have found that a knowledge of the ultimate and inward processes of nature in the production of phenomena is unattainable. The search for it, though it has led to valuable discoveries, has been misleading and always will be. And yet hypothesis, speculation and theory are useful. They are indispensable to progress. But they should be used as anticipations merely, as channels of investigation and never as scientific data. The two things should be kept apart and the speculations should never have place with the simple facts of observation.

That iodine causes emaciation is a matter of fact statement. That it does so because it "stimulates the absorbent system" is a theory merely. In a record of the depressing effects which mercury produces on the nervous system this passage occurs. "It is alleged that these effects are traceable to the direct action of mercurials upon the nervous centers by means of which their fatty constituents are removed." The works on the materia medica,

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using the term in the broad sense, overflow with such speculations or such generalizations. They should not take the place of the plain methodical facts of science.

The records should be made not in terms of theory but of simple fact. General terms should not be used except where their significance is limited beyond question. All hypotheses, all theories should be excluded from the generalizations. "The most rigorous conditions of gradual and successive generalization" should be adopted. Nothing should be deduced from the facts of observation except what they inevitably include. To say that nitric acid exerts a tonic action is not strictly a scientific statement. We need the particulars, increase of appetite, &c. That nitrate of potassa is resolvent, antiseptic, antiphlogistic, diuretic, purgative, &c., is not definite enough. Medicines are frequently said to have sedative effects or stimulant effects without detailing the phenomena on which the general facts are based. Such a course may have its uses. To build up an exact materia medica is not one of them however.

The following statements as to the effects of cinchona I find on a single page of Pereira:

"The general operation of cinchona bark," observes Sundelin, "consists in the *increase and exaltation of the tone of the irritable fibres and of the fibres of the vessels* (hence by its use, the pulse becomes fuller, stronger and regular, and the muscular power increased); also in the *general augmentation of the cohesion of the organic mass* (hence it counteracts a tendency to liquefaction and disintegration, diminishes profuse secretions which proceed from atony of the extremities of the vessels, and of the secerning surfaces and organs, and improves generally the crasis) and lastly, in *augmentation of the vital energy of the sensible system.* (By the last mentioned property it restores sensibility, when defective or abnormally increased, and the property of reaction of the nervous system, to their normal state, and augments the influence of this system on the muscular fibre and on the reproductive system.") (Vol. ii, p. 435.)

The following quotation is made by Christison from Hahnemann, who, in the words of Pereira, "graphically described the condition of slow poisoning by arsenic as 'a gradual sinking of the powers of life, without any violent symptom; a nameless feeling of illness, failure of the strength, an aversion to food and drink and all the other enjoyments of life.'" (Vol. i, p. 533.)

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This is a plain statement of facts. It is available as a contribution to one's knowledge, whatever may be his opinions. The other is so filled with speculations and generalizations, that its value is much impaired.

3. The facts having been ascertained and stated clearly, they are to be arranged in their natural relations, that is, their relations to each other and to the subject of inquiry. This includes (1) comparison of the phenomena and the noting. resemblances and other relations, and (2) classification of the several powers and properties of each agent.

(1.) Among the logical processes next to the observation of phenomena, is the comparison and analysis of them. * Indeed, these processes cannot be separated, and immediately after comes another, generalization, itself also to some extent inseparable from the others. Comparison is a complex process or rather a number of processes. Its applications are numerous. One of them pertains to the order of succession in which the facts appear. Another of its most simple exercises is that whereby we refer phenomena to their relations to sensation. The impressions made upon the sight, the touch, the taste, &c., vary in kind and degree. Resemblances and diversities in endless variety are to be noticed. New grounds of comparison will continually occur. Here and elsewhere we may be aided by inference and deduction. Yet here and always, we are to adhere to the simple facts of observation as strictly as possible and refer to them our decisions whenever new means of obtaining them can be found.

(2.) The phenomena having thus been analyzed, are to be brought together in their natural relations, with reference to the particular subject of investigation. This will distribute them into groups, such for instance as involve the order of sequence, or similarity of kind, or relation to some organ, system, function, sensation or quality. It will be necessary to repeat them at times, in order to bring out their various relations. But the theories, the phenomena and the generalizations of other studies or topics must be allowed no place. Every natural science has gone astray, until this principle of classification is complied with.

