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painters, Dosso Dossi; and the editor, Count Guoli, contributed a stipulation made on October 27, 1481, by Cosimo Rosselli, Sandro Botticelli, Ghirlandajo, and Perugino, that they and their assistants would have their frescoes in the Sistine finished by March 15, 1482. This bit of information furnishes the precise date of the Sistine Quattrocento paintings, and at the same time excludes Signorelli, of whom it makes no mention, from any share in them, as indeed the latest criticism has already excluded him on stylistic grounds. Among the more important articles in the *Archivio* of last year are one by Signor Umberto Rossi, the curator of the Bargello at Florence, on the recent acquisitions made by that institution; a capital monograph by Count Guoli on Luigi Capponi, a Milanese sculptor of the fifteenth century, working in Rome; and a series of studies by Dr. Gustavo Frizzoni, on the Museo del Prado at Madrid. Although this incomparable collection of pictures has been visited by a number of specialists, including Morelli, Dr. Frizzoni is the first to furnish a complete account, from the point of view of the most advanced criticism, of its Italian masters. As literary heir and executor of Morelli, he has used the latter's notes to aid him in the searching analysis made of the works exposed, and the results at which he has arrived are likely to find universal acceptance. In Madrid, everything depends on distinguishing between what, for want of a better term, must be called autographic pictures by a given master, and such as are merely of his school, or are attributed to him by pure accident. Signor Frizzoni reduces the number of genuine Titians from forty-two to twenty-four, the Veroneses to two, the Raphaels also to two. No greater service can be done to the reputation of an artist than to relieve it of the second and third-rate works attributed to him, and the same process puts the public out of danger of squandering its emotions on bad art.

EARLY MAGNETICAL SCIENCE.—I.

William Gilbert of Colchester, physician of London, on the Load-stone and Magnetic Bodies and on the Great Magnet, the Earth: A New Physiology, demonstrated with many Arguments and Experiments. A translation by P. Fleury Mottelay. John Wiley & Sons. 1893.

THE lodestone, which Mr. Mottelay will write load-stone, is a mass of oxide of iron of the approximate composition Fe_3O_4, which is susceptible to magnetic induction, but only very slowly, and which has lain for such eons in the telluric field of magnetism as to have become polarized, often most intensely. Almost all iron ore of this low degree of oxidation, which alone is magnetic, shows more or less polarity. The properties of a lodestone are sensibly different from those of a steel magnet, owing to its great resistance to magnetic induction—a circumstance which simplifies some of the phenomena.

If the scientific stage of experimental inquiry be considered as commencing with the application to it of special apparatus, then the earliest scientific magnetician was Petrus Peregrinus, a Picard, and elder contemporary of Roger Bacon. His treatise on the lodestone was printed in 1558, but that volume is excessively rare, and the contents of the work are not generally known even to specialists. We shall refer here to the text of a MS. of the thirteenth century in the Bibliothèque Nationale (MSS. latins 7378), certainly older than a date often assigned to the composition. The ancients had noticed that lodestones would pick up iron and draw it from a distance, and that one piece of iron hanging from a lodestone would pick up another. But they did not remark the poles, nor that iron could be magnetized. But before Peregrinus wrote, the use of the magnetic needle had begun to come into use with sailors. His treatise (*Epistola*) is addressed to a friend. It begins: "Amicorum intime! Quondam magnetis lapidis occultam naturam a te interpellatus," etc.—in English as follows:

"Inmost of friends! Having been formerly interrogated by thee, I will in a rude narration disclose everywhere the occult nature of the lodestone. For among philosophers nothing is pleasant without participation of knowledge, and the nature of good things is bereaved and clouded in darkness until it is lifted up into the light of mutual surrender. For the love of thee I will write things that to the mob of students are utterly unknown. Nevertheless, of nothing but what is open to observation (*manifestus*)* shall we in this letter deliver knowledge, in that this delivery will be part of the treatise in which we shall treat of constructing physical instruments. To treat of the occult properties of this stone concerns the art of sculpturing stone, and though I call the works of which I have inquired open to observation, still they will be inestimable, and to the vulgar they are as illusions and fancies, and therefore in respect to the vulgar they are secret; but to astrologers and naturalists† they will be sufficiently open to observation; and to them they will be a solace and for sailing travellers no slight assistance."

