NEW CHAPTERS IN THE WARFARE OF SCIENCE: METEOROLOGY

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NEW CHAPTERS IN

THE WARFARE OF SCIENCE

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METEOROLOGY.

THE popular beliefs of classic antiquity regarding storms, thunder, and lightning, took shape in myths representing Vulcan as forging thunderbolts, Jupiter as flinging them at his enemies, Æolus intrusting the winds in a bag to Æneas, and the like. An attempt at their further theological development is seen in the Pythagorean statement that lightnings are intended to terrify the damned in Tartarus.

But, at a very early period, we see the beginning of a scientific view. In Greece, the Ionic philosophers held that such phenomena are obedient to law; Plato, Aristotle, and many lesser lights, attempted to account for them on natural grounds; and their explanations, though crude, were based upon observation and thought. In Rome, Lucretius, Seneca, Pliny, and others, inadequate as their statements were, implanted at least the germs of a science. But, as the Christian Church rose to power, this evolution was checked; the new leaders of thought found, in the Scriptures recognized by them as sacred, the basis for a new view, or rather for a modification of the old view.

This ending of a scientific evolution based upon observation and reason, and this beginning of a sacred science based upon the letter of Scripture and on theology, are seen in the utterances of various Fathers in the early Church. As to the general features of this new development, Tertullian held that sundry passages of Scripture prove lightning identical with hell-fire;* and this idea was transmitted from generation to generation of later churchmen, who found an especial support of Tertullian's view in the sulphurous smell experienced during thunderstorms.† Saint Hilarion thought the firmament very much lower than the heavens, and that it was created for the support of the upper waters, as well as for the tempering of our atmosphere.‡ Saint Ambrose held

* See Tertullian, "Apol. contra gentes," c. 47.

† See, for example, Augustin de Angelis, "Lectiones Meteorologicæ," 64.

‡ See Hilarion, "In Psalm. CXXXV" (Migne, "Patr. Lat.," ix, 773).

the firmament to be a solid vault, and the thunder to be caused by the winds breaking through it; citing from the prophet Amos the sublime passage regarding "Him that establisheth the thunders."* He shows, indeed, some conception of the true source of rain; but his whole reasoning is limited by various scriptural texts. He lays great stress upon the firmament as a solid outer shell of the universe: the heavens he holds to be not far outside this outer shell, and argues regarding their character, from St. Paul's Epistle to the Corinthians and from the one hundred and forty-eighth Psalm. As to "the waters which are above the firmament," he takes up the objection of those who hold that, this outside of the universe being spherical, the waters must slide off it, especially if the firmament revolves; and he points out that it is by no means certain that the *outside* of the firmament *is* spherical, and insists that, if it does revolve, the water is just what is needed to lubricate and cool its axis.†

Saint Jerome held that God at the creation spread out the firmament between heaven and earth, separating the upper waters from the lower, and that, in order to keep all in place, He caused the upper waters, to be frozen into ice. A proof of this view Jerome found in the words of Ezekiel regarding "the crystal stretched above the cherubim."‡

The germinal principle in accordance with which all these theories were evolved, was most clearly proclaimed to the world by Saint Augustine in his famous utterance, "Nothing is to be accepted save on the authority of Scripture, since greater is that authority than all the powers of the human mind."* No treatise was safe thereafter which did not breathe the spirit and conform to the letter of this maxim. Unfortunately, what was generally meant by the "authority of Scripture," was the tyranny of a literature imperfectly transcribed, viewed through distorting superstitions, and frequently interpreted by party spirit.

Following this precept, Saint Augustine developed, in every field, theological views of science which have never led to a single truth—which, without exception, have forced mankind away from the truth, and have caused Christendom to stumble for centuries into abysses of error and sorrow. In meteorology, as in every other science with which he dealt, he based everything upon the letter of the sacred text;

* "Firmans tonitrua" (Amos iv, 13); the phrase does not appear in our version.

† See Ambrose, "Hexæmeron," ii, 3, 4; iii, 5 (Migne, "Patr. Lat.," xiv, 148–150, 153, 155). The passage as to lubrication of the heavenly axis is as follows: "Deinde cum ipsi dicant volvi orbem cœli stellis ardentibus refulgentem, nonne divina providentia necessario prospexit, ut intra orbem cœli, et supra orbem redundaret aqua, quæ illa ferventis axis incendia temperaret?"

