for which the researches of Anaximander had prepared the way,@@1 was in fact one of the great discoveries of Pythagoras, was taught by Parmenides, who was connected with the Pythagoreans, and remained for a long time the exclusive property of the Italian schools.@@2

Whilst in virtue of his political sagacity and intellectual eminence Thales held a place in the traditional list of the wise men, on the strength of the disinterested love of knowledge which appeared in his physical speculations he was accounted a “ philosopher ” (*φιλό­σοφος*)*.* His “philosophy” is usually summed up in the dogma “ water is the principle, or the element, of things but, as the technical terms “ principle ” (ά*ρχή*) and “ element ” *(στoιχeίov)* had not yet come into use, it may be conjectured that the phrase “ all things are water ” *(πάντα ΰδωρ έστί)* more exactly represents his teaching. Writings which bore his name were extant in antiquity ; but, as Aristotle, when he speaks of Thales’s doctrine, always depends upon tradition, there can be little doubt that they were forgeries.

From Aristotle we learn (1) that Thales found in water the origin of things ; (2) that he conceived the earth to float upon a sea of the elemental fluid ; (3) that he supposed all things to be full of gods ; (4) that in virtue of the attraction exercised by the magnet he attributed to it a soul. Here our information ends. Aristotle’s suggestion that Thales was led to his fundamental dogma by observation of the part which moisture plays in the pro­duction and the maintenance of life, and Simplicius’s, that the impressibility and the binding power of water were perhaps also in his thoughts, are by admission purely conjectural. Simplicius’s further suggestion that Thales conceived the element to be modi­fied by thinning and thickening is plainly inconsistent with the statement of Theophrastus that the hypothesis in question was peculiar to Anaximenes. The assertion preserved by Stobæus that Thales recognized, together with the material element “water,” “ mind,” which penetrates it and sets it in motion, is refuted by the precise testimony of Aristotle, who declares that the early physicists did not distinguish the moving cause from the material cause, aud that before Hermotimus and Anaxagoras no one postulated a creative intelligence.

It would seem, then, that Thales sought amid the variety of things a single material cause ; that he found such a cause in one of the forms of matter most familiar to him, namely, water, and accordingly regarded earth and all that it contains as water vari­ously metamorphosed ; and that, asking himself no questions about the manner of its transformation, he was content “ to see in the forces of nature present deities ” (Zeller).

The doctrine of Thales was interpreted and developed in the course of three succeeding generations. First, Anaximander chose for what he called his “ principle ” (αρχή), not water, but a cor­poreal element intermediate between fire and air on tbe one hand and water and earth on the other. Next, Anaximenes, prefer­ring air, resolved its transformations into processes of thinning and thickening. Lastly, Heraclitus asserted the claims of fire, which he conceived to modify itself, not occasionally, but per­petually. Thus Thales recognized change, but was not careful to explain it ; Anaximander attributed to change two directions ; Anaximenes conceived the two sorts of change as rarefaction and condensation ; Heraclitus, perceiving that, if, as his predecessors had tacitly assumed, change was occasional, the interference of a moving cause was necessary, made change perpetual. But all four agreed in tracing the variety of things to a single material cause, corporeal, endowed with qualities, and capable of self-transforma­tion. A new departure was taken by the Eleatic Parmenides (see vol. xviii. p. 315), who, expressly noting that, when Thales and his successors attributed to the supposed element changing qualities, they were untrue to the principle of monism, required that the superficial plurality of nature should be strictly distin­guished from its fundamental unity. Hence, whereas Thales and his successors had confounded the One, the element, and the Many, its modifications, the One and the Not-One or Many became with Parmenides matters for separate investigation. In this way two lines of inquiry originated. On the one hand Empedocles and Anaxagoras, abandoning the pursuit of the One, gave themselves to the scientific study of the Many; on the other Zeno, abandoning the pursuit of the Many, gave himself to the dialectical study of the One. Both successions were doomed to failure; and the result was a scepticism from which the thought of Greece did not emerge until Plato, returning to Parmenides, declared the study of the One and the Many, jointly regarded, to be the true office of philo­sophy. Thus, meagre and futile as the doctrine of Thales was, all the Greek schools, with the solitary exception of that of Pythagoras, took their origin from it. Not in name only, but also in fact, Thales, the first of the Ionian physicists, was the founder of the philosophy of Greece.

