

PLINY'S NATURAL HISTORY

Book II

I. THE world, and this - whatever other name men have chosen to designate the sky whose vaulted roof encircles the universe - is fitly believed to be a deity, eternal, immeasurable, a being that never began to exist and never will perish. What is outside it does not concern men to explore and is not within the grasp of the human mind to guess. It is sacred, eternal, immeasurable, wholly within the whole, nay rather itself the whole, finite and resembling the infinite, certain of all things and resembling the uncertain, holding in its embrace all things that are without and within, at once the work of nature and nature herself. That certain persons have studied, and have dared to publish, its dimensions, is mere madness; and again that others taking or receiving occasion from the former, have taught the existence of a countless number of worlds, involving the belief in as many systems of nature, or, if a single nature embraces all the worlds, nevertheless the same number of suns, moons and other unmeasurable and innumerable heavenly bodies, as already in a single world; just as if owing to our craving for some End the same problem would not always encounter us at the termination of this process of thought, or as if, assuming it possible to attribute this infinity of nature to the artificer of the universe, that same property would not be easier to understand in a single world, especially one that is so vast a structure. It is madness, downright madness, to go out of that world, and to investigate what lies outside it just as if the whole of what is within it were already clearly known; as though, forsooth, the measure of anything could be taken by him that knows not the measure of himself, or as if the mind of man could see things that the world itself does not contain.

II. Its shape has the rounded appearance of a perfect sphere. This is shown first of all by the name of 'orb' which is bestowed upon it by the general consent of mankind. It is also shown by the evidence of the facts: not only does such a figure in all its parts converge upon itself; not only must it sustain itself, enclosing and holding itself together without the need of any fastenings, and without experiencing an end or a beginning at any part of itself; not only is that shape the one best fitted for the motion with which, as will shortly appear, it must repeatedly revolve, but our eyesight also confirms this belief, because the firmament presents the aspect of a concave & hemisphere equidistant in every direction, which would be impossible in the case of any other figure.

III. The world thus shaped then is not at rest but eternally revolves with indescribable velocity, each revolution occupying the space of 24 hours: 2 the rising and setting of the sun have left this not doubtful. Whether the sound of this vast mass whirling in unceasing rotation is of enormous volume and consequently beyond the capacity of our ears to perceive, for my own part I cannot easily say - any more in fact than whether this is true of the tinkling of the stars that travel round with it, revolving in their own orbits; or whether it emits a sweet harmonious music that is beyond belief charming. To us who live within it the world glides silently alike by day and night. Stamped upon it are countless figures of animals and objects of all kinds - it is not the case,

as has been stated by very famous authors, that its structure has an even surface of unbroken smoothness, like that which we observe in birds' eggs: this is proved by the evidence of the facts, since from seeds of all these objects, falling from the sky in countless numbers, particularly in the sea, and usually mixed together, monstrous shapes are generated; and also by the testimony of sight - in one place the figure of a bear, in another of a bull, in another a wain, in another a letter of the alphabet, the middle of the circle across the pole being more radiant.

For my own part I am also influenced by the agreement of the nations. The Greeks have designated the world by a word that means 'ornament' and we have given it the name of mundus, because of its perfect finish and grace! As for our word caelum, it undoubtedly has the signification 'engraved,' as is explained by Marcus Varro. Further assistance is contributed by its orderly structure, the circle called the Zodiac being marked out into the likenesses of twelve animals; and also by the uniform regularity in so many centuries of the sun's progress through these signs.

IV. As regards the elements also I observe that they are accepted as being four in number: topmost the element of fire, source of yonder eyes of all those blazing stars; next the vapour which the Greeks and our own nation call by the same name, air - this is the principle of life, and penetrates all the universe and is intertwined with the whole; suspended by its force in the centre of space is poised the earth, and with it the fourth element, that of the waters. Thus the mutual embrace of the unlike results in an interlacing, the light substances being prevented by the heavy ones from flying up, while on the contrary the heavy substances are held from crashing down by the upward tendency of the light ones. In this way owing to an equal urge in opposite directions the elements remain stationary, each in its own place, bound together by the unresting revolution of the world itself; and with this always running back to its starting-point, the earth is the lowest and central object in the whole, and stays suspended at the pivot of the universe and also balancing the bodies to which its suspension is due; thus being alone motionless with the universe revolving round her she both hangs attached to them all and at the same time is that on which they all rest. Upheld by the same vapour between earth and heaven, at definite spaces apart, hang the seven stars which owing to their motion we call 'planets,' although no stars wander less than they do. In the midst of these moves the sun, whose magnitude and power are the greatest, and who is the ruler not only of the seasons and of the lands, but even of the stars themselves and of the heaven. Taking into account all that he effects, we must believe him to be the soul, or more precisely the mind, of the whole world, the supreme ruling principle and divinity of nature. He furnishes the world with light and removes darkness, he obscures and he illumines the rest of the stars, he regulates in accord with nature's precedent the changes of the seasons and the continuous re-birth of the year, he dissipates the gloom of heaven and even calms the storm-clouds of the mind of man, he lends his light to the rest of the stars also; he is glorious and pre-eminent, all-seeing and even all-hearing -this I observe that Homer the prince of literature held to be true in the case of the sun alone.

V. For this reason I deem it a mark of human weakness to seek to discover the shape and form of God. Whoever God is - provided there is a God - and in whatever region he is, he consists wholly of sense, sight and hearing, wholly of soul, wholly of mind, wholly of himself.

To believe in gods without number, and gods corresponding to men's vices as well as to their virtues, like the Goddesses of Modesty, Concord, Intelligence, Hope, Honour, Mercy and Faith - or else, as Democritus held, only two, Punishment and Reward, reaches an even greater height of folly. Frail, toiling mortality, remembering its own weakness, has divided such deities into groups, so as to worship in sections, each the deity he is most in need of. Consequently different races have different names for the deities, and we find countless deities in the same races, even those of the lower world being classified into groups, and diseases and also many forms of plague, in our nervous anxiety to get them placated. Because of this there is actually a Temple of Fever consecrated by the nation on the Palatine Hill, and one of Bereavement at the Temple of the Household Deities, and an Altar of Misfortune on the Esquiline. For this reason we can infer a larger population of celestials than of human beings, as individuals also make an equal number of gods on their own, by adopting their own private Junos and Genii; while certain nations have animals, even some loathsome ones, for gods, and many things still more disgraceful to tell of - swearing by rotten articles of food and other things of that sort. To believe even in marriages taking place between gods, without anybody all through the long ages of time being born as a result of them, and that some are always old and grey, others youths and boys, and gods with dusky complexions, winged, lame, born from eggs, living and dying on alternate days - this almost ranks with the mad fancies of children; but it passes all bounds of shamelessness to invent acts of adultery taking place between the gods themselves, followed by altercation and enmity, and the existence of deities of theft and of crime. For mortal to aid mortal - this is god; and this is the road to eternal glory: by this road went our Roman chieftains, by this road now proceeds with heavenward step, escorted by his children, the greatest ruler of all time, His Majesty Vespasian, coming to the succour of an exhausted world. To enrol such men among the deities is the most ancient method of paying them gratitude for their benefactions. In fact the names of the other gods, and also of the stars that I have mentioned above, originated from the services of men: at all events who would not admit that it is the interpretation of men's characters that prompts them to call each other Jupiter or Mercury or other names, and that originates the nomenclature of heaven? That that supreme being, whatever it be, pays heed to man's affairs is a ridiculous notion. Can we believe that it would not be defiled by so gloomy and so multifarious a duty? Can we doubt it? It is scarcely pertinent to determine which is more profitable for the human race, when some men pay no regard to the gods at all and the regard paid by others is of a shameful nature: they serve as the lackeys of foreign ritual, and they carry gods on their fingers; also they pass sentence of punishment upon the monsters they worship, and devise elaborate viands for them; they subject themselves to awful tyrannies, so as to find no repose even in sleep; they do not decide on marriage or having a family or indeed anything else except by the command of sacrifices; others cheat in the very Capitol and swear false oaths by Jupiter who wields the thunder-bolts - and these indeed make a profit out of their crimes, whereas the others are penalised by their religious observances. Nevertheless mortality has rendered our guesses about God even more obscure by inventing for itself a deity intermediate between these two conceptions. Everywhere in the whole world at every hour by all men's voices Fortune alone is invoked and named, alone accused, alone impeached, alone pondered, alone applauded,

alone rebuked and visited with reproaches; deemed volatile and indeed by most men blind as well, wayward, inconstant, uncertain, fickle in her favours and favouring the unworthy. To her is debited all that is spent and credited all that is received, she alone fills both pages in the whole of mortals' account; and we are so much at the mercy of chance that Chance herself, by whom God is proved uncertain, takes the place of God. Another set of people banishes fortune also, and attributes events to its star and to the laws of birth, holding that for all men that ever are to be God's decree has been enacted once for all, while for the rest of time leisure has been vouchsafed to Him. This belief begins to take root, and the learned and unlearned mob alike go marching on towards it at the double: witness the warnings drawn from lightning, the forecasts made by oracles, the prophecies of augurs, and even inconsiderable trifles - sneeze, a stumble - counted as omens. His late Majesty put abroad a story that on the day on which he was almost overthrown by a mutiny in the army he had put his left boot on the wrong foot. This series of instances entangles unforeseeing mortality, so that among these things but one thing is in the least certain - that nothing certain exists, and that nothing is more pitiable, or more presumptuous, than man! inasmuch as with the rest of living creatures their sole anxiety is for the means of life, in which nature's bounty of itself suffices, the one blessing indeed that is actually preferable to every other being the fact that they do not think about glory, money, ambition, and above all death.

