

THE LIBERTY OF SCIENCE IN THE MODERN STATE¹

III.

IF what I have said before is true—that half-knowledge is more or less the characteristic of all naturalists, that in many, perhaps in most, of the lateral branches of their own science, even the naturalists themselves are only half-knowers; if later on I said that the true naturalist was distinguished by his being perfectly aware of the limit between his knowledge and his ignorance, then you understand, gentlemen, that also with regard to the public at large we must confine our claims to demanding that merely what every single investigator in his own direction, in his sphere, can designate as reliable truth which is common to all—that only this shall be admitted into the general plan of education.

In thus marking the confines of our knowledge we must remember before all things that what is generally termed natural science is, like all other knowledge in this world, composed of three totally different parts. Generally a difference is only made between *objective* and *subjective* knowledge, but there is a certain intermediate part—I mean *belief*—which also exists in science, with this difference only, that here it is applied to other things than in the case of religious belief. It is somewhat unfortunate, in my opinion, that the expression belief has been so completely monopolised by the church, that one can hardly apply it to any secular object without being misunderstood. In reality there is a certain domain of belief even in science, upon which the single worker no longer undertakes to prove what is transmitted to him as true, but where he instructs himself merely by means of tradition, just what we have in the church. I would like to remark on the contrary—and my conception has not been contradicted by the church—that it is not belief alone which is taught in the church, but that even ecclesiastical dogmas have their objective and their subjective sides. No church can avoid developing in the three directions I have pointed out: in the middle the path of belief, which is certainly very broad, but on the one side of which there is a certain quantity of objective historical truth, and on the other a variable series of subjective and often very fantastic ideas. In this the ecclesiastical and the scientific doctrines are alike. The cause of this is that the human mind is a simple one, and that it carries the method which it follows in one domain finally into all the others as well. But we must be aware at all times how far each of the directions mentioned extends in the different domains. Thus, for instance, in the ecclesiastical domain—it is easier to show it in this one—we have the real dogma, the so-called positive belief; about this I need not speak. But each creed has its peculiar historical side. It says: this has happened, this has occurred, these events have taken place. This historical truth is not simply handed down, but in the garb of an objective truth it appears with certain proofs. This is the case with the Christian religion just as much as with the Mohammedan, with Judaism just as much as with Buddhism. On the other side we find the left wing as it were, where subjectivity reigns; there the single individual dreams, there visions come and hallucinations. One religion promotes them by special drugs, another by abstinence, &c. Thus subjective individual currents are developed, which occasionally assume the shape of perfectly independent phenomena existing by the side of and apart from the previous ecclesiastical domain, which at other times are rejected as heresies, but which often enough lead into the large current of the recognised church. All this we find again in natural science. There too we have the current of the dogma, there too we have the currents of the objective and subjective doctrines. Consequently our task is a compound one. First of all we always try to reduce the dogmatic current. The principal aim of science has for centuries been to strengthen more and more the right, the conservative side. This side, which collects the *ascertained facts* with the *full consciousness of proof*, this side, which adheres to *experiment as the highest means of proof*, this side, which is in possession of the real scientific treasury, has always grown larger and broader, and this principally at the expense of the dogmatic stream. Really, if we only consider the number of natural sciences which since the end of last century have grown and now flourish, we must admit that an almost incredible revolution has taken place.

There is no science in which this is so eminently evident as in medicine, because it is the only science, which has a continuous

history of nearly 3,000 years. We are, so to speak, the patriarchs of science, inasmuch as we have the dogmatic current at its longest. This current was so strong, that in the early part of the middle ages even the catholic church embraced it, and the heathen Galen appeared like a father of the church in the ideas of men; indeed, if we read the poems of that period, he often presents himself exactly in the position of a church dignitary. The medical dogma went on until the time of the Reformation. As contemporaries of Luther, Vesal and Paracelsus came and made the first grand attempts at reduction, they drove piles into the dogmatic stream, constructed dykes by its sides, and left only a narrow fair-way to it. Beginning from the sixteenth century it has grown narrower and narrower every century, so that finally only a very small channel has remained for the therapeutists. Thus vanishes the lordliness of the world.