The results of the inductive processes are to be grouped, on the principles thus stated. Precise details as to the course to be pursued cannot be given in advance. Sciences differ according to the object in view. What is essential is, that systematic arrangements

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be made, which shall include the facts of science and exclude everything else, and place the facts in their relations to each other and to them only. Thus we secure command over the knowledge acquired and can see where it needs to be added to. This is not done where a few inductions are buried under a mass of speculations, deductions and reaching after practical utility.

The particular end in view in the materia medica is the determination of the special properties of medicinal agents. What organs each acts on, what functions it modifies, what activities it arouses, &c. Hence it follows that though we may not be able to specify precisely what classification of the properties of medicines will be found most useful, it is plain, that some such groups as the following should be made.

In one group will be brought together the relations of the medicine under experiment to sleep, including wakefulness, dreams, &c. We are to note the various degrees of sleep induced by it, from a slight slumber to the most complete stupor. The peculiarities of pulse and of breathing, and other symptoms occurring during sleep under its influence, such as starting, snoring, moaning, &c., are to be observed. Dreams and mental impressions are not to be overlooked. Symptoms which occur on waking are to be recorded also.

Our knowledge of this class of symptoms, as elicited by one agent, is quite exceptional. The chief properties of *opium*, in this direction, happen to be well known. A good account of them is given by Dr. Wood. This fact suggests the wish that in this way all the symptoms relating to sleep, which it is possible to obtain, should be secured in the study, one by one, of all the articles which compose the materia medica.

The respiratory organs and functions form another natural group, including of course the breathing, cough, and its varieties, the secretions and various subjective and objective phenomena. Other groups will be formed from the various organs and functions, as for example the cerebral, the gastric, the abdominal and the urinary. Besides these topical arrangements, the phenomena should be classified so as to show their other relations, such as those of quality, of causality, of intensity, &c.

After a while a classified schedule can be made, according to which the properties of a medicine can be arranged as fast as they are ascertained. It will present at a glance, the symptoms relating to any subject. It will give the means of comparative and differ-

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ential diagnosis between medicines. It will show where deficiencies in our knowledge of a medicine call for further experiment. Other branches of knowledge do not take the name of science until some such classification is secured.

If now we desire to know the effects which *aconite* produces on the respiratory or on the abdominal functions, we shall be able to find them in their places. It will not be necessary to search for them amid other details. If an account were called for, of the symptoms which nux vomica causes relating to the brain, it ought to be possible to turn to a classified record, where they are distinctly stated separate from all other phenomena. Whether this can be done or not will be seen by him who makes the attempt. It is said of veratrum album that "it produces a small, feeble irregular pulse." This is well. Of how many other medicines can we turn to the record and without unnecessary delay, learn the minute peculiarities of pulsation caused by them?

Suppose it were asked what effects are produced on the tissues of the mouth by chlorate of potassa. This is a plain question and should find a ready answer. Turn to Stillé. The answer must be culled amid various details, pathological, therapeutical, historical, speculative. Collecting such particulars as bear upon the point before us, the record is as follows: "The surface of the tongue and gums are of a florid red." "A sense of constriction of the mouth" occurs. "The gums felt rough, the saliva somewhat increased and more fluid than usual." "Copious salivation with a saltish taste in the mouth." What more might be elicited on this subject, by careful experiments on healthy persons, does not appear, but the following statement renders it probable, that something further might be reached. "It is a curious and interesting fact, that occasionally chlorate of potassa produces ulceration of the month, when administered for diseases in which the buccal membrane is unaffected." Stillé adds the following. "These facts prove that the medicine is a powerful stimulant, and that it is curative of the various diseases in which it is administered, by virtue of its stimulant power." Such a mode of deduction, by embodying the facts of science in generic propositions, from which inferences are drawn, has been very common in the history of medicine. It will be seen that it is different from the classifications we have advocated.