But it agrees with life's experience to believe that in these matters the gods exercise an interest in human affairs; and that punishment for wickedness, though sometimes tardy, as God is occupied in so vast a mass of things, yet is never frustrated; and that man was not born God's next of kin for the purpose of approximating to the beasts in vileness. Put the chief consolations for nature's imperfection in the case of man are that not even for God are all things possible - for he cannot, even if he wishes, commit suicide, the supreme boon that he has bestowed on man among all the penalties of life, nor bestow eternity on mortals or recall the deceased, nor cause a man that has lived not to have lived or one that has held high office not to have held it - and that he has no power over what is past save to forget it, and (to link our fellowship with God by means of frivolous arguments as well) that he cannot cause twice ten not to be twenty or do many things on similar lines: which facts unquestionably demonstrate the power of nature, and prove that it is this that we mean by the word 'God.' It will not have been irrelevant to have diverged to these topics, which have already been widely disseminated because of the unceasing enquiry into the nature of God.

VI. Let us return from these questions to the remaining facts of nature. We have stated that the stars are attached to the firmament, not assigned to each of us in the way in which the vulgar believe, and dealt out to mortals with a degree of radiance proportionate to the lot of each, the brightest stars to the rich, the smaller ones to the poor, the dim to those who are worn out; they do not each rise with their own human being, nor indicate by their fall that someone's life is being extinguished. There is no such close alliance between us and the sky that the radiance of the stars there also shares our fate of mortality. When the stars are believed to fall, what happens is that owing to their being over fed with a draught of liquid they give back the surplus with a fiery flash, just as with us also we see this occur with a stream of oil when lamps are lit. But the heavenly bodies have a nature that is eternal - they interweave

the world and are blended with its weft; yet their potency has a powerful influence on the earth, indeed it is owing to the effects that they produce and to their brilliance and magnitude that it has been possible for them to become known with such a degree of precision, as we shall show in the proper place. Also the system of the revolutions of the sky will be more appropriately stated when we deal with geography, since it is entirely related to the earth; only we must not postpone the discoveries that have been made as to the zodiac. Tradition says that Anaximander of Miletus in the fifty-eighth Olympiad was the first person to discover the obliquity of the zodiac, that is, to open the portals of science; and that next Cleostratus explained the signs in it, beginning with the Ram and the Archer; the firmament itself having been explained long before by Atlas.

Let us now leave the frame of the world itself and treat the remaining bodies situated between the sky and the earth. The following points are certain: (1) The star called Saturn's is the highest and consequently looks the smallest and revolves in the largest orbit, returning in thirty years at the shortest to its initial station. (2) The motions of all the planets, and among them the sun and moon, follow a course contrary to that of the world, namely to the left, the world always running to the right. (3) Although they are borne on by it and carried westward with an unceasing revolution of immeasurable velocity, nevertheless they travel with an opposite motion along their respective tracks. (4) Thus it comes about that the air is not massed in a dull lethargic ball by revolving in the same direction because of the eternal rotation of the world, but is scattered into separate portions by the opposite impact of the stars. (5) Saturn is of a cold and frozen nature. The orbit of Jupiter is much below it and therefore revolves much faster, completing one rotation every twelve years. The third star is Mars, called by some Hercules; owing to the proximity of the sun it has a fiery glow; it revolves once in about two years, and consequently, owing to its excessive heat and Saturn's frost, Jupiter being situated between them combines the influence of each and is rendered healthy. (6) Next, the sun's course is divided into 360 parts, but in order that an observation taken of the shadows that it casts may come round to the starting-point, five and a quarter days per annum are added; consequently to every fourth a year an intercalary day is added to make our chronology tally with the course of the sun.

Below the sun revolves a very large star named Venus, which varies its course alternately, and whose alternative names in themselves indicate its rivalry with the sun and moon - when in advance and rising before dawn it receives the name of Lucifer, as being another sun and bringing the dawn, whereas when it shines after sunset it is named Vesper, as prolonging the daylight, or as being a deputy for the moon. This property of Venus was first discovered by pythagoras of Samos about the 42nd Olympiad, 142 years after the foundation of Rome. Further it surpasses all the other stars in magnitude, and is so brilliant that alone among stars it casts a shadow by its rays. Consequently there is a great competition to give it a name, some having called it Juno, others Isis, others the Mother of the Gods. Its influence is the cause of the birth of all things upon earth; at both of its risings it scatters a genial dew with which it not only fills the conceptive organs of the earth but also stimulates those of all animals. It completes the circuit of the zodiac every 348 days, and according to Timaeus is never more than 46 degrees distant from the sun. The star next to Venus is Mercury, by some called Apollo; it has a similar orbit, but is by no means similar in magnitude or power. It travels in a lower circle, with a revolution nine

days quicker, shining sometimes before sunrise and sometimes after sunset, but according to Cidenas and Sosigenes never more than 22 degrees away from the sun. Consequently the course of these stars also is peculiar, and not shared by those above mentioned: those are often observed to be a quarter or a third of the heaven away from the sun and travelling against the sun, and they all have other larger circuits of full revolution, the specification of which belongs to the theory of the Great Year.

But the wonder of everyone is vanquished by the last star, the one most familiar to the earth, and devised by nature to serve as a remedy for the shadows of darkness - the moon. By the riddle of her transformations she has racked the wits of observers who are ashamed that the star which is nearest should be the one about which we know least - always waxing or waning, and now curved into the horns of a sickle, now just halved in size, now rounded into a circle; spotted and then suddenly shining clear; vast and full-orbed, and then all of a sudden not there at all; at one time shining all night and at another rising late and for a part of the day augmenting the light of the sun, eclipsed and nevertheless visible during the eclipse, invisible at the end of the month when she is not believed to be in trouble; again at one time low down and at another up aloft, and not even this in a uniform way, but sometimes raised to the sky and sometimes touching the mountain-tops, now borne up to the North and now carried down to the South. The first human being to observe all these facts about her was Endymion - which accounts for the traditional story of his love for her. We forsooth feel no gratitude towards those whose assiduous toil has given us illumination on the subject of this luminary, while owing to a curious disease of the human mind we are pleased to enshrine in history records of bloodshed and slaughter, so that persons ignorant of the facts of the world may be acquainted with the crimes of mankind.

The moon then is nearest to the pole, and therefore has the smallest orbit, completing the same distance every $27 \frac{1}{3}$ days that Saturn the highest star covers, as we have said, in 30 years. Then she lingers two days in conjunction with the sun, and after the 30th day at latest sets out again on the same course - being perhaps our teacher as to all the facts that it has been possible to observe in the heavens; (1) that the year is to be divided into twelve monthly spaces, because she herself that number of times follows the sun in his return to his starting point; (2) that she is governed by the sun's radiance as are the rest of the stars, as in fact she shines with a light entirely borrowed from him, like the light which we see flickering reflected in water; (3) that consequently she only causes water to evaporate with a rather gentle and imperfect force, and indeed increases its quantity, whereas the sun's rays dry it up; (4) also that the reason why she is seen to vary in her light is that she is full only when opposite to the sun, and on the remaining days shows as much light from herself to the earth as she herself conceives from the sun; though (5) she is indeed invisible when in conjunction with the sun, because being turned towards him she gives back the entire draught of light to the source from which she receives it; (6) but that the stars are undoubted nourished by the moisture of the earth, since she is sometimes seen spotted in half her orb, clearly because she has not yet got sufficient strength to go on drinking - her spots being merely dirt from the earth taken up with the moisture; (7) but that her eclipses and those of the sun, the most marvellous and indeed portentous occurrence in the whole of our observation of nature, serve as indications of their dimensions and shadow.

VII. It is in fact obvious that the sun is hidden by the passage across it of the moon, and the moon by the interposition of the earth, and that they retaliate on one another, the same rays of the sun being taken away from the earth by the moon intervening and from the moon by the earth: at the transit of the former a sudden shadow passes over the earth, and in return the shadow of the latter dims the heavenly body (the moon), and the darkness is merely the earth's shadow, but the shape of the shadow is conical, resembling a spinning-top upside down, as it impinges only with its point and does not go beyond the altitude of the moon, because no other star is obscured in the same way, and a conical figure always tapers off into a point: that shadows are made to disappear by distance is proved when birds fly to extreme heights. Consequently the frontier between the moon and the other heavenly bodies is at the point where the air ends and the aether begins. All the space above the moon is clear and filled with continual light, but to us the stars are visible through the night in the same way as other lights in shadows. And these are the reasons why the moon wanes in the night-time; but both of her wanings are irregular and not monthly, because of the slant of the zodiac and the widely varying curves of the moon's course, as has been stated, the motion of the heavenly bodies not always tallying in minute fractional quantities.

VIII. This theory leads mortal minds upward to heaven, and discloses to their observation from that height, as it were, the greatness of the three greatest parts of the universe; clearly it would not be possible for the whole of the sun to be eclipsed from the earth by the passage of the moon between them if the earth were larger than the moon. The vast size of the sun will be shown with the more certainty from the two bodies, so that there is no need to investigate its size by the evidence of the eyes and by logical inference arguing that it is immeasurably large for the following reasons: (1) the shadow that it throws of rows of trees along the balks of fields are at equal distances apart for ever so many miles, just as if over the whole space the sun were in the centre; a (2) during the equinoxes it reaches the vertical simultaneously for all the inhabitants of the southern region; (3) the shadows of the people living round the Tropic of Cancer fall northward at midday but westward at sunrise, which could not happen unless the sun were much larger than the earth; (4) when it is rising its breadth exceeds Mount Ida, overlapping it widely right and left - and that though it is separated from it by so great a distance.