Only thirty years ago the Hippocratic method was spoken of as something so sublime and important that nothing more sacred could be imagined. Nowadays we must own that this method is annihilated nearly down to its root. At least, a good deal of imagination is necessary if we say that any physician of the present day acts as Hippocrates did. Indeed, if we compare the medicine of to-day with the medicine of the year 1800—accidentally the year 1800 marks a great turning-point in medicine—then we find that our science has undergone a complete reformation during the last seventy years. At that time the great Paris school was formed, immediately under the influence of the French Revolution, and we must admire the genius of our neighbours that enabled them to find all at once the fundamental basis of an entire new discipline. If now we see medicine continue its development in the greater breadth of objective knowledge, we will never forget that the French were the precursors, as in the middle ages the Germans were.

By our own example I only wished to show you shortly what changes both the methods and the storehouse of knowledge undergo. I am convinced that in medicine, at the end of the present century, only a sort of clay-pipe system will have remained, through which the last weak waters of the dogmatic stream may move—a sort of drainage. For the rest the objective current will probably have entirely consumed the dogmatic one.

Perhaps the subjective one will remain as well. Perhaps even then many an individual will dream his beautiful dreams. The field of objective facts in medicine, great as it has become, has yet left such a number of lateral fields, that for anybody who *wants* to speculate, plenty of opportunities offer daily. And these opportunities are honestly made use of. A multitude of books would remain unwritten if only objective things were to be communicated. But the subjective wants are still so great, that I believe I am justified in maintaining that of our present medical literature about one half might safely remain unpublished, without doing any damage worth mentioning to the objective side.

Now when we *teach*, in my opinion, we ought not to look upon this subjective side as an essential object in the doctrine. I believe I now belong to the oldest professors of medicine; I have taught my science now for over thirty years, and I may say that during these thirty years I have honestly striven by myself to free my mind more and more from all subjective tendency, and to get more and more into the objective current. Nevertheless I openly confess that I find it impossible to give up subjectivity altogether. Every year I see again and again that even in points, where I had believed myself to be entirely objective, I still retained a large number of subjective ideas. I do not go so far as to make the inhuman demand that everybody is to express himself entirely without any subjective vein, but I do say that we must set ourselves the task to transmit to the students the real knowledge of facts in the first place, and if we go further, we must tell them each time: "but this is not proved, but this is *my opinion, my idea, my theory, my speculation.*"

This, however, we can only do with those who are already educated and developed. We cannot carry the same method into the elementary schools, we cannot say to each peasant boy, "This is a fact, this we know, and that we only suppose." On the contrary, that which is known, and that which is only supposed, as a rule get so thoroughly mixed up that that which is supposed becomes the main thing, and that which is really known appears only of secondary importance. Therefore we who support science, we who live in science, are all the more called upon to abstain from carrying into the heads of men, and most of all into the heads of teachers, that which we only suppose. Certainly, we cannot give facts only as raw material, that is impossible. They must be arranged in a certain systematic

¹ Address delivered at the Munich meeting of the German Association, by Prof. Rudolf Virchow, of Berlin. Continued from p. 94.

order. But we must not extend this arrangement beyond what is absolutely necessary.

This is a reproach which I cannot help making against Prof. Nägeli as well. Prof. Nägeli has discussed, certainly in the most measured way and—you will notice this if you read his address—in a thoroughly philosophical manner, the difficult questions which he has chosen as subjects for his address. Nevertheless he has taken a step which I consider extremely dangerous. He has indeed done in another direction what is in one way done by *generatio æquivoca*. He asks that the mental domain shall be extended not only from animals to plants, but that finally we shall actually pass from the organic world into the inorganic with our conceptions of the nature of mental phenomena. This method of thinking, which is represented by great philosophers, is natural in itself. If anyone wants by any means to connect mental phenomena with those of the rest of the universe, then he will necessarily come to transfer the mental processes, as they occur in man and the animals of highest organisation, to the lower and lowest animals; afterwards a soul is even ascribed to plants; further on the cell thinks and feels, and finally he finds a passage down to chemical atoms, which hate or love one another, seek one another, or flee from one another. All this is very fine and excellent, and may after all be quite true. It may be. But then, do we really want, is there some positive scientific necessity, to extend the domain of mental phenomena beyond the circle of those bodies, in which and by which we see them really happening? I have no objection if carbon atoms have a mind as well, or that they obtain a mind in their union with the plastic association, but I do not know in what I am to recognise this. It is simply playing with words. If I declare attraction and repulsion to be mental occurrences, to be mental phenomena, then I simply throw the mind (*die Psyche*) out of the window; then the mind ceases to be mind. The phenomena of the human mind may eventually be explained in a chemical way, but for the present, I think, it is not our task to mix up these domains. On the contrary, it is our duty to keep them strictly where we understand them to be. And as I have always laid stress upon this, that we should not in the first line try to find the transition from the inorganic into the organic, but that we should first of all determine the contrast between the inorganic and the organic, and carry on our investigations among those contrasts in the same way, I now maintain that the only way to progress—and I hold the firmest conviction that we shall not advance at all otherwise—is to limit the domain of mental phenomena where we really perceive mental phenomena, and not to suppose mental phenomena, where perhaps they may be, but where we do not notice any visible, audible, sensible, in one word, perceptible phenomena, which we might call mental ones. There is no doubt that for us the whole sum of mental phenomena is attached to certain animals, not to the totality of all organic beings, not even to all animals generally, and I maintain this without hesitation. We have no reason yet to say that the lowest animals possess mental characteristics; we find them only with the higher animals, and with perfect certainty only with the highest.