In making our classifications we must not content ourselves with merely bringing together the phenomena belonging to a topic, as a row of figures are arranged or as beads are strung. Their rela-

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tions to each other are manifold. We are to welcome any inductions that will aid the mind to understand these relations, or to judge of their characteristics, their relative importance and their bearings on other topics. From the nature of the subject, the process is to be almost indefinitely continued by new contributions. But all theories, all generalizations that are largely speculative, all suggestions from other sciences, all practical applications are to be severely scrutinized or rigidly excluded.

The materia medica as found in standard authors is in a transition state. To some extent it is assuming the character of a science of observation. It is adding to its phenomena and securing a more perfect knowledge of them. This has not been so long. Even now a very large proportion of its conclusions are theoretical. Deductions from processes of reasoning are deemed essential to a scientific explanation of the operations of medicines. Heretofore such inferences have usually proved to be imperfect and have often been exploded by the progress of investigation. What will be the fate of those now dominant, remains to be seen. The acquisition of new phenomena will doubtless modify many positions now held as secure.

In the meantime, we have virtually two sciences asserting their claims upon us. As compared with each other, one is inductive and one is speculative. They cover in part the same ground, they overlap each other at points, they modify each other in different degrees.

Unless the materia medica proves an exception in history, the science of observation will gradually assume more and more the characteristics which mark a true science, and reconstruct and absorb the other, whose basis is chiefly speculative.

We may apply Lord Bacon's formula quoted on page 6. There are two ways of studying the materia medica, and can only be two. The one starts from the particular facts of sensation, takes a flight to the generic properties of medicines, and from these generalizations, invents and judges of their intermediate powers. The other method collects its facts from the phenomena of sensation also, but ascends *continuously and by degrees*, and in this manner arrives at its generalizations. The latter method is the true one, but until the present century untried.

A department of knowledge founded on the principles and devel oped by the methods which have been inculcated, will have certain

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characteristics, which will show that it is entitled to a place with the other physical sciences. Of these characteristics the following may be noted.

1. It will be *systematic* in its scope, aims, construction, &c. It will be found to consist of, or to comprise an unlimited number of objects, powers or materials. In one science it is minerals, in another it is the heavenly bodies, &c. The subjects which make up a science will have certain properties in common, with individual characteristics. They have been compared to a bundle of rods, no two of which are exactly alike. Thus in Botany the subjects of inquiry are plants. Those which agree in certain properties are, for convenience of study, classified together. The members of a class are broken into groups by differences. Thus the divisions go on until individuals are found, which are characterized by particulars or by combinations of particulars peculiar to themselves. In every case, it is these individual peculiarities, rather than those which are generic, that it is most important to seek. The importance of the generic distinctions and of the various methods of classification, is to aid us, in knowing the individual features.

The agents which constitute the materia medica a science, are those substances which are found capable of exerting modifying influences on the bodily organs and functions. These operations are infinite in number and in variety. In determining the minute effects of medicines, the reactions of one organ upon another are numerous and complex. The same confusion arises which occurs to the student of every other branch. Method must be resorted to for success. It requires minute analysis and careful discrimination to determine the peculiarities of each individual. Medicines may cause "physiological" disturbance of the entire economy. The history of a medicine will of course specify its effects on those organs on which it chiefly acts. But it will also affect other organs, and these symptoms are to be noted. The acting on one organ causes reactions on others, and thus, in ever branching, ever varying ways, the medicine may awaken sympathies in every part. The completed record includes them all. All are wanted. There is time enough to obtain them all. What one man fails to get, another must seek. What one secures, is to be added to the past and increased by future acquisitions, until another natural science is built up, to take rank with those, which now link God to his creatures.

In these sciences we are taught, that no two objects are alike.

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Each has its special powers, properties and uses. It is for us to determine them. Systematic analysis enables us to do so. Classes are subdivided into groups and these into individuals. The further the analysis of any effect common to different medicines is carried, the more characteristic are the distinctions. The more complete the apparent resemblance between substances, the more definite, subtle and delicate are their peculiar features found to be. This is true elsewhere. Why not in medicine. It cannot be, that one science differs from others in this respect. Stramonium and belladonna have resemblances. But a detailed analysis of one of these substances cannot properly be substituted, as has sometimes been attempted, for that of the other of them. Podophyllum has been spoken of as probably identical in its operations with jalap. On the contrary, the more closely one natural object resembles another, the more close must be the study required to discriminate them. When the inquiry is for the characteristics of sulphate of soda, to refer us to a class of similar salts is not to furnish an answer. It is the power of recognizing the characteristics of individuals not those of classes, which shows tact, skill, science. The differential diagnosis of similar substances is the ultimate field of study. How can the characteristics be determined unless they are sought? To obtain them, to provide channels for such minute investigation, each in its own sphere, is the constant aim of all the sciences, which are educed from physical phenomena.