The eclipse of the moon supplies indubitable proof of the size of the sun, just as the sun itself when it suffers eclipse proves the smallness of the earth. For shadows are of three shapes, and it is clear that, if the solid object that throws a shadow is equal in area to the shaft of light, the shadow projected is shaped like a pillar and is of infinite length, but if the solid body is larger than the light, the shadow has the shape of an upright spinning-top, so that it is narrowest at the bottom, and infinite in length as in the former case, while if the solid is smaller than the light the result is the figure of a cone narrowing down to end in a point, and this is the nature of the shadow observed during an eclipse of the moon; hence it is proved without any further possibility of doubt remaining that the sun exceeds the earth's size. Indeed, this is also proved by the silent testimony of nature herself; for why in the [division of the turns of the year does the winter sun retire, so as to refresh the earth with the darkness of the nights? when otherwise it would unquestionably scorch up the earth, and even as it does so in a certain part, so great is its magnitude.

The stars - their
magnitude
Astronomical
discoveries

IX. The first person indeed of Roman nationality who published an explanation of both kinds of eclipse was Sulpicius Gallus - the colleague in the consulship

of Marcus Marcellus, but at the time military tribune - who delivered the army from fear when on the day before the defeat of King Perseus by Paulus he was brought before an assembly by the commander-in-chief to foretell an eclipse, and later also by writing a treatise. The original discovery was made in Greece by Thales of Miletus, who in the fourth year of the 48th Olympiad (585 B.C.) foretold the eclipse of the sun that occurred in the reign of Alyattes, in the 170th year after the foundation of Rome. After their time the courses of both stars for 600 years were prophesied by Hipparchus, whose work embraced the calendar of the nations and the situations of places and aspects of the peoples - his method being, on the evidence of his contemporaries, none other than full partnership in the designs of nature. O mighty heroes, of loftier than mortal estate, who have discovered the law of those great divinities and released the miserable mind of man from fear, mortality dreading as it did in eclipses of the stars crimes or death of some sort (those sublime singers, the bards Stesichorus and Pindar, clearly felt this fear owing to an eclipse of the sun), or in the dying of the moon inferring that she was poisoned and consequently coming to her aid with a noisy clattering of cymbals (this alarm caused the Athenian general Nicias, in his ignorance of the cause, to be afraid to lead his fleet out of harbour, so destroying the Athenians' resources): all hail to your genius, ye that interpret the heavens and grasp the facts of nature, discoverers of a theory whereby you have vanquished gods and men! for who beholding these truths and the regularity of the stars' periods of trouble (for so it has pleased you to call them), would not forgive his own destiny for the generation of mortals?

Now I will briefly and summarily touch on facts that are admitted about the same matters, giving an account of them only at necessary points and in a cursory manner, because such theorising does not form part of the task that I have set in hand, and also it is less surprising that explanations cannot be produced for all the facts than that agreement has been reached on some of them.

X. It is certain that eclipses recur in cycles of 223 months - eclipses of the sun only when the moon is in her last or first phase (this is called their 'conjunction'), eclipses of the moon only at full moon - and always within the period of their last occurrence; but that yearly at fixed days and hours eclipses of either star occur below the earth, and that even when they occur above the earth they are not visible everywhere, sometimes owing to clouds, more often because the earth's globe stands in the way of the world's curvature. Less than 200 years ago the penetration of Hipparchus discovered that an eclipse of the moon also sometimes occurs four months after the one before and an eclipse of the sun six months, and that the latter when above earth is hidden twice in thirty days, but that this eclipse is visible to different nations, and - the most remarkable features of this remarkable occurrence - that when it comes about that the moon is obscured by the shadow of the earth, this sometimes happens to it from the west side and sometimes from the east; and he also discovered for what exact reason, although the shadow causing the eclipse must from sunrise onward be below the earth, it happened once in the past that the moon was eclipsed in the west while both luminaries were visible above the earth. For the eclipse of both sun and moon within 15 days of each other has occurred even in our time, in the year of the third consulship of the elder Emperor Vespasian and the second consulship of the younger.

XI. It is unquestionable that the moon's horns are always turned away from the sun, and that when waxing she faces east and when waning west; and that the moon shines 47 1/2 minutes longer daily from the day after new moon to full

The moon's motions

and 472 minutes less daily to her wane, while within 14 degrees of the sun she is always invisible. This fact proves that the planets are of greater magnitude than the moon, since these occasionally become visible even on reaching 7 degrees' distance; but their altitude makes them appear smaller, just as the sun's radiance makes the fixed stars invisible in daytime, although they are shining as much as in the night, which becomes manifest at a solar eclipse and also when the star is reflected in a very deep well.

XII. The three planets whose positions we have stated to be above the sun travel with the sun when they set and are never more than 11 degrees separate from the sun at dawn when they rise. Afterwards they retire from contact with his rays, and make their morning or 'first' stations in a triangle 120 degrees away, and subsequently their evening risings opposite 180 degrees away, and again approaching from the other side, make their evening or 'second' stations 120 degrees away, till the sun overtaking them at 12 degrees obscures them - this is called their evening setting. The planet Mars being nearer feels the sun's rays even from its quadrature, at an angle of 90 degrees, which has given to his motion after each rising the name of 'first' or 'second ninety-degree.' At the same time Mars remains stationary in the signs of the zodiac for periods of six months (otherwise having a two-month period), whereas Jupiter and Saturn spend less than four months in each station. The two lower planets (Mercury and Venus) are similarly obscured at their evening conjunction, and when left by the sun make their morning rising the same number of degrees away, and from the further limits of their distance follow the sun and when they have overtaken him are hidden in their morning setting and pass away. Then they rise in the evening at the same distance apart, as far as the limits we have stated. From these they pass backward to the sun, and disappear in their evening setting. The planet Venus actually makes two stations, morning and evening, after each rise, from the furthest limits of her distance. Mercury's stations have too short a period to be perceptible.

Motions of the planets
Theory of their light
Causes of apparent recession and approach
General properties of planets
Reasons for changes of colour

XIII. This is the system of the shining and occultation of the planets: it is more complicated from their motion and involves many remarkable facts, inasmuch as they change their magnitude and their colours, and both approach the North and retire towards the South, and suddenly are seen closer to the earth or to the sky. And although our account of these matters will differ in many points from that of our predecessors, we confess that credit for these points also must be given to those who first demonstrated the methods of investigating them: only nobody must abandon the hope that the generations are constantly making progress.

All these occurrences are due to a plurality of causes. The first is the factor of the circles which in the case of the stars the Greeks designate apsides or arcs (it will be necessary to employ Greek terms). Each planet has its own circle, and these are not the same as those of the firmament, since the earth between the two vertices, named in Greek poles, is the centre of the sky, and also of the zodiac, which is situated on a slant between the poles. [All these facts are always established beyond doubt by the method of compasses.] Therefore the special arc of each is drawn from a different centre, and consequently they have different orbits and dissimilar motions, because the inner arcs must necessarily be shorter.

It follows that the points of the arcs highest above the centre of the earth are: in the case of Saturn in Scorpio, in that of Jupiter in Virgo, of Mars in Leo, of the sun in the Twins, of Venus in the Archer, of Mercury in Capricorn, of the moon in the Bull, at the middle of each, and the points lowest and nearest to the centre of the earth are opposite. The result of this is that they appear to move

slower and to be smaller when they are travelling at the highest point of their circuit, but to be larger and travel faster when they have come nearer to the earth, not because they actually accelerate or reduce their natural motions, which are fixed and individual to them, but because lines drawn from the top of the arc to the centre necessarily converge like the spokes of a wheel, and the same motion at one time is perceived as faster and at another slower according to its distance from the centre.

Another reason of their elevations is because they have the points of their arcs highest from their centre in different signs - Saturn in the 20th degree of the Scales, Jupiter in the 15th of the Grab, Mars in the 28th of Capricorn, the sun in the 29th of the Ram, Venus in the 27th of the Fishes, Mercury in the 15th of Virgo, the moon in the 4th of the Bull.

A third explanation of their altitudes is explained by the dimensions of the firmament, not that of a circle, the eye judging them to rise or to sink through the depth of the air.

Linked with this is the cause of the latitudes of the zodiac and of its obliquity. The stars we have mentioned travel through the zodiac, and the only habitable part of the earth is what lies beneath it - all the other parts towards the poles are frost-bound. Only the planet Venus goes two degrees outside the zodiac; this is understood to be the reason that causes some animals to be born even in the desert places of the world. The moon also wanders through the whole of its breadth, but without going at all outside it. The planet Mercury diverges very widely from these, but without wandering over more than 8 of the 12 degrees of latitude of the zodiac, and these 8 not uniformly but two in the middle of the zodiac, four above it and two below it. Then the sun travels unevenly in the middle of the zodiac between the two halves with a wavy serpentine course, the planet Mars over 4 degrees in the middle, Jupiter one in the middle and two above it, Saturn two like the sun. This will be the principle of the latitudes of the planets when setting towards the South or rising towards the North. Most people have supposed that with this system agrees also the third mentioned above, that of their rising from the earth to the sky, and that this ascent also is made simultaneously; but this is a mistake. To refute them it is necessary to develop an extremely abstruse argument that embraces all the causes mentioned. It is agreed b that the planets are nearest to the earth in both altitude and latitude at their evening setting, and that their morning risings occur at the beginning of both altitude and latitude, while their stations occur in the middle sections of the altitudes, called 'ecliptics.' It is similarly admitted that their velocity increases as long as they are in the neighbourhood of the earth and decreases when they withdraw from it to a height: this theory is specially supported by the apogees of the moon. It is equally undoubted that the three higher ones moreover increase their motion in their morning risings and diminish it from their first (morning) stations to their second (evening) stations. In view of these facts it will be evident that the latitudes are ascended from their morning rising, because in that state their acceleration first begins to diminish, but in their first stations their altitude also is ascended, since then the numbers first begin to be reduced and the stars begin to recede. The reason for this must especially be given. When struck in the degree that we stated and by a triangular ray of the sun they are prevented from pursuing a straight course, and are lifted upward by the fiery force. This cannot be directly perceived by our sight, and therefore they are thought to be stationary, which has given rise to the term 'station.' Then the violent force of the same ray advances and compels them by the impact of the heat to retire. This occurs much more at their evening rising, when they are driven out to the top of their apsides by the full opposing force of the sun, and appear very small because they are at the distance of their greatest altitude and are moving with their smallest velocity - which is proportionately smaller when this occurs in the highest signs of their

apsides. From their evening rise their altitude is descended with a velocity now decelerating less and less, but not accelerating before their second stations, when their altitude also is descended, the ray passing above them from the other side and pressing them down again to the earth with the same force as that with which it had raised them to the sky from the former triangle. So much difference does it make whether the rays come from below or from above, and the same things occur far more in the evening setting. This is the theory of the higher stars; that of the rest is more difficult and has been explained by nobody before ourselves.