‡ See Jerome, "Epistola," lxix, 6 (Migne, "Patr. Lat.," xxii, 659).

* "Major est quippe Scripturæ hujus auctoritas, quam omnis humani ingenii capacitas."—Augustine, "De Genesi ad Lit.," ii, 5 (Migne, "Patr. Lat.," xxxiv, 266, 267). Or, as he is cited by Vincent of Beauvais ("Spec. Nat.," iv, 98): "Non est aliquid temere diffiniendum, sed quantum Scriptura dicit accipiendum, cujus major est auctoritas quam omnis humani ingenii capacitas."

and it is characteristic of the result that this man, so great when untrammeled, thought it his duty to guard especially the whole theory of the "waters above the heavens."

In the sixth century this theological reasoning was still further developed by Cosmas Indicopleustes. Basing his theory of the universe upon the ninth chapter of Hebrews, he insisted that the earth is flat, a parallelogram, and that from its outer edges rise immense walls supporting the firmament; then, throwing together the reference to the firmament in Genesis and the outburst of poetry in the Psalms regarding the "waters that be above the heavens," he insisted that over the terrestrial universe are solid arches bearing a vault, closing it in and supporting a vast cistern "containing the waters"; finally, taking from Genesis the expression regarding the "windows of heaven," he insisted that these windows are opened and closed by the angels whenever the Almighty wishes to send rain upon the earth or to withhold it.*

This was accepted by the universal Church as a vast contribution to thought; for over a thousand years it was the orthodox doctrine, and various leaders in theology devoted themselves to developing and supplementing it.

About the beginning of the seventh century, Isidore, Bishop of Seville, was the ablest prelate in Christendom, and was showing those great qualities which led to his enrollment among the saints of the Church. His theological view of science marks an epoch. As to the "waters above the firmament," Isidore contends that they must be lower than the uppermost heaven, though higher than the lower heaven, because in the one hundred and forty-eighth Psalm they are mentioned *after* the heavenly bodies and the "heaven of heavens," but *before* the terrestrial elements. As to their purpose, he hesitates between those who held that they were stored up there by the prescience of God for the destruction of the world at the flood, as the words of Scripture that "the windows of heaven were opened" seemed to indicate, and those who held that they were kept there to moderate the heat of the heavenly bodies. As to the firmament, he is in doubt whether it envelops the earth "like an egg-shell," or is merely spread over it "like a curtain"; for he holds that the passage in the one hundred and fourth Psalm may be used to support either view.

Having laid these scriptural foundations, Isidore shows considerable power of thought; indeed, at times, when he discusses the rainbow, rain, hail, snow, and frost, his theories are rational, and give evidence that, if he could have broken away from his adhesion to the letter of Scripture, he might have given a vast impulse to the evolution of a true science.†

* See Cosmas, "Topographia Christiana" (in Montfaucon, "Collectio nova patrum," ii).

† See Isidore, "Etymologiæ," xiii, 7–9, "De ordine creaturarum," 3, 4, and "De natura rerum," 29, 30 (Migne, "Patr. Lat.," lxxxii, 476, 477, lxxxiii, 920–922, 1001–1003).

About a century later appeared, at the other extremity of Europe, the second in the trio of theological men of science in the early middle ages, Bede the Venerable. The nucleus of his theory also is to be found in the accepted view of the "firmament" and of the "waters above the heavens," derived from Genesis; the firmament he holds to be spherical, and of a nature subtile and fiery; the upper heavens, he says, which contain the angels, God has tempered with ice, lest they inflame the lower elements; as to the waters placed above the firmament, lower than the spiritual heavens, but higher than all corporeal creatures, he says, "Some declare that they were stored there for the deluge, but others, more correctly, that they are intended to temper the fire of the stars." He goes on with long discussions as to various elements and forces in Nature, and dwells at length upon the air, of which he says that the upper, serene air is over the heavens; that the other, which is coarse with humid exhalations, is sent off from the earth, and that in this are lightning, hail, snow, ice, and tempests, finding proof of this in the one hundred and forty-eighth Psalm, where these are commanded to "praise the Lord from the earth."*