The natural history of a substance thus obtained, every exposition of it will substantially agree with every other. Not of course either formally or verbally, for they will vary in completeness and in method. But there will be harmony in principle and for the most part in detail. There will be no irreconcilable conflict between different writers. Nor will there be great gaps in the history of one agent as compared with that of another. The schedule of one, will symmetrically give us suggestions for the others.

If a substance, secale cornutum for example, is found to disorganize important tissues, it is to be supposed that it must produce directly or indirectly some effects on the thoracic organs, to be noted by definite symptoms. If a record of the properties of secale cornutum, contains no allusion to such phenomena, science calls for their determination by experiment. It is as if the mineralogist were to leave out of the history of an important mineral any determination of its hardness or its crystallization, or as if the anatomist should omit the relations between the ulna and the

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radius. Just so, if dilute nitric acid causes pain in the liver or the bones, that record of nitric acid is incomplete which omits these symptoms. If this agent produces any action on the lungs, the bronchia, the heart, the mental and the moral state, these effects should be recorded. There will be a place for them and they will be in their place. The student of the materia medica needs to have before him a classified record of its phenomena, separated from all other material. Aconite has been used for centuries. Its properties were supposed to be understood. In the year 1840 it was made the subject of experiment by Dr. Alexander Fleming of Edinburgh. The results indicated, that aconite produces striking effects, heretofore not generally recognized. Hundreds of other medicines still await similar and far more extended experimentation. The science that leaves the determination of important facts to accident or to caprice, lacks something in its scope. If astronomers and navigators had for ages used in their calculations the phases and motions of the planet Venus, but had gathered such only of its phenomena as were made obvious during these practical applications, whenever it should be made the subject of scientific observation, doubtless something more would be discovered.

2. Another characteristic of a science is the unlimited extent of its range. It is not so with art. The artist, like the mere practitioner, selects his materials. He takes such as are adapted to his purpose. He excludes those which are not useful to him.

Science, as we have already seen, knows no such limits. It is comprehensive, as well as specific. It is constantly adding to its materials. It welcomes every new fact. It has a place for everything that comes within its own sphere. It is not confused or dismayed by any amount of material. The more numerous its phenomena, the more available is its knowledge. With it no two natural objects are identical in properties. Some differences can be detected, that will sharpen our ideas of both. When one is tempted to reduce the number of articles on the plea of excluding those whose properties are doubtful and those which possess no advantages over others,* the principles of scientific investigation dictate a different course.

It is just so with the individual characteristics of the objects which constitute a science. Our powers of analysis can never exhaust them. Doubtless no two medicines cause precisely the same

* See Dunglison's Med. Dictionary, article Mat. Med.

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pain or nausea or other group of symptoms. Knowledge of these minute peculiarities cannot be dispensed with, without infinite loss. The progress of the science is marked by the continued development of these characteristics. The minutest fact is to be eagerly cherished, as having a possible bearing upon the most important of questions. It is to be regretted that for ages such facts as the following have been known in medicine, without scientific recognition or practical use, namely, that senna causes flatulence and griping. The only notice taken of the phenomena is the attempt to get rid of it, by the direction to combine the senna with aromatics. Were the question asked what are the characteristics of the griping colics caused severally by senna, by rhubarb, by colocynth and by lead, the analogy of other sciences would lead us to expect a more ready answer than we shall be likely to find.

Not that it is to be expected that every one who has occasion to apply medicine as an art, should master all these details. But it is to be expected that the aims, methods and processes of other sciences should receive formal recognition and that the materia medica should be gradually built up in accordance with them.