XIV. First therefore let us state the reason why Venus never departs more than 46 degrees and Mercury never more than 23 degrees from the sun, and why they often retire and return towards the sun within those limits. As situated below the sun both have arcs that are the opposite of those of the other planets, and as much of their circle is below the earth as that of the planets mentioned before is above it; and they cannot be further from it than they are because the curve of their arcs does not allow greater elongation there; consequently the edges of their arcs put a limit on a similar principle for each, and compensate for the dimensions of their longitude by the enlargement of their latitude. But, it will be objected, why do they not reach 46 and 23 degrees always? As a matter of fact they do, but the explanation escapes the theorists. For it is manifest that even their arcs alter, because they never cross the sun; accordingly when the edges have fallen on one side or the other into the actual degree of the sun, then the stars also are understood to have reached their longest distances, but when the edges are short of that, they themselves too are compelled to return with proportionately greater velocity, since with each of them that is always the extreme limit.

This also explains the contrary principle of their motions. For the higher planets travel most quickly in their evening setting, whereas these travel most slowly, and the former are farthest from the earth when their pace is slowest but the latter are highest when their pace is quickest - the reason being that with the latter the circumference of the circle accelerates their pace in the same manner as proximity to the centre does in the case of the former; the former begin to decelerate from their morning setting, but the latter to accelerate. The former travel backward from their morning to their evening station, the planet Venus from her evening to her morning station. But she begins to climb her latitude after her morning rise, but after her morning station to ascend her altitude and follow the sun, being swiftest and highest at her morning setting; whereas she begins to descend in latitude and decelerate after her evening rising, and to turn back and simultaneously to descend in altitude after her evening station; on the other hand the planet Mercury begins to climb in both ways after his morning rising, but after his evening rising to descend in latitude, and following the sun at an interval of 15 degrees he stands motionless for almost four days. Afterwards he descends from his altitude and proceeds back from his evening setting to his morning rise. And only this planet and the moon set in as many days as they have risen in; Venus ascends in 15 times as many days as she sets in, while Saturn and Jupiter descend in twice as many, and Mars in actually four times as many. So great is the variety of nature; but the reason is evident - bodies that strain up into the heat of the sun also have difficulty in descending.

XV. Many more facts can be produced about these mysteries of nature and the laws that she obeys - for example, in the case of the planet Mars (whose course it is very difficult to observe) that it never makes its station with Jupiter at an angle of 120° , and very seldom with Jupiter separated 60° (which amounts to

1/6 of the celestial sphere, and never makes its rises simultaneously with Jupiter except in two signs only, Cancer and Leo, whereas the planet Mercury rarely makes its evening rises in Pisces, and most frequently in Virgo, its morning rises in Libra, and also its morning rises in Aquarius, very rarely in Leo; it does not make its return in Taurus and in Gemini, and not below the 25th degree in Cancer; Gemini is the only sign in which the moon makes conjunction with the sun twice, Sagittarius the only one in which she does not meet him at all, Aries the only one in which the old moon and the new moon are visible on the same day or night (and this too it has happened to few mortals to see, hence Lynceus's reputation for keen sight); the longest period of invisibility for the planets Saturn and Mars is 170 days, for Jupiter 36 days; the shortest periods for all these are 10 days less; Venus's period is 69 days or at shortest 52, Mercury's 13 or at longest 17.

XVI. The colours of the planets vary with their colours of altitudes, inasmuch as they are assimilated to the stars into whose atmosphere they come in rising, and the circuit of another's path modifies their colour in either direction as they approach, a colder circuit to pallor, a hotter one to redness, a windy one to a leaden colour, the sun and the intersection of its orbit with theirs, and also the extremities of their paths, changing them to black darkness. It is true that each has its own special hue - Saturn white, Jupiter transparent, Mars fiery, Lucifer bright white, Vesper glaring, Mercury radiant, the moon soft, the sun when rising glowing and afterwards radiant; with these being causally connected also the appearance of the fixed stars. For at one time there is a dense crowd of stars in the sky round the circle of the half-moon, a fine night giving them a gentle radiance, but at another time they are scarce, so that we wonder at their flight, when the full moon hides them or when the rays of the sun or the planets above-mentioned dim our sight. But the moon herself also is undoubtedly sensitive to the variations of the strength of impact of the rays of the sun, as moreover the curve of the earth dulls their impact, except when the impact of the rays meets at a right angle. And so the moon is at half in the sun's quadrature, and curved in a hollow circle in its trinal aspect, but waxes to full at the sun's opposition, and then waning exhibits the same configurations at corresponding intervals, on the same principle as the three planets above the sun.

XVII The sun itself has four differences, as there are two equinoxes, in spring and autumn, when it coincides with the centre of the earth at the eighth degree of Aries and Libra, and two changes of its course, in the eighth degree of Capricorn at midwinter when the days begin to lengthen and in the same degree of Cancer at the summer solstice. The variation is due to the slant of the zodiac, as at every moment an equal part of the firmament is above and below the earth; but the planets that follow a straight path at their rising keep their light for a longer tract and those that follow a slanting path pass in a swifter period.

The sun's motions
Reason for
inequality of days

XVIII. Most men are not acquainted with a truth known to the founders of the science from their arduous study of the heavens, that what when they fall to earth are termed thunderbolts are the fires of the three upper planets, particularly those of Jupiter, which is in the middle position - possibly because it voids in this way the charge of excessive moisture from the upper circle (of Saturn) and of excessive heat from the circle below (of Mars); and that this is the origin of the myth that thunderbolts are the javelins hurled by Jupiter. Consequently heavenly fire is spit forth by the planet as crackling charcoal flies from a burning log, bringing prophecies with it, as even the part of himself that he discards does not cease to function in its divine tasks. And this is accompanied by a very great disturbance of the air, because moisture collected causes an overflow, or because it is disturbed by the birth-pangs so to speak of the planet in travail.

Thunderbolts, why attributed to Jove

XIX. Many people have also tried to discover the distances of the planets from the earth, and have given out that the distance of the sun from the moon is 19 times that of the moon itself from the earth. The penetrating genius of Pythagoras, however, inferred that the distance of the moon from the earth was 15,750 miles, and that of the sun from the moon twice that figure, and of the sun from the twelve signs of the Zodiac three times. Our fellow-countryman Sulpicius Gallus also held this view.

The stars - their distances apart

XX. But occasionally Pythagoras draws on the theory of music, and designates the distance between the earth and the moon as a whole tone, that between the moon and Mercury a semitone, between Mercury and Venus the same, between her and the sun a tone and a half, between the sun and Mars a tone (the same as the distance between the earth and the moon), between Mars and Jupiter half a tone, between Jupiter and Saturn half a tone, between Saturn and the zodiac a tone and a half: the seven tones thus producing the so-called diapason, i.e. a universal harmony; in this Saturn moves in the Dorian mode, Jupiter in the Phrygian, and similarly with the other planets - a refinement more entertaining than convincing.

Music from the stars

XXI. A stade is equivalent to 125 Roman paces, that is 625 feet. Posidonius holds that mists and winds and clouds reach to a height of not less than 5 miles from the earth, but that from that point the air is clear and liquid and perfectly luminous, but that the distance between the cloudy air and the moon is 250,000 miles and between the moon and the sun 625,000 miles, it being due to this distance that the sun's vast magnitude does not burn up the earth. The majority of writers, however, have stated that the clouds rise to a height of 111 miles. These figures are really unascertained and impossible to disentangle, but it is proper to put them forward because they have been put forward already, although they are matters in which the method of geometrical inference, which never misleads, is the only method that it is possible not to reject, were anybody desirous of pursuing such questions more deeply, and with the intention of establishing not

Dimensions of the world

precise measurement (for to aspire to that would mark an almost insane absorption in study) but merely a conjectural calculation. For since it appears from the sun's revolution that the circle through which its orb travels extends nearly 366 degrees, and since the diameter of a circle always measures a little less than $\frac{1}{3} + \frac{1}{21}$ of the circumference, it appears that, as half the circle is subtracted by the interposition of the earth at the centre, the measure of the sun's altitude comprises about $\frac{1}{6}$ th of this conjecturally estimated immense space of the solar circle round the earth, and the moon's altitude $\frac{1}{12}$ th, since the moon runs in a circuit that is much shorter than the sun's; so that it comes between the sun and the earth. It is marvellous to what length the depravity of man's intellect will go when lured on by some trifling success, in the way in which reason furnishes impudence with its opportunity in the case of the calculations above stated. And when they have dared to guess the distances of the sun from the earth they apply the same figures to the sky, on the ground that the sun is at its centre, with the consequence that they have at their finger's ends the dimensions of the world also. For they argue that the circumference of a circle is $\frac{22}{7}$ times its diameter, as though the measure of the heavens were merely regulated from a plumb line! The Egyptian calculation published by Petosiris and Nechepsos infers that one degree of the lunar circle measures (as has been said) just over $4 \frac{1}{8}$ miles at the least, one degree of the widest circle, Saturn's, twice that size, and one of the sun's circle, which we stated to be in the middle, the mean between the other two. This computation is a most shameful business, since the addition of the distance of the zodiac itself to the circle of Saturn produces a multiple that is even beyond reckoning.