Truly, the scientific spirit and insight of this and other passages of the epistle are surprising. Apart from the affectionate warmth which has in all ages been characteristic of scientific men, but is almost incomprehensible to outsiders—well-nigh incomprehensible, for instance, that Agassiz, greatly injured as a scientific leader, and, indeed, worn nearly to death by his long and vehement dispute with Darwin, should, though a strong hater when occasion was, welcome with the utmost delight, "for their father's sake," the young Darwins, whose father had, as a matter of course, recommended them to Agassiz—apart from this, there are other little traits, veritable shibboleths among the race of *Naturforscher*. We remark that the above passage contains a sort of definition of what was meant by an "occult quality" among the mediæval physicists. It means a quality not deducible from the Aristotelian doctrine of hot and cold, moist and dry, and not discoverable except by experiment, and therefore a secret to all who do not make experiments, though "satis manifesta" to those who do. We also remark that the present treatise is regarded as an instalment of a larger one which is to treat of what?—of the "construction of physical instruments"; and directly after follows a passage (imitated, in form, from Geber, but far superior to the original in matter), to the effect that a physicist ought to be a mechanician, because it is not by mere thinking but by handiwork that he is to discover the natures of things ("Scito verissime quod oportet hujus artificem scire," etc., with which compare Geber's "Scias, carissime," etc., and "Oportet artificem hujus operis in scientiis philosophiæ naturalis eruditum esse," etc. There were many mediæval imitations of the me chapter of Geber, but none to compare wit this).

Accordingly, the first thing that Pilgrim Peter does is to put a lodestone into a lathe, or in some way (to be explained in another work) reduces it to a spherical form. A happy thought that. Then he lays a bit of iron wire (*acus*) upon the ball, and finds it at once turns round in a definite direction. He marks this upon the stone, and pushes the needle along in the same line. This is done at several different places on the stone, and the different lines so drawn are found, on being continued, to intersect at two points only. At those points alone the wire stands up at right angles to the surface of the sphere. They are called by Peter its *poles;* they have retained that name ever since. He next floats the lodestone with its axis horizontal in a little round boat, and finds that a certain one of the poles always turns to the north. "Si millesies amoveatur, millesies ad suum locum revertetur nutu Dei." The pole pointing north he calls the north pole, and *vice versa*. Next, taking a second lodestone, he finds that unlike poles attract, while like poles repel, one another. Next, he shows that an oblong piece of iron touched at its end by a pole of the lodestone acquires the properties of a lodestone. He also shows the effect of breaking the stone across its axis, and that of uniting two stones in the way which satisfies their attractions. He thus recognizes magnetization by contact, but not induction at a distance.

So far, he has done his thinking, apparatus in hand; he has hardly so much as made suggestions; certainly, the conclusions were those of nature's own mind. But now he tries a little thinking with his individual brain. He concludes that the poles of the magnet direct themselves to the poles of the heavens. If he had only tried letting his lodestone sphere sink through water or some more viscous fluid, he would have discovered the magnetic dip, and would have refuted his error. But his mediæval mind was beginning to chafe under the harness of experiment. The poles of the lodestone point, he declares, to the poles of the heavens; and "no doubt every part of the lodestone points to an appropriate part of the heavens." So he suggests that his correspondent should try the following experiment: Let a spherical lodestone be so mounted between bearings as to turn freely on its axis, and be in equilibrium in every position, while the axis is held parallel to the axis of the heavens. "Then," he says, "if the stone turns with the revolution of the heavens, you may rejoice to have discovered a wonderful secret. But if t, it is to be imputed rather to your want of skill in mounting the stone than to any defect of nature." Is not this human?

After Peregrinus, three centuries and a half elapsed without the invention of any new apparatus, and consequently without any important discovery. That of the variation of the compass (the consequence of that invention) seems to have been made by navigators without reclamation. Its different amounts in different places are shown on the maps of the Venetian Andrea Biancho, made in 1436. The dip was first clearly proved by Robert Norman in his book, 'The newe Attractive, containyng a short discourse of the Magnes or Lodestone, and amongst his other vertues, of a newe discovered secret and subtill propertie, concernyng the Declinyng of the Needle touched therewith, under the plaine of the Horizon. Now first found out by R. Norman Hydrographer' (2 parts, London, 1581, 4to; other editions 1585, 1596, 1611). Norman was led to this discovery from having constructed a very accurately balanced needle.