3. Still another characteristic of a science is, that its applications to other subjects are accompanied by the power of prediction or anticipation. Its practical applications are suggested either immediately or by aid of some determinate principles rather than by accident. They require no explanatory theories, they excite no surprise, they find a ready welcome.

In some such way, we should expect that the materia medica, after reaching a certain degree of development, would suggest therapeutic agents with great uniformity; that their confirmation would not excite surprise but receive a prompt acquiescence. If it has such a character, it is to be inferred that in determining new remedies it will assert its place as a science and keep ever in advance of accident, of caprice, of empiricism. Hitherto the science has not fulfilled reasonable expectations in this respect. Pereira says of Nux vomica, "It is one of the few remedies the discovery of which is not the effect of mere chance."—(*Mat. Med.* vol. 2, p. 336.) Stillé says "Nearly every medicine has become a popular remedy before being adopted or even tried by physicians." (*Therap.* vol. 1, p. 31.)

A science founded on correct principles and developed by fitting methods, will be a depository of knowledge, ever growing yet never unmanageable, because well ordered and systematized. Its

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positions once accepted will stand forever. Every new contribution will find a welcome place and often will be obtained because a place for it was seen to be vacant. Precise facts gathered one by one, grouped naturally with constant additions, gradually comprehending more and more, rigidly excluding all speculations and only combining by their own inevitable crystallizations, such is science.

Some of its conclusions will be new and lack coincidence with what had been supposed to be true. "Some of the things already discovered are such as before their discovery did not enter into men's minds, even to suspect, so that one would have despised them as impossibilities."—(*Nov. Org.*, p. 1, Sec. 6.)

Had these methods been pursued what confusion would have been avoided! On how many topics on which the medical profession has taken positions has it proved to be mistaken. What conflicting statements would, to-day, be made about agents which have been used for centuries. Does calomel increase or does it diminish the secretion of bile? Strange as it may seem, this is an open question. (See Stillé.) The same question may be asked of rhubarb. Read what is taught about camphor or about acetate of ammonia and then read a page at random of some other physical science. Who can tell whether colchicum increases or diminishes the amount of uric acid eliminated from the system. The materia medica needs to go back to first principles.

It may perhaps be said that an undue importance has been assigned to the processes herein recommended inasmuch as medicines do not have such minute characteristics in their action as has been implied or at least that such discrimination if attainable would have no practical utility.

Unfortunately these views are dominant with the profession. The result is what might have been expected. Probably there is no record of the properties of any one medicine that would be universally accepted as trustworthy and satisfactory. If the demand were, for certain physical peculiarities of a distant heavenly body, as Jupiter for example, the record could be furnished. A treatise on mineralogy would furnish an account of a mineral which all scientific men would recognize as approximately correct. But who can produce a complete account of the operations of a medicine, on the organs and functions of the human body, unmixed with theories and free from numerous relations to other subjects?

If the materia medica were studied in the way which has been

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urged, much would be found that is not now secured. In every other branch of knowledge, the adoption of the methods of rigid induction forms its epoch. From that time its progress is sure, steady, rapid. It is unreasonable to doubt that were this course followed in medicine, it would add largely to our knowledge and to our useful material.

It will also appear that the records of the operations of medicines, with which we are furnished will do something to remove the objections above stated. Scanty as these records are, compared with what they might be, a careful study of them will show that medicines do have characteristics which are distinct and minute. This may be seen, for example, from an analysis of the operations of some of those medicines, a knowledge of whose properties is furnished to us through accident chiefly, knowledge most of which, it would seem, nothing but neglect has prevented being the voluntary contribution of science.

I select Belladonna and Secale cornutum, one an acute, the other a very slow poison. The comparison is given not as a sample of a complete or perfect analysis of their relative effects, but as such an approximation as may serve for illustration. It is my aim not to introduce anything which cannot be substantiated in standard authorities.

In the action of belladonna and of secale cornutum, there are some striking analogies and quite as remarkable differences. Both act powerfully on the nervous system. Each, in its own way may cause determination of blood to the head, headache, vertigo, delirium, craziness, spasmodic contortion of the eyes and various disorders of vision. Each causes congestion of the minute blood vessels, fever, eruptions, inflammation of the skin and other tissues. Nausea, vomiting and disorder of the digestive organs are produced by both. Each disorders the urinary and the uterine organs. Each causes spasms and convulsions. Both of them suspend to some extent the control of the will over the muscular system. Death may ensue from the action of either of them.

