principles anew, raises on them a superstructure, which, even if it logically follows from them, can have no more validity than the premises on which it is based. When the premises are not accepted by other philosophers, the whole scheme becomes merely the doctrine of one man, and, if it lives at all, may oppress by the dead weight of authority the struggle of living thought beneath it.

The history of the atomic theory of Leucippus and Democritus illustrates the difficulties of a position where speculation has outstripped observation. The theory was nearer what is now accepted as truth than any other of the ancient schemes of physics. Yet the grounds on which it was based were so insecure that Aristotle (c. 340 b.c.), who started with other preconceptions, was able to bring to bear such destruc­tive criticism that the theory ceased to occupy the foremost place in Greek thought. Although, with the knowledge then available, we can but admit that some of Aristotle’s criticism was just, much of it consists of metaphysical arguments against the atomists, while in parts he rejects true conclusions owing to what he considers their impossibility. Democritus, for instance, had held that all things would fall with equal speed in a vacuum, and that the fact that heavy bodies were observed to fall faster than very light ones was due to the resistance of the air. Democritus’s belief was true, though he was of course quite unconscious of the grounds on which it can alone be demonstrated—the universal attraction of gravity, and the remarkable and curious experimental fact that the weights of bodies are proportional to their masses. Aristotle agrees that in a vacuum all bodies would fall at an equal rate, but the conclusion appears to him so inconceivable that he rejects the idea of the existence of any empty space at all, and with the “ void ” rejects the rest of the allied concepts of the atomic theory. If all bodies were composed of the same ultimate matter, he argues, they must all be heavy, and nothing would be light in itself and disposed to rise. A large mass of air or fire would then necessarily be heavier than a small mass of earth or water. This result he thinks impossible, for certain bodies always tend upwards and rise faster as their bulk increases. It will be seen that Aristotle has no idea of the con­ceptions we now call density and specific gravity, though clear views about the question why some things rise through water or air might have been obtained without the aid of physical apparatus. Aristotle’s doctrine that bodies are essentially heavy or light in themselves persisted all through the middle ages, and did much to delay the attainment of more exact knowledge. It was not till Galileo Galilei (1564-1642) dis­covered by actual experiment that, in cases where the resistance of the air is negligible, heavy things fall at the same speed

as light ones, that the Aristotelian dogma was overthrown.

Turning to the biological sciences, we may trace a somewhat similar course of development. Owing to its practical im­portance, medicine has left many records by which its progress can be traced. Just as primitive man personified the sun and the moon, the wind and the sea, so he regarded disease as due to the action of some malignant demon or to the spells of some human enemy. Once more Greek literature enables us to trace the gradual decrease in the import­ance assigned to charms and magic, and the growth of more rational ideas among physicians. But here, as in the physical sciences, the philosophic range of the intellect of the Greeks led them astray. Assumptions as to the nature of man or the origin of organic life were too often made the starting point of a train of deductive reasoning, the consequences of which were not always compared with the results of observation and experiment, even where such comparison was possible. «The Greek philosophers tried to make bricks without straw, usually in sublime unconsciousness that straw was necessary. Many centuries of humble observation and tentative fitting together of small parts of the great puzzle were needed before enough material was collected to make possible useful generalizations about the questions, answers to which the Greeks assumed as

the very basis of their inquiries.

Among the multitude of their guesses, a few somewhat re­sembled the views that are now again rising into prominence from the basis of definite and exact experiment. A good example of the strength and weakness of ancient speculation is found in the cosmogony of the atomists, both on its physical and on its biological side. Lucretius describes how the world was formed by the conjunction of streams of atoms, which con- densed into the earth, with its attendant water, air and aether, to form a self-contained whole. Unconscious of the mighty gap between inorganic matter and living beings, he proceeds to tell how, in the chances of infinite time, all possible forms of life appeared, while only those fittest to survive persisted and reared offspring. Here, surrounded by unsupported statements and false conclusions, we see dimly the germs of the ideas of the nebular hypothesis and the theory of natural selection, though Lucretius had the profoundest ignorance of the difficulties of the problem, and the vast stretches of time necessary for cosmical and biological development.

In those branches of biological science in which less ambitious theorizing and more detailed observation were forced on the Greeks, considerable progress was made. Aristotle compiled a laborious account of the animals known in his day, with many accurate details of their anatomical structure. Beginning from an earlier date, steady advance was made with geographical discovery. Maps of the known world, developed from the local maps invented by the Egyptians for the purposes of land- surveying, gave definiteness to the knowledge thus acquired, and showed its bearing on wider problems.

One of the most striking successes of Greek thought is seen in the development of geometry. Geometry has a twofold importance, as being itself the study of the properties of the space known to our senses, and as teaching us methods and means of studying nature by unfolding the full logical consequences of any hypothesis: geometry is the best type of deductive reasoning. Based on axioms, the result of simple experience, it traces from the ideas of solids, surfaces, lines and points the properties of other figures defined in terms of those ideas. As an example to other sciences, the deductive geometry of Euclid (c. 300 b.c.) had, perhaps, an unfortunate influence in emphasizing the deductive method, and teaching men to neglect the need of verifying by experiment the theories put forward to explain the more complex phenomena of nature at the conclusion, and at each possible step, of the deduction. But, in itself, the science of Euclidian geometry was brought to such a state of perfection that no advance was made till modern times: no change even in form attempted till quite recently. Unlike some other branches of inquiry we have mentioned, Euclid’s geometry carried universal conviction, and represented a permanent step in advance which never had to be retraced.

Alongside the study of individual sciences, the Greeks paid even more attention to the laws of thought, and to the examination of the essence of the methods by which knowledge in general is acquired. In opposition to Plato’s theory that all knowledge is but the unfolding and development of forgotten memories of a previous state of existence, Aristotle taught that we learn to reach the generaliza­tions, which alone the Greeks regarded as knowledge, by remem­bering, comparing and co-ordinating numerous particular acts or judgments of sense, which are thus used as a means of gaining knowledge by the action of the innate and infallible nous or intellect. Neither Plato nor Aristotle could be satisfied without finding infallibility somewhere. Aristotle, it is true, investigated the logical processes by which we pass from particular instances to general propositions, and laid stress on the importance of observing the facts before generalizing about them, but he had little appreciation of the conditions in which observation and the induction based on it must be conducted in practice in order to obtain results where the probability of error is a minimum. Aristotle regarded induction merely as a necessary preliminary to true science of the deductive type best seen in geometry, and, in applying his principles, he never reached the “ positive ” stage, in which metaphysical problems are evaded, if not excluded,