William Gilbert came of an ancient family, seated at Clare, in Suffolk, on the border of Essex. His father was a prominent and apparently wealthy lawyer in Colchester. The boy attended the grammar school, and in 1558 obtained the scholarship in St. John's, Cambridge, belonging to that school. He arrived in Cambridge just at the beginning of one of the religious revolutions there. St. John's, then altogether the most distinguished college in England, had for its master, when Gilbert first went there, an excellent scholar, George Bullock, who, on account of his Romanism, was within a year displaced by a still more learned man, and a wise one, James Pilkington, an ardent Calvinist, later Bishop of Durham. The Cambridge undergraduates were at that time coarse enthusiasts for Calvinism; but the dons mostly looked upon the church as a union to uphold holy living and put down evil, and thought theology was a secondary matter. They changed about from Protestantism to Catholicism and from Catholicism to Protestantism, without enthusiasm and without reluctance, at the royal bidding. It is rather a remarkable fact that Gilbert's great work contains not a single direct reference to God. In Book VI., cap. iii., he refers to the waters above the firmament "of the divine Moses," merely to explode the idea. Being a strong Copernican, he does remark that the Holy Scriptures recognize no *primum mobile* nor rotation of the entire firmament. But this is the only reply he condescends to make to the theological objections to the Copernican opinion, except that in one place he exclaims, "Excutiant theologi et spongiis deleant aniles istas" (Let theologians shake off and wipe out such old woman's nonsense). He speaks of "the divine and perspicacious genius" of Aquinas; but to translate "Divus Thomas," where *Divus* is simply the title of his grade of official sainthood, by "the godlike Thomas," as Mr. Mottelay does, is hardly warranted. However, these expressions pretty clearly show that Gilbert was a convinced Anglican, or, as we may say, Elizabethan, in religion.

Gilbert showed an early bent for chemistry. The latest novelty in that line was then Giambattista Porta's 'Natural Magic,' first published in Naples in 1558; and though this work was written when the author was only fifteen years old, it had an immense popularity, and was soon translated into Italian, French, Spanish, and Arabic. It was republished, greatly enlarged, in 1589. (We shall refer to the corrected edition of 1591.) But a passion for chemistry would imply readings in Ripley and in Paracelsus. Accordingly, we find in the 'De Magnete' several passages of Paracelsist leaning. During Gilbert's first year in Cambridge, he had, in accordance with the statutes then in force, to devote himself chiefly to the study of arithmetic, although the commission of 1559 changed this to rhetoric. Gilbert's writings amply attest his unusual accomplishments in both directions, but more particularly in mathematics. It is true that, in the last chapter of the 'De Magnete,' Mr. Mottelay (p. 354) makes Gilbert sneer at mathematicians; but the use of *hi*, "the latter," shows that not the mathematicians, but the philosophers, are meant. During his second year at the university, he was required to devote his studies to logic. Sir T. Wilson's 'Rule of Reason' was the only book on the subject that had been printed in England, but Gilbert certainly went deeper than that; his writings show it unmistakably. He was graduated in 1560, and obtained a fellowship. If, as Anthony à Wood asserts, he studied also in Oxford, it was most probably about this time. In 1565 he was mathematical examiner in St. John's, in 1569 he took his degree in medicine, and was appointed Senior Fellow.

On leaving college he went to travel on the Continent. He returned in 1573, and established himself in London. His house was on St. Peter's Hill, between Upper Thames Street and Little Knightrider Street. Mr. Mottelay locates this in Colchester; but the street (in the parish of St. Peter Paul's Wharf), called St. Peter's Hill, a continuation of Sermon Lane, appears on the old maps of London, and exists to this day. Upon being appointed principal physician to Queen Elizabeth, Gilbert seems to have moved to Whitehall. This broke up a society, the precursor of Gresham College and the Royal Society, which had for a long time met at his house. During his years in London he filled several offices in the Royal College of Physicians, those of censor, treasurer, consilarius, and finally, in 1600, the year of the publication of his great work, that of president. He died November 30, 1603, which was a plague year.

Gilbert is described as tall in stature. If we may trust to his portrait, he was robust and of energetic bearing. His head was square, his forehead square and smooth, his chin long, his physiognomy that of a practical man. At the same time, his appearance is refined and somewhat delicate. He was probably handsome. He never married. He was of a calm and cheerful disposition. "reserved but not morose," says Thomas Fuller. His book abounds in irascible expressions concerning certain classes of writers: "May the gods damn all such sham, pilfered, distorted works, which do but muddle the minds of students" (Book II., chap. xxxv.). He occasionally speaks rather haughtily of individuals. Thus, Jean Baptiste Besard (whose name Mr. Mottelay twice writes Bessard), certainly a very distinguished physician, is referred to as "one Besardus, a Frenchman." Although in 1600 Francis Bacon had not published anything about science, he had, no doubt, talked about it with Gilbert, and he is not improbably alluded to among the *rabulis*, or "pettifoggers," to whom the magnetic philosophy will not prove acceptable. Bacon, when his turn came, spoke contemptuously of Gilbert; but he gave dignity to what he said by making it quite true: "Gilbert has not unscientifically introduced the question of magnetic force. But he has himself become a magnet. That is, he has ascribed too many things to that force, and built a ship out of a shell."