The *fever of belladonna* is active, with great heat and congestion of the capillary vessels. The pulse is quick and bounding. The heat and redness of the surface is intense. A bright florid rash may appear.

The fever of *ergot* is marked by chilliness, which at times is severe. There may be burning, internal heat, with cold skin and slow, small pulse and fœtid sweats.

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The *delirium* of belladonna is demonstrative. There will be immoderate laughter, senseless prattle, merry craziness, determination to do something, showing itself in attempts at violence to self, or in quarrelling or fooling with others and in various extravagant actions.

The delirium of ergot is sadder; it is marked by exhaustion, malaise, anxiety.

The convulsions of belladonna are active, easily excited and usually exhaust themselves quickly without injury to the part. If they are severe, the muscle is left relaxed and weak but soon regains its excitability, unless the toxicating impression is extreme.

The convulsions of secale are rigid and if they are protracted the part is left paralyzed.

The inflammations of belladonna are acute and painful, locating chiefly on the mucous membranes and on central organs.

In the inflammations of ergot the surface is cold, dusky, dry and brittle. They usually involve the skin and the extremities and may terminate in gangrene of the affected part.

In contrasting the action of these two agents, it may serve to aid the mind (and the suggestion is made for this purpose) to consider that of belladonna as expressing or exaggerating the peculiarties of *youth*, secale those of *age*. We have in the one case, the excited circulation, the over active nervous system, the sensitiveness of childhood. The person cannot help doing, though he knows it is foolish. His muscles will act in spite of him. His senses play him fantastic tricks. He sees visions, images, brilliant colors and objects. He cannot stop thinking. His ideas are extravagant and usually gay. Though conscious of these perturbations, he has no power to control them.

In ergot we have the languid circulation, the deficient vital power, the listlessness and torpor of age intensified. Its long continued action disorganizes and destroys.

It may perhaps be thought that these two medicines are exceptional in their operations or that they happen to have some correlative action, which makes them unfair exponents of the peculiarities of the materia medica.

That this is not so, can be shown by taking a third substance which has some peculiarities in common and others distinct from those of belladonna and secale.

Opium acts powerfully upon the nervous system. It as well as they, causes determination of blood to the head, headache, vertigo,

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delirium, at times spasmodic contortion of the eyes and disorders of vision, congestion of the capillary vessels, fever, occasionally inflammation of the skin and other tissues. Vomiting and disorders of the digestive organs are among its occasional effects. Urinary and uterine disturbances and finally spasms and convulsions and even death itself link it to the other medicines.

But the effects produced by opium, characteristically differ from those caused either by belladonna or by ergot.

The fever of opium has burning heat, though the skin may be moist and the pulse and respiration may be but slightly quickened. Indeed these are often slower than usual. The mouth is dry, but the thirst is not in proportion to the dryness. The face is flushed, (in extreme cases dark red) and there may be headache with great sense of weariness or heaviness of the limbs. The cold period is accompanied by soporose symptoms, more or less decided.

As contrasted with the two other medicines, the activity and the depression of opium are more like those of the mature adult. Thus the mental symptoms are either sad, anxious, taciturn, stupid, with indifference to pain and pleasure, or the reverse of those, showing great cheerfulness, excess of courage, of fancies and of mental activity, extreme sensitiveness to pain and pleasure, with courage to do, or to dare, or to suffer. There will be disposition to work or to think, while in belladonna it is to play or to quarrel, and in ergot to mope. Under the influence of opium, the mind runs on deep meditations and important business. The delirium is that of the adult—for instance he is angry if thought mad, though reproaching himself with madness. He retains the consciousness of his mental operations with great enjoyment in them. The social feelings and the pleasures of sensation are either dormant or are excessive.

What have been given as effects of belladonna, opium and secale cornutum are by no means all that are known to be produced by these agents. The phenomena only have been noticed to which each of the medicines is in some way related. Nor in regard to these is the record by any means complete, as only those effects are adduced, about which physicians are supposed to be agreed. As is true on other subjects, men differ about the operations of medicines. The mine is a rich one, and will repay labor in all the directions in which men are working.