Now I will admit with pleasure that certain gradations, certain gradual transitions, certain points can be found, where from mental phenomena one gets to phenomena of simply material or physical nature. I certainly do not declare that it will never be possible to bring psychical phenomena into immediate connection with physical ones. All I say is, that at present we are not justified in setting down this possible connection as a scientific doctrine, and I must distinctly oppose the attempts to enlarge our doctrines prematurely in this manner, and to bring again and again into the foreground as a positive statement what we so often proved a useless problem. We must distinguish strictly between what we want to teach and what we want to investigate. What we investigate are problems. We need not keep them to ourselves; we may communicate them to the whole world and say, There is the problem, this is what we are trying to find; like Columbus, who, when he started to discover India, made no absolute secret of it, but who eventually did not find India, but America. And the same happens to us not rarely. We start to prove certain problems which we suppose to be perfectly correct, and in the end we find something quite different, which we never expected. The investigation of such problems, in which the whole nation may be interested, must be open to everybody. That is the *liberty of research*. But the problem is not at once to be the object of instruction. When we teach we must confine ourselves to those smaller domains which are already so large, and which we have actually mastered

Gentlemen, I am convinced that only with a resignation of this kind, which we impose on ourselves, which we exercise towards the rest of the world, shall we be enabled to conduct the fight against our enemies with a victorious result. All attempts to transform our problems into doctrines, to introduce our theories as the basis of a plan of education, particularly the attempt simply to depose the church, and to replace its dogma by a religion of descent without further trouble, these attempts, I say, must fail, and their failure would at the same time bring the greatest dangers upon the position of science generally.

Therefore let us be moderate, let us exercise resignation, so that we give even the most treasured problems which we put forth, always as problems only, and that we say it a hundred and again a hundred times: "Do not take this for confirmed truth, be prepared that this may perhaps be changed; only for the moment we are of opinion that it may be true."

By way of illustration I will add another example. At this moment there are probably few naturalists who are not of opinion that man is allied to the rest of the animal world, and that a connection will possibly be found, if indeed not with apes, then perhaps in some other direction, as is now the opinion of Prof. Vogt.

I acknowledge openly that this is a desideratum of science. I am quite prepared for it, and I would not for a moment wonder nor be alarmed if the proof were found that the ancestors of man were vertebrate animals. You know that just at present I work by preference in the field of anthropology, but yet I must declare that every step of positive progress which we have made in the domain of prehistoric anthropology, has really moved us further away from the proof of this connection. At this moment anthropology studies the question of fossil man. From man in the present "period of creation" we have descended to the quaternary period, to that period when, as Cuvier maintained with the greatest confidence, man never existed at all. Nowadays quaternary man is a generally accepted fact. Quaternary man is no longer a problem, but a real doctrine. But tertiary man is a problem—of course a problem which is already in a stage of material discussion. There are objects already about which discussions are going on as to whether they may be admitted as proofs for the existence of man during the tertiary period. We do not merely speculate on the subject, but we discuss certain objects, whether they may be recognised as witnesses for the activity of man during the tertiary period. The question raised is answered differently according to whether these objective material elements of proof are considered sufficient or not. Even men who, like Abbé Bourgeois, are decided ecclesiastics, are convinced that man has lived during the tertiary period; for them tertiary man is already a doctrine. For us, who are of a more critical nature, tertiary man is still a problem, but, as we must acknowledge, a problem worthy of discussion. Let us therefore for the present remain at quaternary man, whom we really find. If we study this quaternary, fossil man, who ought after all to stand nearer to our ancestors in the series of descent, or rather of ascent, we find a man just the same as we are ourselves.