XXII. A few facts about the world remain. There are also stars that suddenly come to birth in the heaven itself; of these there are several kinds. The Greeks call them 'comets,' in our language 'long-haired stars,' because they have a blood-red shock of what looks like shaggy hair at their top. The Greeks also give the name of 'bearded stars' to those from whose lower part spreads a mane resembling a long beard. 'Javelin-stars' quiver like a dart; these are a very terrible portent. To this class belongs the comet about which Titus Imperator Caesar in his 5th consulship wrote an account in his famous poem, that being its latest appearance down to the present day. The same stars when shorter and sloping to a point have been called 'Daggers'; these are the palest of all in colour, and have a gleam like the flash of a sword, and no rays, which even the Quoit-star, which resembles its name in appearance but is in colour like amber, emits in scattered form from its edge. The 'Tub-star' presents the shape of a cask, with a smoky light all round it. The 'Horned star' has the shape of a horn, like the one that appeared when Greece fought the decisive battle of Salamis. The 'Torch-star' resembles glowing torches, the 'Horse-star' horses' manes in very rapid motion and revolving in a circle. There also occurs a shining comet whose silvery tresses glow so brightly that it is scarcely possible to look at it, and which displays within it a shape in the likeness of a man's countenance. There also occur 'Goat comets,' enringed with a

Shooting stars
Comets, their nature,
position and kinds

sort of cloud resembling tufts of hair. Once hitherto it has happened that a 'Mane-shaped' comet changed into a spear; this was in the 108th Olympiad, A.U.C. 408. The shortest period of visibility on record for a comet is 7 days, the longest 80.

XXIII. Some comets move, like the planets, but others are fixed and stationary, almost all of them towards the due North, not in any particular part of it, though chiefly in the luminous region called the Milky Way. Aristotle also records that several may be seen at the same time - a fact not observed by anyone else, as far as I am aware - and that this signifies severe winds or heat. Comets also occur in the winter months and at the south pole, but comets in the south have no rays. A terrible comet was seen by the people of Ethiopia and Egypt, to which Typhon the king of that period gave his name; it had a fiery appearance and was twisted like a coil, and it was very grim to behold: it was not really a star so much as what might be called a ball of fire. Planets and all other stars also occasionally have spreading hair. But sometimes there is a comet in the western sky, usually a terrifying star and not easily expiated: for instance, during the civil disorder in the consulship of Octavius, and again during the war between Pompey and Caesar, or in our day about the time of the poisoning which secured the bequest of the empire by Claudius Caesar to Domitius Nero, and thereafter during Nero's principate shining almost continuously and with a terrible glare. People think that it matters in what direction a comet darts, what star's strength it borrows, what shapes it resembles, and in what places it shines; that if it resembles a pair of flutes it is a portent for the art of music, in the private parts of the constellations it portends immorality, if it forms an equilateral triangle or a rectangular quadrilateral in relation to certain positions of the fixed stars, it portends men of genius and a revival of learning, in the head of the Northern or the Southern Serpent it brings poisonings.

The only place in the whole world where a comet is the object of worship is a temple at Rome. His late Majesty Augustus had deemed this comet very propitious to himself; as it had appeared at the beginning of his rule, at some games which, not long after the decease of his father Caesar, as a member of the college founded by him he was celebrating in honour of Mother Venus. In fact he made public the joy that it gave him in these words: 'On the very days of my Games a comet was visible for seven days in the northern part of the sky. It was rising about an hour before sunset, and was a bright star, visible from all lands. The common people believed that this star signified the soul of Caesar received among the spirits of the immortal gods, and on this account the emblem of a star was added to the bust of Caesar that we shortly afterwards dedicated in the forum.' This was his public utterance, but privately he rejoiced because he interpreted the comet as having been born for his own sake and as containing his own birth within it; and, to confess the truth, it did have a health-giving influence over the world.

Some persons think that even comets are everlasting, and travel in a special circuit of their own, but are not visible except when the sun leaves them; there are others, however, who hold that

they spring into existence out of chance moisture and fiery force, and consequently are dissolved.

XXIV. Hipparchus before-mentioned, who can never be sufficiently praised, no one having done more to prove that man is related to the stars and that our souls are a part of heaven, detected a new star that came into existence during his lifetime; the movement of this star in its line of radiance led him to wonder whether this was a frequent occurrence, whether the stars that we think to be fixed are also in motion; and consequently he did a bold thing, that would be reprehensible even for God - he dared to schedule the stars for posterity, and tick off the heavenly bodies by name in a list, devising machinery by means of which to indicate their several positions and magnitudes, in order that from that time onward it might be possible easily to discern not only whether stars perish and are born, but whether some are in transit and in motion, and also whether they increase and decrease in magnitude - thus bequeathing the heavens as a legacy to all mankind, supposing anybody had been found to claim that inheritance!

XXV. There are also meteoric lights that are only seen when falling, for instance one that ran across the sky at midday in full view of the public when Germanicus Caesar was giving a gladiatorial show. Of these there are two kinds: one sort are called lampades, which means 'torches', the other bolides (missiles), - that is the sort that appeared at the time of the disasters of Modena. The difference between them is that 'torches' make long tracks, with their front part glowing, whereas a 'bolis' glows throughout its length, and traces a longer path.

XXVI. Other similar meteoric lights are 'beams.' in Greek dokoi, for example one that appeared when the Spartans were defeated at sea and lost the empire of Greece. There also occurs a yawning of the actual sky, called chasma, (**XXVII**) and also something that looks like blood, and a fire that falls from it to the earth - the most alarming possible cause of terror to mankind; as happened in the third year of the 107th Olympiad, when King Philip was throwing Greece into disturbance. My own view is that these occurrences take place at fixed dates owing to natural forces, like all other events, and not, as most people think, from the variety of causes invented by the cleverness of human intellects; it is true that they were the harbingers of enormous misfortunes, but I hold that those did not happen because the marvellous occurrences took place but that these took place because the misfortunes were going to occur, only the reason for their occurrence is concealed by their rarity, and consequently is not understood as are the risings and setting of the planets described above and many other phenomena.

XXVIII. Stars are also seen throughout the daytime in company with the sun, usually actually surrounding the sun's orb like wreaths made of ears of corn and rings of changing colour - for instance, when Augustus Caesar in early manhood entered the city after the death of his father to assume his mighty surname. Similar haloes occur round the moon and round the principal fixed stars. **XXIX.** A bow appeared round the sun in the

Identification of stars
- method of Hipparchus

Sky portents - recorded instances: torches, shafts, sky-beams, sky-yawning, colours of the sky, sky-flame, sky-wreaths, sudden rings, prolonged solar eclipses, several suns, several moons, daylight at night, burning shield; an unique sky-portent

consulship of Lucius Opimius and Quintus Fabius, a hoop in that of Gaius Porcius and Manius Acilius, and a red ring in that of Lucius Julius and Publius Rutilius.

XXX. Portentous and protracted eclipses of the sun occur, such as the one after the murder of Caesar the dictator and during the Antonine war which caused almost a whole year's continuous gloom. **XXXI.** Again, several suns are seen at once, neither above nor below the real sun but at an angle with it, never alongside of nor opposite to the earth, and not at night but either at sunrise or at sunset. It is also reported that once several suns were seen at midday at the Bosphorus, and that these lasted from dawn till sunset. In former times three suns have often been seen at once, for example in the consulships of Spurius Postumius and Quintus Mucius of Quintus Marcius and Marcus Porcius, of Marcus Antonius and Publius Dolabellal and of Marcus Lepidus and Lucius Plancus; and our generation saw this during the principate of his late Majesty Claudius, in his consulship, when Cornelius Orfitus was his colleague. It is not stated that more than three suns at a time have ever been seen hitherto.

XXXII. Also three moons have appeared at once, for instance in the consulship of Gnaeus Domitius and Gaius Fannius.

XXXIII. A light from the sky by night, the phenomenon usually called 'night-suns,' was seen in the consulship of Gaius Caecilius and Gnaeus Papirius and often on other occasions causing apparent daylight in the night.

XXXIV. In the consulship of Lucius Valerius and Gaius Marius a burning shield scattering sparks ran across the sky at sunset from west to east.

XXXV. In the consulship of Gnaeus Octavius and Gaius Scribonius a spark was seen to fall from a star and increase in size as it approached the earth, and after becoming as large as the moon it diffused a sort of cloudy daylight, and then returning to the sky changed into a torch; this is the only record of this occurring. It was seen by the proconsul Silanus and his suite.

XXXVI. Also stars appear to shoot to and fro; this invariably portends the rise of a fierce hurricane from the same quarter.

XXXVII. Stars also come into existence at sea and on land. I have seen a radiance of star-like appearance clinging to the javelins of soldiers on sentry duty at night in front of the rampart; and on a voyage stars alight on the yards and other parts of the ship, with a sound resembling a voice, hopping from perch to perch in the manner of birds. These when they come singly are disastrously heavy and wreck ships, and if they fall into the hold burn them up. If there are two of them, they denote safety and portend a successful voyage; and their approach is said to put to flight the terrible star called Helena: for this reason they are called Castor and Pollux, and people pray to them as gods for aid at sea. They also shine round men's heads at evening time; this is a great portent. All these things admit of no certain explanation; they are hidden away in the grandeur of nature.