While these effects are before the mind, it is natural to ask how they are related to the therupeutic powers of the same agents. Here too is opportunity for difference of opinion. If the mind is allowed to dwell on such differences exclusively, it is easy for the

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parties to take the attitude of antagonism. The questions thus started are not within the range of this paper. It is one thing to improve the instrument, quite another to learn how to use it. It may not be out of place, however, to offer some suggestions tending to show that more comprehensive views would narrow the ground of antagonism between men of different positions.

All would surely agree that these "physiological" effects of medcines will aid in determining the remedial powers of these agents. Between the two classes of effects, they would find some links. The more we know of the agent, the better we are likely to use it. The principles on which either of the two classes of phenomena should be determined and classified, do not admit of dispute. The relation between inductive science and the study of the materia medica surely can be determined. The same is true of therapeutics. Once settle these and let the results be acted on, the questions about the uses of medicine must be nearer solution. Even now it may be supposed that any two physicians would find more points of agreement than they imagine, and that the progress of inquiry will be constantly narrowing the extent of difference.

Men are coming to more accord as to the province of medication and as to the relative importance of all artificial aids in disease. It is seen that it is nature's own processes that cure and that medicines are useful only as they excite or promote these.

In all modes of treatment much depends on hygienic means, on nursing, on the removal of obvious causes, on the proper application of heat and cold and moisture, on quiet, rest, pure air, diluent and nourishing drinks, the encouragement of hope, and the many of nature's own restorative powers.

In the application of therapeutic agents, where the differences between men are sharpest, there is less antagonism than appears. The alterative properties of medicines are sought by all and are supposed by each one to be obtained by his own processes. While in regard to the mechanical, the chemical and the tonic powers of medicines, the difference is not so much as to the positive effects as it is in regard to the relative importance of those agents. Positions that seem to be antagonistic, may be correlative truths, or due to the balancing of opposite principles, the progressive and the conservative. It has often happened that when parties are harmonized, a higher plane is reached than either had thought of. Even an erroneous doctrine may contain the germ of an unrecognized truth struggling for deliverance.

All physicians agree in making experience the test of practice.

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Evidence that a remedy has cured certain definite forms of disease is the most conclusive evidence that it will cure such disease in future. Any presumptions we may have, previous to such experience, are subordinate to experience itself. To *obtain* evidence, certain principles and processes are used as channels of investigation. The value of them depends on two things, their being specific and at the same time comprehensive, reaching to minute particulars and including many of them.

Accumulated experience is the ultimate test of the remedial powers of medicines. It may be obtained either empirically or rationally. In other words, either by inductive processes solely, or by aid of those which are deductive. In the one case we have the mere experience unsustained by other evidence. In the other, the medicine furnished to us is certified to, by another science, as having the powers and properties which make it reasonable to be thus used. Thus it may be reasoned upon and associated with principles which furnish corroborative evidence. Other sciences may furnish suggestions. It would seem that a scientific materia medica would always be ready to do so, although its evidence cannot be substituted for that of the inductions of therapeutics. But while in practice, the physiological or pathogenetic effects of medicines are subordinate to the remedial, *in the development of the materia medica, the order is reversed.* The positive facts of one science are but suggestions in the other. Every clearly ascertained fact in regard to the operations of a medicine should be held sacred by all men, and thus the materia medica, being placed on a scientific basis and then being duly developed, becomes fitted to take its place along with anatomy, physiology, pathology and chemistry as the foundation of our medical knowledge.

The positions taken in this paper, are due to various sources. The *facts* on which the arguments are based, are samples of those which have been accumulating for ages under the observation of physicians. It has been our aim to use none except those which have the undoubted authority of the most eminent members of the profession and the sanction of universal reception. The principles on which the arguments have been constructed, are those which are the accredited basis of all science.

But the central idea or ideas which suggested the application of the principles to the facts, are due to one, destined, we suppose to, take a rank not yet fully accorded to him, as the peer of the most eminent observers and philosophers of every science, and of all time.

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THE

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By
Wm W. Rodman

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