

philosophising or indulging in hypotheses framed for the purpose of explaining the facts which are her peculiar province.

Now it is with regard to these two different kinds of occupations of science that this paper is chiefly concerned, and in attempting to indicate what the reasonable attitude of the religious man is, or ought to be to science, it is of the first importance for us to distinguish between scientific facts and scientific hypotheses. Most readers of popular works, having never learnt the alphabet of science, in which they resemble more than one of the writers of the same works, wholly confuse the essential

Difference between Facts and Hypotheses,

and hence fall into utter confusion as to the whole of the controversy which rages, or has raged, around certain biological ideas and theories.

At the outset, therefore, one must distinguish carefully between scientific facts and scientific hypotheses. The former are matters of observation, the latter of deduction. The former scarcely admit of doubt, if they admit of it at all; the latter may appear to be incontrovertible, or may not rise to as high a level even as a pious opinion. For example, it is an unquestioned fact that some living creatures have backbones and some have not; that certain animals live in one part of the world and in that part alone; that certain acids combine with certain bases to form certain combinations or salts.

There is no gainsaying facts such as these, nor has the Church anything to say to them save in so far as she chooses to use them in building up her system of philosophy.

An hypothesis endeavours to explain facts, to bind them together, to co-relate them. As an example we might take the much-debated theory which asserts that all living animals have been derived from simpler forms—the doctrine of transformation.

Before discussing our attitude to such hypotheses there are three points which it will be well to keep in mind:

(1) That what has long been thought to be a scientific fact may turn out to have been all along only an hypothesis, and perhaps an inaccurate hypothesis too. I shall deal more fully with this point when I come to touch upon the question of the so-called chemical elements.

(2) That scientific facts without hypotheses to bind them together are interesting but disjointed. They may, like the sheep's head, afford 'fine confused feeding,' but the effect upon the student will be like that produced upon the man who attempted to satisfy his literary cravings by reading Johnson's 'Dictionary.'

They are like the bricks and mortar out of which the genius of the architect can construct a Westminster Cathedral, but which otherwise remain a confused and meaningless mass.

(3) That these hypotheses are liable, at any moment, to be upset by facts newly come to light. But even if overthrown and cast on the scrap-heap, they may still have served a useful purpose as stepping-stones on the way to truth.

Hence the construction of hypotheses is not only a legitimate exercise of scientific imagination, it is also an absolutely necessary one if science is to progress and knowledge to increase.

But what is too often forgotten is that many—it would not be too much to say most—of these theories never attain to a greater dignity than of a working hypothesis, and many of them perish before they have arrived even at this pitch of acceptance.

In the biological sciences at least it may safely be said that there is hardly a single theory which can be regarded as being, even in its measure, as firmly established as a mathematical proposition.

Take the

Theory of Evolution,

which, as the little scientific manuals are never tired of assuring us, unless a scientific man believe, he is undoubtedly lost. What is the real value of this hypothesis? It may fairly be said that it is accepted by most, though perhaps not by all men of science, though the same men of science differ as widely as can be as to how evolution has come about. Few, however, if any, would be so teme-

rious as to say that this hypothesis rests on as secure a foundation, as, say, a proposition of Euclid, or as one of the positive facts of science like those alluded to previously. But if this be the case, and it can hardly be denied, then this theory, like others, remain only a theory and cannot be accepted as being more than a working hypothesis, though admittedly the most fruitful of results of all the hypotheses which have been put forward by scholars belonging to the biological wing of the scientific army.

As I have already said, this is not the view which is taken of this subject by the compilers of the little manuals which flutter in such swarms from the popular press, but it is of great importance to take these manuals at their real value and not at that which is set upon them by their writers. A recent writer has very pertinently observed:—

'Laymen in science who wish to follow the trend of modern discovery are limited for the most part to one of two things: Either they must read the pseudo-science of the magazines, which is arranged chiefly for dramatic effect rather than for accurate exposition, or they must turn to specialised and technical works written by the discoverers themselves for their fellow-workers—books in which technical training is taken for granted, and the lay-reader, however cultured and thoughtful he may be, becomes utterly and hopelessly lost. The world is, then, divided between men who know and cannot tell, and men who tell and cannot know.'

For the sake of those but little conversant with the literature of science it may be well to give one example of the kind of thing which is here alluded to. Readers of evolutionary books will not require to be told that the stock example of a chain of animals in direct descent is that of

The Horse and Its Predecessors,

an example which is so much quoted in such books as to lead many to suspect that it is the only quotable instance.

In any case, as ordinarily given, it certainly is a very striking instance, and one which might well be considered to go a long way in the direction of proving the theory of transformation, at any rate, so far as this particular species is concerned. And so we find, in one of the most recent and dithyrambic of the little books on evolution, that 'this great service, the affording of unquestionable proof of this momentous theory' [of organic evolution] 'mankind owes to its trusty servant the horse.'

So impressed with this point is the writer that he proceeds:—'The horse always stands to me for three things: First, its obsolescent use as a beast of burden; second, its proof of the truth of organic evolution; third, its priceless services—irreplaceable by any machine—in giving its blood to save our children's lives when they are in the clutches of diphtheria.' The order of the services or aspects of interest of the horse is rather odd, but at least it is clear that the writer in question attached extraordinary importance to the piece of evidence which it is supposed to afford. Indeed, he does not hesitate to describe it as 'A Conclusive Instance' in the heading of the chapter which deals with the subject. So much for the man who tells. Let us now turn to the man who knows. For every thousand persons who glance through the pages of the booklet from which I have been quoting, it may be taken that perhaps not more than one will consult the learned 'Text-book of Zoology,' published in 1905 by the present occupant of the chair of that subject in the University of Cambridge. Hence but few in comparison will learn what the position of science is on that subject to-day. After describing the points alluded to above, with regard to the so-called ancestry of the horse, the learned writer proceeds: 'So far as the characters mentioned are concerned, we have here a very remarkable series of forms which at first sight appear to constitute a linear series with no cross-connections. Whether, however, they really do this is a difficult point to decide. There are flaws in the chain of evidence which require careful and detailed consideration. For instance, the genus *Equus* appears in the Upper Siwalik beds, which have been ascribed to the Miocene age. It has, however, been maintained that these beds are really Lower Pliocene or even Upper Pliocene. It is clear that the decision of this question is of the utmost importance. If *Equus* really existed in the Upper Miocene, it was antecedent to some