Disruption of stars
The 'Castores'

XXXVIII. So much as to the world itself and the stars. Now the

The air

remaining noteworthy facts as to the heavens: for the name 'heaven' was also given by our ancestors to this which is otherwise designated 'air' - the whole of that apparently empty space which pours forth this breath of life. This region below the moon, and a long way below it (as I notice is almost universally agreed), blends together an unlimited quantity from the upper element of air and an unlimited quantity of terrestrial vapour, being a combination of both orders. From it come clouds, thunder-claps and also thunder-bolts, hail, frost, rain, storms and whirlwinds; from it come most of mortals' misfortunes, and the warfare between the elements of nature. The force of the stars presses down terrestrial objects that strive to move towards the sky, and also draws to itself things that lack spontaneous levitation. Rain falls, clouds rise, rivers dry up, hailstorms sweep down; rays scorch, and impinging from every side on the earth in the middle of the world, then are broken and recoil and carry with them the moisture they have drunk up. Steam falls from on high and again returns on high. Empty winds sweep down, and then go back again with their plunder. So many living creatures draw their breath from the upper air; but the air strives in the opposite direction, and the earth pours back breath to the sky as if to a vacuum. Thus as nature swings to and fro like a kind of sling, discord is kindled by the velocity of the world's motion. Nor is the battle allowed to stand still, but is continually carried up and whirled round, displaying in an immense globe that encircles the world the causes of things, continually overspreading another and another heaven interwoven with the clouds. This is the realm of the winds. Consequently their nature is here pre-eminent, and almost includes all the rest of the phenomena caused by the air, as most men attribute the hurling of thunderbolts and lightning to the winds' violence, and indeed hold that the cause of the rain of stones that sometimes occurs is that the stones are caught up by the wind; and likewise many other things. On this account more facts have to be set out at the same time.

XXXIX. Storms and rain obviously have some regular causes, but some that are accidental, or at all events not hitherto explained. For who can doubt that summer and winter and the yearly vicissitudes observed in the seasons are caused by the motion of the heavenly bodies? Therefore as the nature of the sun is understood to control the year's seasons, so each of the other stars also has a force of its own that creates effects corresponding to its particular nature. Some are productive of moisture dissolved into liquid, others of moisture hardened into frost or coagulated into snow or frozen into hail, others of a blast of air, others of warmth or heat, others of dew, others of cold. But it must not be thought that the stars are of the size that they appear to the sight, since the consideration of their immense altitude proves that none of them is smaller than the moon. Consequently each of them exercises its own nature in its own motion, a fact which the transits of Saturn in particular make clear by their storms of rain. Nor does this power belong to the moving stars only, but also to many of those that are fixed to the sky, whenever they are impelled forward by the

approach of the planets or goaded on by the impact of their rays, as we observe occurring in the case of the Little Pigs, the Greek name for which is consequently the Hyades, a word denoting rain. Indeed some stars move of themselves and at fixed times - compare the rising of the Kids. But the rising of the constellation Arcturus is almost always accompanied by a hail-storm.

XL. For who is not aware that the heat of the sun increases at the rising of the Lesser Dog-star, whose effects are felt on earth very widely? At its rise the seas are rough, wine in the cellars ripples in waves, pools of water are stirred. There is a wild animal in Egypt called the gazelle that according to the natives stands facing this dog-star at its rise, and gazing at it as if in worship, after first giving a sneeze. It is indeed beyond doubt that dogs throughout the whole of that period are specially liable to rabies.

XLI. Moreover also the parts of some constellations have an influence of their own - for instance at the autumnal equinox and at mid-winter, when we learn by the storms that the sun is completing its orbit; and not only by falls of rain and storms, but by many things that happen to our bodies and to the fields. Some men are paralysed by a star, others suffer periodic disturbances of the stomach or sinews or head or mind. The olive and white poplar and willow turn round their leaves at the solstice. Fleabane hung up in the house to dry flowers exactly on midwinter day, and inflated skins burst. This may surprise one who does not notice in daily experience that one plant, called heliotrope, always looks towards the sun as it passes and at every hour of the day turns with it, even when it is obscured by a cloud. Indeed persistent research has discovered that the influence of the moon causes the shells of oysters, cockles and all shell-fish to grow larger and again smaller in bulk, and moreover that the phases of the moon affect the tissues of the shrew mouse, and that the smallest animal, the ant, is sensitive to the influence of the planet and at the time of the new moon is always slack. This makes ignorance all the more disgraceful to man, especially as he admits that with some cattle diseases of the eyes increase and diminish with the moon. His excuse is the heaven's vastness, being divided at an enormous height into 72 signs, that is, shapes of things or of animals into which the learned have mapped out the sky. In them they have indeed noted 1600 stars as being specially remarkable for their influence or their appearance, for instance the seven which they have named the Pleiades in the tail of the Bull and the Little Pigs in his forehead, and Bootes, the star that follows the Seven Plough oxen.

XLII. I would not deny that rain and wind can arise from other causes than these; it is certain that the earth exhales a damp mist and at other times a smoky one due to vapour, and that clouds are formed out of moisture rising to a height or air

condensed into moisture. Their density and bulk are conjectured with certain inference from the fact that they obscure the sun, which is otherwise visible even to those diving into water to whatever depth.

XLIII. Consequently I would not go against the view that it is also possible for the fires of stars to fall from above into the clouds (as we often see happen in fine weather, and the impact of these fires unquestionably shakes the air since even weapons when flung make a hissing noise); and that when they reach the cloud, a hissing steam is produced, just as when red-hot iron is plunged into water, and a coil of smoke whirls up. And I agree that these produce storms, and if there is wind or steam struggling in the cloud, it gives out claps of thunder, if it bursts out on fire, flashes of lightning, if it forces its way on a longer track, heat-lightning. The latter cleaves the cloud, the flashes burst through it, and thunderclaps are the blows of the fires colliding, causing fiery cracks at once to flash out in the clouds. It is also possible for breath emerging from the earth, when pressed down by the counter-impact of the stars, to be checked by a cloud and so cause thunder, nature choking down the sound while the struggle goes on but the crash sounding when the breath bursts out, as when a skin is stretched by being blown into. It is also possible for this breath, whatever it is, to be set on fire by the friction during its headlong progress. It is also possible for it to be struck out by the impact of the clouds, as by that of two stones, with heat-lightning flashing out like sparks. But all these occurrences are accidental - they cause mere senseless and ineffectual thunder-claps, as their coming obeys no principle of nature - they merely cleave mountains and seas, and all their other blows are ineffectual; but the former are prophetic and sent from on high, they come by fixed causes and from their own stars.

XLIV. Similarly I am not prepared to deny that it is possible for winds or rather gusts of air to be produced also by a dry and parched breath from the earth, and also possible when bodies of water breathe out a vapour that is neither condensed into mist or solidified into clouds; and also they may be caused by the driving force of the sun, because wind is understood to be nothing else than a wave of air; and in more ways as well. For we see winds arising both from rivers and bays and from the sea even when calm, and others, called *altani*, arising from the land; the latter when they come back again from the sea are called turning winds, but if they go on, offshore winds. The windings of mountains and their clustered peaks and ridges curved in an elbow or broken off into shoulders, and the hollow recesses of valleys, cleaving with their irregular contours the air that is consequently reflected from them (a phenomenon that in many place causes words spoken to be endlessly echoed) are productive of winds. So again are caverns, like the one with an enormous gaping mouth on the coast of Dalmatia, from which, if you throw some light object into it, even in calm weather a gust like a whirlwind bursts out; the name of the place is Senta. Also it is said that in the

province of Cyrenaica there is a certain cliff, sacred to the South wind, which it is sacrilege for the hand of man to touch, the South wind immediately causing a sand-storm. Even manufactured vessels in many houses if shut up in the dark have peculiar exhalations. Thus there must be some cause for this.

XLV. But there is a great difference between a gust of air and a wind. The latter, regular and blowing steadily, and felt not by some particular tract only but by whole countries, and not being breezes nor tempests but winds - even their name being a masculine word - whether they are caused by the continuous motion of the world and the impact of the stars travelling in the opposite direction or whether wind is the famous 'breath' that generates the universe by fluctuating to and fro as in a sort of womb, or air whipped by the irregular impact of the planets and the non-uniform emission of their rays, or whether they issue forth from these nearer stars which are their own or fall from those stars which are fixed in the heaven - it is manifest that the winds too obey a law of nature that is not unknown, even if not yet fully known.

More than twenty Greek authors of the past have published observations about these subjects. This makes me all the more surprised that, although when the world was at variance, and split up into kingdoms, that is, sundered limb from limb, so many people devoted themselves to these abstruse researches, especially when wars surrounded them and hosts were untrustworthy, and also when rumours of pirates, the foes of all mankind, terrified intending travellers - so that now-a-days a person may learn some facts about his own region from the notebooks of people who have never been there more truly than from the knowledge of the natives - yet now in these glad times of peace under an emperor who so delights in productions of literature and science, no addition whatever is being made to knowledge by means of original research, and in fact even the discoveries of our predecessors are not being thoroughly studied. The rewards were not greater when the ample successes were spread out over many students, and in fact the majority of these made the discoveries in question with no other reward at all save the consciousness of benefiting posterity. Age has overtaken the characters of mankind, not their revenues, and now that every sea has been opened up and every coast offers a hospitable landing, an immense multitude goes on voyages - but their object is profit not knowledge; and in their blind engrossment with avarice they do not reflect that knowledge is a more reliable means even of making profit. Consequently in view of these thousands of persons who go on voyages I will give a more detailed account of the winds than is perhaps suited to the task I have set in hand.