So great was Bede's authority that nearly all the anonymous speculations of the next following centuries upon these subjects were eventually ascribed to him. In one of these spurious treatises an attempt is made to get new light upon the sources of the waters above the heavens, the main reliance being the sheet containing the animals let down from heaven, in the vision of Saint Peter. Another of these treatises is still more curious, for it endeavors to account for earthquakes and tides by means of the Leviathan mentioned in Scripture. This characteristic passage runs as follows: "Some say that the earth contains the animal Leviathan, and that he holds his tail after a fashion of his own, so that it is sometimes scorched by the sun, whereupon he strives to get hold of the sun, and so the earth is shaken by the motion of his indignation; he drinks in also, at times, such huge masses of the waves that when he belches them forth all the seas feel their effect."† And this theological theory of the tides, as caused by the alternate suction and belching of Leviathan, went far and wide.

In the writings thus covered with the name of Bede, there is much showing a scientific spirit, which might have come to something of permanent value had it not been hampered by the supposed necessity of conforming to the letter of Scripture. It is as startling as it is refreshing to hear one of these mediæval theorists burst out against those who are content to explain everything by the power of God, as follows: "What is more pitiable than to say that a thing *is*, because God is able to do it, and not to show any reason why it is so, nor any purpose for which it is so; just as if God did everything that he is

* See Bede, "De natura rerum" (Migne, "Patr. Lat.," xc).

† See the treatise "De mundi constitutione," in Bede's "Opera" (Migne, "Patr. Lat.," xc, 884).

able to do! You talk like one who says that God is able to make a calf out of a log. But *did* he ever do it? Either, then, show a reason why a thing is so, or a purpose wherefore it is so, or else cease to declare it so."*

The most permanent contribution of Bede to scientific thought in this field was his revival of the view that the firmament is made of ice; and he supported this from the words in the twenty-sixth chapter of Job, "He bindeth up the waters in his thick cloud, and the cloud is not rent under them."

About the beginning of the ninth century appeared the third in that triumvirate of churchmen who were the oracles of sacred science throughout the early middle ages—Rabanus Maurus, Abbot of Fulda and Archbishop of Mayence. Starting, like all his predecessors, from the first chapter of Genesis, borrowing here and there from the ancient philosophers, and excluding everything that could conflict with the letter of Scripture, he follows, in his work upon the universe, his two predecessors, Isidore and Bede, developing especially Bede's theory that the firmament is strong enough to hold up the "waters above the heavens," because it was made of ice.†

For centuries the authority of these three great teachers was unquestioned, and in countless manuals and catechisms their doctrine was translated and diluted for the common mind.‡ But, about the second quarter of the twelfth century, a priest, Honorius of Autun, produced several treatises which show that thought on this subject had made some little progress. He explained the rain rationally, and mainly in the modern manner; with the thunder he is less successful, but insists that the thunderbolt "is not stone, as some assert." His thinking is vigorous and independent.* Had theorists such as he been many, a new science could have been rapidly evolved, but the theological current was too strong.

The strength of this current which overwhelmed the thought of Honorius is seen again in the work of the Dominican monk, John of San Geminiano, who in the thirteenth century gave forth his "Summa

* See "Elementa philosophiæ," in Bede's "Opera" (Migne, "Patr. Lat.," xc, 1139). This treatise, which has also been printed, under the title of "De philosophia mundi," among the works of Honorius of Autun, is believed by modern scholars (Hauréau, Werner, Poole) to be the production of William of Conches.

† See Rabanus Maurus, "Comment. in Genesim" and "De Universo" (Migne, "Patr. Lat.," cvii, cxi).

‡ For a charmingly *naïve* example of these primers, see the little Anglo-Saxon manual of astronomy, sometimes attributed to Ælfric. It is in the vernacular, but is translated in Wright's "Popular Treatises on Science during the Middle Ages." Bede is, of course, its chief source.

* See Honorius Augustodunensis, "De imagine mundi," and "Hexæmeron" (Migne, "Patr. Lat.," clxxii). The "De philosophia mundi," the most rational of all, is, however, believed by modern scholars to be unjustly ascribed to him. See note above.