Only ten years ago, when a skull was found, perhaps in peat or in lake dwellings, or in some old cave, it was believed that wonderful marks of a wild and quite undeveloped state were seen in it. Indeed we were then scenting monkey air. But this has died out more and more. The old troglodytes, lake inhabitants, and peat people turn out to be quite a respectable society. They have heads of such a size that many a person living would feel happy to possess one like them. Our French neighbours have certainly warned us not to conclude too much from these big heads; it may be possible that they were not filled only with nerve-substance, but that the old brains had more intermediary tissues than is the case now-a-days, and that their nerve-substance in spite of the size of the brain, remained at a low state of development. However this is only a friendly conversation which to some extent is held as a support of weak minds. On the whole we must really acknowledge that all fossil type of a lower human development is absolutely wanting. Indeed if we take the total of all fossil men that have been found hitherto and compare them with what the present offers, then we can maintain with certainty that amongst the present generation there is a much larger number of relatively low-type individuals than amongst the fossils hitherto known. That only the highest geniuses of the quaternary period enjoyed the good fortune of being preserved for us I do not dare to suppose. As a rule we draw conclusions from the condition of a single fossil object with respect to the majority of others which have not been found. But I will not do this. I will not maintain that the whole race was as

good as the few skulls which were found. But I must say that one fossil monkey-skull or man-ape skull which really belonged to a human proprietor has never been found. Every addition which we have obtained in the material inventory of objects for discussion has moved us further away from the problem to be solved. Now of course we cannot avoid the consideration that perhaps it was on some quite special spot of the earth that tertiary man lived. This is quite possible, since during the last few years the remarkable discovery has been made in North America that the fossil ancestors of our horses occur in countries from which the horse had entirely disappeared for a long time. When America was discovered there were no horses there at all; in the very place where the ancestors of our horses had lived no living horse had remained. Thus it may also be that tertiary man has existed in Greenland or Lemuria, and will again be brought to light from under the ground somewhere or other. But as a fact we must positively acknowledge that there is always a sharp limit between man and the ape. *We cannot teach, we cannot designate it as a revelation of science, that man descends from the ape or from any other animal.* We can but designate this as a problem, may it seem ever so probable and may it lie ever so near.

We ought to be sufficiently warned by the experiences of the past, at a time when we are not justified in drawing conclusions, not unnecessarily to burden ourselves with the obligation, or yield to the temptation of drawing them all the same. Look you, gentlemen, it is in this that the difficulty lies for every naturalist who speaks to the world at large. Whoever speaks or writes for the public, ought, in my opinion, doubly to examine just now, how much of that which he knows and says is objective truth. He ought to try as much as possible to have all inductive extensions which he makes, all progressing conclusions by the laws of analogy, however probable they may seem, printed in small type underneath the general text, and to put into the latter only that which really is objective truth. In that case we might perhaps succeed in gaining an always increasing circle of followers, in obtaining an always increasing number of fellow-workers, and in causing the educated public to continue to take part in that fertile manner in which it has already taken part in many domains. Otherwise, gentlemen, I fear that we overrate our power. Certainly old Bacon said with perfect justice, *scientia est potentia*, knowledge is power. But he has also defined knowledge, and the knowledge which he meant was not speculative knowledge, not the knowledge of problems, but it was the objective knowledge of facts. I think that we should abuse our power, we should endanger our power, if in our teaching we do not fall back upon this perfectly justified, perfectly safe, and impregnable domain. From this domain we may as investigators make our excursions in the direction of problems, and I am convinced that every attempt of this kind will then find the necessary safety and support.