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THALLIUM, one of the rarer elements of chemistry. Its discovery is one of the outcomes of Bunsen and Kirchhof’s method of spectrum analysis. When Crookes, in 1861, applied this method to the flue-dust produced in the roasting of a certain kind of pyrites he observed in its spectrum a green line foreign to all then known spectra, and concluded that his substance must contain a new element, to w’hich he gave the name of *thallium,* from *θαλλός,* a green twig. Crookes presumed that his thal­lium was something of the order of sulphur, selenium, or tellurium ; but Lamy, who anticipated him in isolating the new element, found it to be a metal. Our present knowledge of the chemistry of thallium is based chiefly upon the labours of Crookes.

The chemical character of thallium presents striking peculiarities. Dumas once called it the “ *ornithorhynchus paradoxus* of metals.” As an elementary substance, it is very similar in its mechanical and physical properties to lead ; like lead it forms an almost insoluble chloride and an insoluble iodide. But the hydroxide of thallium, in most of its properties, comes very close to those of the alkali metals ; it is strongly basilous, forms an insoluble chloroplatinate, and an alum strikingly similar to the corresponding potassium compounds. Yet, unlike potas­sium or lead, it forms a feebly basic sesquioxide similar to manganic oxide, Mn2O3.

Traces of thallium exist in many kinds of pyrites, as used for vitriol-making. The only known mineral of which it forms an essential component is the “ crookesite ” of Skrikerum, Småland, Sweden, which, according to Norden- skiöld, contains 33∙3 of selenium, 45∙8 of copper, 3∙7 of silver, and 17∙2 of thallium in 100 parts. Crookesite, however, is scarce. The best raw materials for the pre­paration of thallium are the flue-dusts produced indus­trially in the roasting of thalliferous pyrites and the “chamber muds” accumulating in vitriol-chambers wrought with such pyrites ; in both it is frequently associated w’ith Selenium (*q.v.*)*.* The flue-dust from the pyrites of Theux, near Spa (Belgium), according to Böttcher, contains 0∙5 to 0∙75 per cent. of thallium; that of the pyrites of Meggen, according to Carstanjen, as much as 3∙5 per cent.; while that of the pyrites of Ruhrort yielded 1 per cent. of the pure chloride to Gunning.

For the extraction of the metal from chamber mud, the latter is boiled w’ith water, which extracts the thallium as Tl2SO4. From the filtered solution the thallium is precipitated by addition of hydrochloric acid, as T1C1, along, in general, with more or less of chloride of lead. The mixed chlorides are boiled down to dryness with oil of vitriol to convert them into sulphates, which are then separated by boiling water, which dissolves only the thallium salt. From the filtered solution the thallium is recovered, as such, by means of pure metallic zinc, or by electrolysis. The (approximately pure) metallic sponge obtained is washed, made compact by com­pression, fused in a porcelain crucible in an atmosphere of hydro­gen, and cast into sticks. Methods for the final purification of the metal will easily be deduced from what follows.

The *metal* is bluish white ; it is extremely soft but almost devoid of tenacity and elasticity. Its specific gravity is 11∙86. It fuses at 290o C. ; at a white heat it boils and can be distilled in hydrogen gas. When heated in air it is readily oxidized, with formation of a reddish or violet vapour. When exposed to the air it readily draws a film of oxide ; the tarnished metal when plunged into water reassumes its metallic lustre, the oxide film being quickly dissolved. When kept in contact with water and air it is gradually converted into hydroxide, Tl2OH2O or T1OH.

This *hydrate,* T10H, most conveniently prepared by decomposing the solution of the sulphate with baryta water, crystallizes from its

@@@1 In likening the earth to a cylinder Anaximander recognized its circular figure in one direction.

@@@2 See G. V. Schiaparelli, *I Precursori di Copernico nell' Antichità,* p. 2, Milan, 1873.