XLVI. The ancients noticed four winds in all, corresponding to the four quarters of the world (this is the reason why even Homer mentions no more)- a dull-witted system, as it was soon afterwards considered; the following age added eight - this system on the other hand was too subtle and meticulous. Their

successors adopted a compromise, adding to the short list four winds from the long one. There are consequently two winds in each of the four quarters of the heaven: Subsolanus blowing from the equinoctial sunrise (E). and Vulturnus from the winter sunrise (S.E.)- the former designated by the Greeks Apeliotes, the latter Eurus; Auster from the sun at midday (S.) and Africus from the winter sunset (S.W.)- named in Greek Notus and Libs; Favonius from the equinoctial sunset (W.), Corus from the sunset at the solstice (N.W.)- these the Greeks call Zephyr and Argestes; Septentrio from the North and Aquilo between him and sunrise at the solstice (N.E.) - called in Greek Aparctias and Boreas. The more numerous scheme had inserted four between these: Thrascias (N.N.W.) in the space between Septentrio (N.) and the sunset at the solstice (N.W.) and also Caecias (E.N.E.) in the space between Aquilo (N.E.) and the equinoctial sunrise (E.) on the side of the sunrise at the solstice, and Phoenix (S.S.E.) in the space between winter sunrise (S.E.) and midday (S.), and also between Libs (S.W.) and Notus (S.) the combination of the two, Libonotus (S.S.W.), midway between midday (S.) and winter sunset (S.W.). Nor is this the end, inasmuch as others have also added one named Meses between Boreas (N.E.) and Caecias (E.N.E.), and Euronotus between Eurus (S.E.) and Notus (S.). There are also certain winds peculiar to particular races, which do not go outside a special region, e.g. the Athenians have Sciron, slightly diverging from Argestes (N.W.), a name unknown to the rest of Greece - elsewhere the same breeze is called Olympias: customarily an these names are taken to denote Argestes. Some people call Caecias (E.N.E.) Hellespontias, and others have other variants for these names. Similarly in the province of Narbonne the most famous of the winds is Circius (W.N.W.), which is inferior to none other at all in force and which usually carries a vessel right across the Ligurian Sea to Ostia; the same wind is not only unknown in the remaining quarters of the sky, but it does not even touch Vienne, a city of the same province, a few miles before reaching which this mighty wind is checked by the obstacle of a moderate ridge of hills. Fabianus asserts that South winds also do not penetrate Egypt - which reveals the law of nature that even winds have their prescribed limits as well as seasons.

XLVII. Accordingly the spring opens the seas to voyagers; at its beginning the West winds soften the wintry heaven, when the sun occupies the 25th degree of Aquarius; the date of this is Feb. 8. This also practically applies to all the winds whose positions I shall give afterwards, although every leap-year they come a day earlier, but they keep the regular rule in the period that follows. Certain persons give the name Chelidonias to the West wind on the 19th February, owing to the appearance of the swallow, but some call it Ornithias, from the arrival of the birds on the 71st day after the shortest day, when it blows for nine days. Opposite to the West wind is the wind that we have called Subsolanus (E.). The rise of the Pleiads in the same degrees of Taurus on May 10 brings summer; it is a period of South wind, Auster, the opposite of Septentrio. But in the

hottest period of summer the Dog-star rises, when the sun is entering the first degree of Leo - this day is July 17. The Dog-star's rise is preceded for about eight days by North-east winds: these are called the Forerunners. But two days after his rising the North-east winds begin again, and continue blowing steadily for 30 days; these are called Etesian or Annual winds. They are believed to be softened by the sun's warmth being reinforced by the heat of the star; and they are the most regular of any of the winds. They are followed in turn by South winds, continuing to the rise of Arcturus, which occurs 40 days before the autumnal equinox. With the equinox begins the Northwest wind; this, the opposite of Volturnus, marks the beginning of autumn. About 44 days after the autumnal equinox the setting of the Pleiads marks the beginning of winter, which it is customary to date on November 11; this is the period of the winter Aquilo, which is very unlike the summer one mentioned above; it is opposite to the Southwest wind. But for six days before the shortest day and six days after it the sea calms down for the breeding of the halcyons from which these days derive their name. The rest of the time there is wintry weather. However, not even the fury of the storms closes the sea; pirates first compelled men by the threat of death to rush into death and venture on the winter seas, but now avarice exercises the same compulsion.

XLVIII. The actually coldest winds are those that we have stated to blow from the North, and their neighbour Corus (N.W.); these check the other winds and also drive away the clouds. The Southwest and especially the South are for Italy the damp winds; it is said that on the Black Sea the Eastnorth-east also attracts clouds. The North-west and South-east are dry, except when they are falling. The North-east and North are snow winds; the North brings hailstorms, and so does the North-west. The South wind is hot, the South-east and West warm; the latter are also drier than the East wind, and in general all the northerly and westerly winds are drier than the southerly and easterly. The healthiest of all is the North wind; the South is harmful, and more so when dry, perhaps because when damp it is colder; living creatures are believed to be less hungry when it is blowing. Etesian winds usually cease at night and rise at eight o'clock in the morning; in Spain and Asia they are East winds, on the Black Sea North, and in other regions South. But they also begin to blow at midwinter (when they are called the Birdwinds), but more gently and only for a few days. Two winds also change their nature with their geographical position: the South wind in Africa is fine and the North-east cloudy. All the winds blow in their own turns, usually the one opposite to the one that ceases beginning. When those next to the ones falling rise, they go round from left to right like the sun. The fourth moon usually decides about the course of the winds for the month. Vessels by means of slacking sheets can sail in contrary directions with the same winds, so that collisions occur, usually at night, between ships on opposite tacks. The South wind causes larger waves than the Northeast because the former being below blows from the bottom of the

sea but the latter from the top; consequently earthquakes following South winds are specially destructive. The South wind is more violent at night and the North-east wind in the daytime; and easterly winds continue longer than westerly. North winds usually stop after blowing an odd number of days, an observation that holds good in many other departments of nature also: this is why the odd numbers are thought to be masculine. The sun both increases and reduces the force of the wind - the former when rising and setting, the latter at midday in summer seasons; consequently the winds are usually lulled at midday or midnight, because either excessive cold or excessive heat makes them slack. Also winds are lulled by rain; but they are most to be expected from quarters where the clouds have broken, revealing a clear sky. Eudoxus however thinks that (if we choose to study the minimal circuits) there is a regular recurrence of all phenomena - not only of winds but largely of other sorts of bad weather as well - in four-yearly periods, and that the period always begins in a leap-year at the rising of Sirius. These are our observations with regard to the winds that are regular.

XLIX. Now as to sudden blasts which arise as has been said from exhalations of the earth, and fall back again to the earth drawing over it an envelope of cloud; these occur in a variety of forms. The fact is that their onrush is quite irregular, like that of mountain torrents (as we have pointed out is the view of certain persons), and they give forth thunder and lightning. If travelling with a heavier momentum they burst a great gap in a dry cloud, they produce a storm called by the Greeks a cloudburst; but if they break out from a downward curve of cloud with a more limited rotation, they cause a whirl unaccompanied by fire - I mean by lightning - that is called a typhoon, which denotes a whirling cloudburst. This brings down with it a portion of heat torn from a cloud, which it turns and whirls round, increasing its own downward velocity by its weight, and shifting from place to place with a rapid whirl; it is specially disastrous to navigators, as it twists round and shatters not only the yards, but the vessels themselves, leaving only the slender remedy of pouring out vinegar in advance of its approach, vinegar being a very cold substance. The same whirlwind when beaten back by its very impact snatches things up and carries them back with it to the sky, sucking them high aloft.

L. But if it bursts out of a larger cavern of downward pressing cloud but not so wide a one as in the case of a storm, and is accompanied by a crashing noise, this is what they call a whirlwind, which overthrows everything in its neighbourhood. When the same rages hotter and with a fiery flow, it is called a prester, as while sweeping away the things it comes in contact with it also scorches them up. But a typhoon does not occur with a northerly wind, nor a cloudburst with snow or when snow is lying. If it flared up as soon as it burst the cloud, and had fire in it, did not catch fire afterwards, it is a thunderbolt. It

differs from a fiery pillar in the way in which a flame differs from a fire: a fiery pillar spreads out its blast widely, whereas a thunderbolt masses together its onrush. On the other hand a tornado differs from a whirlwind by returning, and as a whizz differs from a crash; a storm is different from either in its extent - it is caused by the scattering rather than the bursting of a cloud. There also occurs a darkness caused by a cloud shaped like a wild monster - this is direful to sailors. There is also what is called a column, when densified and stiffened moisture raises itself aloft; in the same class also is a waterspout, when a cloud draws up water like a pipe.

LI. Thunderbolts are rare in winter and in summer, from opposite causes. In winter, owing to the thicker envelope of cloud, the air is rendered extremely dense, and all the earth's exhalation being stiff and cold extinguishes whatever fiery vapour it receives. This reason renders Scythia and the frozen regions round it immune from the fall of thunderbolts, while conversely the excessive heat does the same for Egypt, inasmuch as the hot and dry exhalations from the earth condense very rarely, and only form thin and feeble clouds. But in spring and autumn thunderbolts are more frequent, their summer and winter causes being combined in each of those seasons; this explains why they are frequent in Italy, where the milder winter and stormy summer make the air more mobile, and it is always somewhat vernal or autumnal. Also in the parts of Italy that slope down from the north towards the warmth, such as the district of Rome and the Campagna, lightning occurs in winter just as in summer, which does not happen in any other locality.