AMERICAN SCIENCE

THE principal paper in the *American Journal of Science and Arts* for November, is Prof. Marsh's able address at the recent meeting of the American Association, on the Introduction and Succession of Vertebrate Life in America, which we have given at length. —Discussing the question, Is the existence of growth rings in the early exogenous plants proof of alternating seasons? Dr. Warring concludes from observations, that some exogens form rings at intervals much less than a year; others require intervals of several years, and some form no rings. The presence or absence of rings in exogens occurs in all climates. Large and well-defined rings are found where there is absolutely no appreciable variation of temperature or moisture throughout the year. An exogen naturally forming rings will continue to form them, although the climate become uniform throughout the year. Thus the existence of these markings in ancient flora gives no information as to the existence at that time of seasons, and so far as they are concerned we are left free to adopt any conclusion as to inclination of the earth's axis, which may appear most reasonable. —Some years ago Prof. Newcomb showed that the improvements introduced into the theory of the moon's mean motion by Hansen's lunar tables did not extend to the inequalities of long period in that motion. While Hansen, by an empirical term had secured a very good agreement with observations from 1750 to 1860, this agreement was found to have been obtained by sacrificing the agreement before 1750, and the moon had then begun to deviate from the tables at such a rate that they could

not continue satisfactorily to represent the observations. Prof. Newcomb has since attempted a complete discussion of all recorded observations of any astronomical value before the year 1750, and his suspicion has been entirely confirmed. The results of this examination are communicated. Comparing a theory of the moon's mean motion founded on gravity alone, with the observations, he is led to suppose that the deviations may be due to the action of some of the bodies of the solar system. He corrects Hansen's term by an empirical addition. — Prof. Dana contributes to the number a note on the Helderberg formation of Bernardston, Massachusetts, and Vernon, Vermont, and Mr. Mallet describes "Serpylite," a new niobate, from Amherst County, Virginia.

The *New York Tribune* states that the Johns Hopkins Scientific Association has recently been organised in Baltimore. Prof. Sylvester is president, Prof. Remsen, vice-president, Dr. Story, secretary. A great feature in the programme is that the essays presented are to be short and concise, and to contain the particulars of original research exclusively. There is also to be a discussion of new scientific publications, both foreign and domestic, at the meetings, of which the first has been held, with a score of members present.

Under date November 20, the *Tribune* has the following telegram from Washington:—Messrs. S. H. Scudder of Cambridge, and F. C. Bowditch, of Boston, have just returned from a two months' tour in Colorado, Wyoming, and Utah, where, under the direction of Dr. Hayden, they have been exploring for fossil insects and collecting specimens especially in the high regions. They report having secured many specimens of fossil insects at different points along the railways from Pueblo to Cheyenne, and from Cheyenne to Salt Lake, as well as at Lakin, Kansas, and Garland, and Georgetown, Col., and in various parts of the South Park and surrounding region. Their time was so limited that they were unable to visit White River and explore the beds of fossil insects known to exist there. Ten days were spent at Green River, and in that vicinity, in exploring the tertiary strata for fossil insects, but with very unsatisfactory results. Near Florisante the tertiary basin was found to be exceedingly rich in insects and plants. Mr. Scudder spent several days in the careful survey of this basin, and estimates that the extent of the insect-bearing shales there is at least fifty times as great as that of those in Southern Bavaria. Six or seven thousand specimens of insects, and 2,000 or 3,000 of plants have already been received from Florisante, and as many more are expected before the close of the year. Arrangements were also made with persons who have found a new and rich deposit of fossils in the tertiary strata in Wyoming to forward all the specimens obtained there. Mr. Scudder believes that the tertiary strata of the Rocky Mountain region are richer in the remains of fossil insects than any others in the world, and that within the next few months the amount of material at hand for the study of the subject will be greater than was ever before possessed by any single naturalist. Prof. Joseph Leidy, the comparative anatomist and microscopist, has also recently returned from his second visit to the west, under the direction of Dr. Hayden. His field of operations during the past season was the country about Fort Bridger, Uintah Mountains and the Salt Lake Basin. The specimens he has collected comprise the lowest and simplest forms of animal life, the most minute requiring high microscopic power to distinguish their structure.

THE METEOR

WE have received some further communications concerning this remarkable phenomenon, and some interesting details concerning a similar body will be found in our "Astronomical Column." Mr. A. O. Walker writes from Chester:—

In reading the notice of the meteor of November 23 in *NATURE*, vol. xvii. p. 94, I am surprised to see no mention of any report from it. As I only heard it without seeing it I send you the notice of it from my diary, written immediately after the occurrence:—

"About 8.30 P.M. heard a loud report like that of a cannon (say 32 lbs.), fired about 200 yards off, which shook the house, and the servants saw a bright flash. The sky overhead was quite clear and only cloudy on the horizon south and east. Thought it was the explosion of an aerolite."

Next day I made inquiries and added the following:—

"Parry and Field said the flash was blue, and five minutes