ANOTHER LIFE OF GEN. THOMAS.

General Thomas. By Henry Coppée, LL.D., Professor in the Lehigh University, and formerly an officer of artillery in the United States Army. D. Appleton & Co. 12mo, pp. xiv, 332. [Great Commanders Series.]

THE tone of Prof. Coppée's Life of Gen. Thomas is in refreshing contrast to some other publications on the same subject. He has found it easy to eulogize his hero without vilifying others. There is, perhaps, only a single instance in which his reference to others is questionable, and that is where he speaks of Thomas as "beset" by the authorities at Washington in December, 1864 (p. 258). He apparently forgets that Lincoln and Stanton did not send despatches to Thomas, but expressed their fears and their criticisms to Gen. Grant, who was always measured, if he was emphatic, in his orders and despatches. The author's characterizations of Gen. Thomas are happy, both in the development of the man in the earlier chapters, and in the summary near the end of the book. The military preëminence which is attributed to him over all his contemporaries will not be accepted as the final verdict, but is so much in the vein of special biographies that we must expect each of the subjects of the Commanders Series to be in turn set on the same pinnacle. We shall have to judge for ourselves, after all, among these clashing preeminences.

In one respect, however, we had the right to expect from the author another sort of workmanship than that which he has given us. It certainly would not be asking too much to demand that a résumé of campaigns should be accurate and intelligible. The errors in the present one are so numerous and so serious that it is not going too far to say that the more familiar the reader may be with the military operations of 1864, the more he will be puzzled in reading these pages. To justify this judgment it is necessary to give examples.

The period named covers Sherman's campaign of Atlanta and Thomas's campaign of Nashville. The battle of Resaca occurred on the 14th of May. After a sketch of it the author proceeds to "the next great step in the campaign, which was the turning of Allatoona Pass. The same tactics were employed as before." Instead, however, of the manœuvres to turn Allatoona, we find another sketch of the movements at Resaca, and one which is contradictory of that before given. In the former, Thomas and Schofield "formed the left of Sherman's army" (p. 205); now they form the right (p. 208). Yet Johnston is described as making "a desperate effort to turn the left of Schofield"; but as Schofield is just described as being "in line on Thomas's right," Johnston's effort could not be "to turn" Schofield, but to pierce the line between Thomas and Schofield. The two sketches cannot be made to hang together, and neither is the second consistent with the first, nor would any change of names make it apply to Allatoona.

The combat of New Hope Church is said to have been (p. 209) "one of the most terrible battles of the war," but the description which follows is that of the affair at Pickett's Mill, which occurred at another time and place. Hooker's corps had the prominent part at the church, Howard's at the mill. Hooker's men are not mentioned, and the sketch is wholly made up of incidents of Howard's engagement. The movements of Sherman's army between May 25 and June 14 are summarized without specifying dates, the 9th of June being the one last named, when (p. 210) we are told that "at three P. M. Hood made an attack in triple line." This can refer only to the combat at Culp's Farm, which occurred not on the 9th but on the 22d. Immediately following the last is the incident of the death of Gen. (Bishop) Polk on Pine Mountain on the 14th of June, eight days before the engagement at Culp's, which in the sequence of the narrative is just before it.

Johnston was removed from the command of the Confederate army on July 17, and Hood succeeded him on the 18th. We are told that on assuming command "Hood made two successive attacks"; but the first, at Peach Tree Creek, is said to have been on the 18th (p. 214). It was, in fact, on the 20th, and the incidents given are those of the 20th. On pages 216 to 219, under a regular title of the Battle of Peach Tree Creek, we have a fuller account of what purports to be the second of these attacks, but it is the identical one which was partially described as of the 18th, though the correct date is now given. The same engage-

* The use of the word *manifestus* in this sense, which is almost peculiar to modern physicists, and that without explanation, seems to indicate the existence of a sufficiently large class of physicists early in the thirteenth century to have developed a diction of their own.

† Another word betraying the existence of a large class of natural philosophers.