LII. Of thunderbolts themselves several varieties are reported. Those that come with a dry flash do not cause a fire but an explosion. The smoky ones do not burn but blacken. There is a third sort, called 'bright thunderbolts,' of an extremely remarkable nature; this kind drains casks dry without damaging their lids and without leaving any other trace, and melts gold and copper and silver in their bags without singeing the bags themselves at all, and even without melting the wax seal. Marcia, a lady of high station at Rome, was struck by lightning when enceinte, and though the child was killed, she herself survived without being otherwise injured. Among the portents in connexion with Catiline, a town-councillor of Pompei named Marcus Herennius was struck by lightning on a fine day.

LIII. The Tuscan writers hold the view that there are nine gods who send thunderbolts, and that these are of eleven kinds, because Jupiter hurls three varieties. Only two of these deities have been retained by the Romans, who attribute thunderbolts in the daytime to Jupiter and those in the night to Summanus, the latter being naturally rare because the sky at night is colder. Tuscany believes that some also burst out of the ground, which it calls 'low bolts,' and that these are rendered exceptionally direful and accursed by the season of winter, though all the

bolts that they believe of earthly origin are not the ordinary ones and do not come from the stars but from the nearer and more disordered element: a clear proof of this being that all those coming from the upper heaven deliver slanting blows, whereas these which they call earthly strike straight. And those that fall from the nearer elements are supposed to come out of the earth because they leave no traces as a result of their rebound, although that is the principle not of a downward blow but of a slanting one. Those who pursue these enquiries with more subtlety think that these bolts come from the planet Saturn, just as the inflammatory ones come from Mars, as, for instance, when Bolsena, the richest town in Tuscany, was entirely burnt up by a thunderbolt. Also the first ones that occur after a man sets up house for himself are called 'family meteors,' as foretelling his fortune for the whole of his life. However, people think that private meteors, except those that occur either at a man's first marriage or on his birthday, do not prophecy beyond ten years, nor public ones beyond the 30th year, except those occurring at the colonization of a town.

LIV. Historical record also exists of thunderbolts being either caused by or vouchsafed in answer to certain rites and prayers. There is an old story of the latter in Tuscany, when the portent which they called Olta came to the city of Bolsena, when its territory had been devastated; it was sent in answer to the prayer of its king Porsina. Also before his time, as is recorded on the reliable authority of Lucius Piso in his Annals I, this was frequently practised by Numa, though when Tullus Hostilius copied him with incorrect ritual he was struck by lightning. We also have groves and altars and rites, and among the other Jupiters, the Stayers and Thunderers and Receivers of Offerings, tradition gives us Jupiter the Invoked. On this matter the opinion of mankind varies, in correspondence with our individual dispositions. It takes a bold man to believe that Nature obeys the behests of ritual, and equally it takes a dull man to deny that ritual has beneficent powers, when knowledge has made such progress even in the interpretation of thunderbolts that it can prophecy that others will come on a fixed day, and whether they will destroy a previous one or other previous ones that are concealed: this progress has been made by public and private experiments in both fields. In consequence although such indications are certain in some cases but doubtful in others, and approved to some persons but in the view of others to be condemned, in accordance with Nature's will and pleasure, we for our part are not going to leave out the rest of the things worth recording in this department.

LV. It is certain that when thunder and lightning occur simultaneously, the flash is seen before the thunderclap is heard (this not being surprising, as light travels more swiftly than sound); but that Nature so regulates the stroke of a thunderbolt and the sound of the thunder that they occur together, although the sound is caused by the bolt starting, not striking; moreover that the current of air travels faster than the

bolt, and that consequently the object always is shaken and feels the blast before it is struck; and that nobody hit has ever seen the lightning or heard the thunder in advance. Flashes on the left are considered lucky, because the sun rises on the left-hand side of the firmament; and their approach is not so visible as their return, whether after the blow a fire springs from it or the breath returns when its work is done or its fire used up. In making these observations the Tuscans divided the heaven into sixteen parts: the first quarter is from the North to the equinoctial sunrise (East), the second to the South, the third to the equinoctial sunset (West), and the fourth occupies the remaining space extending from West to North; these quarters they subdivided into four parts each, of which they called the eight starting from the East the left-hand regions and the eight opposite ones the right-hand. Of these the most formidable are those lying between West and North. Hence the line of approach and the line of retirement of thunderbolts is of very great importance. It is best for them to return to parts in the region of sunrise. Accordingly it will be a portent of supreme happiness when they come from the first part of the sky and retire to the same part - a sign that history records to have been vouchsafed to the dictator Sulla; but all the others are less fortunate or actually direful, in accordance with the division of the actual firmament where they occur. Some people think it wrong to give or to listen to reports of thunderbolts, except if they are told to a guest or a parent. The great folly of paying attention to these occurrences was discovered when the Temple of Juno at Rome was struck by lightning in the consulship of Scaurus, who was afterwards head of the state. Lightning unaccompanied by thunder occurs more often by night than in the daytime. Man is the one creature that is not always killed when struck - all others are killed on the spot; nature doubtless bestows this honour on man because so many animals surpass him in strength. All things (when struck) fall in the opposite direction to the flash. A man does not die unless the force of the blow turns him right round. Men struck from above collapse. A man struck while awake is found with his eyes shut; while asleep, with them open. It is not lawful to cremate a man who loses his life in this manner, religious tradition prescribes burial. No living creature can be burnt by lightning without being killed. The temperature of the wound of those struck is lower than that of the rest of the body.

LVI. Among things that grow in the ground, it does not strike a laurel bush. It never penetrates more than five feet into the earth; consequently when in fear of lightning men think caves of greater depth are the safest, or else a tent made of the skin of the creatures called sea-calves, because that alone among marine animals lightning does not strike, just as it does not strike the eagle among birds; this is why the eagle is represented as armed with a thunderbolt as a weapon. In Italy in the time of the Caesarian war people ceased to build towers between Terracina and the Temple of Feronia, as every tower there was destroyed by lightning.

LVII. Besides these events in the lower sky, it is entered in the

records that in the consulship of Manius Acilius and Gaius Porcius it rained milk and blood, and that frequently on other occasions there it has rained flesh, for instance in the consulship of Publius Volumnius and Servius Sulpicius, and that none of the flesh left un plundered by birds of prey went bad; and similarly that it rained iron in the district of Lucania the year before Marcus Crassus was killed by the Parthians and with him all the Lucanian soldiers, of whom there was a large contingent in his army; the shape of the iron that fell resembled sponges; the augurs prophesied wounds from above. But in the consulship of Lucius Paullus and Gaius Marcellus it rained wool in the vicinity of Compsa Castle, near which Titus Amlius Milo was killed a year later. It is recorded in the annals of that year that while Milo was pleading a case in court it rained baked bricks.

LVIII. We are told that during the wars with the Cimbri a noise of clanging armour and the sounding of a trumpet were heard from the sky, and that the same thing has happened frequently both before then and later. In the third consulship of Marius the inhabitants of Ameria and Tuder saw the spectacle of heavenly armies advancing from the East and the West to meet in battle, those from the West being routed. It has often been seen, and is not at all surprising, that the sky itself catches fire when the clouds have been set on fire by an exceptionally large flame.

LIX. The Greeks tell the story that Anaxagoras of Clazomenae in the 2nd year of the 78th Olympiad was enabled by his knowledge of astronomical literature to prophecy that in a certain number of days a rock would fall from the sun; and that this occurred in the daytime in the Goat's River district of Thrace (the stone is still shown - it is of the size of a wagon-load and brown in colour), a comet also blazing in the nights at the time. If anyone believes in the fact of this prophecy, that involves his allowing that the divining powers of Anaxagoras covered a greater marvel, and that our understanding of the physical universe is annihilated and everything thrown into confusion if it is believed either that the sun is itself a stone or ever had a stone inside it. But it will not be doubted that stones do frequently fall. A stone is worshipped for this reason even at the present day in the exercising ground at Abydos - one of moderate size, it is true, but which the same Anaxagoras is said to have prophesied as going to fall in the middle of the country. There is also one that is worshipped at Cassandria, the place that has been given the name of Potidaea, and where a colony was settled on account of this occurrence. I myself saw one that had recently come down in the territory of the Vocontii.

LX. The common occurrences that we call rainbows have nothing miraculous or portentous about them, for they do not reliably portend even rain or fine weather. The obvious explanation of them is that a ray of the sun striking a hollow cloud has its point repelled and is reflected back to the sun, and that the diversified colouring is due to the mixture of clouds, fires and air. Rainbows certainly do not occur except opposite to the sun, and never except in semi-circular shape, and not at night

time, although Aristotle does state that a rainbow has been sometimes seen at night, though he also admits that it cannot happen except on the 14th day of the lunar month. Rainbows in winter occur chiefly when the day is drawing in after the autumnal equinox; when the day draws out again after the vernal equinox they do not occur, nor in the longest days about the solstice, but they occur frequently in midwinter; also they are high in the sky when the sun is low and low when it is high; and smaller but of wider breadth at sunrise or sunset, and narrow but of large circumference at midday. In summer they are not seen during midday, but after the autumn equinox they are seen at any hour; and never more than two are seen at once.

LXI. I observe that the facts as to the other phenomena of the same kind are generally familiar: viz. that hail is produced from frozen rain and snow from the same fluid less solidly condensed, but hoar frost from cold dew; that snow falls during winter but not hail, and hail itself falls more often in the daytime than at night, and melts much faster than snow; that mists do not occur in summer nor in extremely cold weather, nor dew in frosty or very hot or windy weather, and only on fine nights; that liquid is reduced in bulk by freezing, and when ice is thawed the bulk produced is not the same; that variations of colour and shape are seen in the clouds in proportion as the fire mingled with them gains the upper hand or is defeated; LXII. and moreover that particular places have particular special qualities: the nights of Africa are dewy in summer, in Italy rainbows are seen every day at Locri and at the Veline Lake, at Rhodes and Syracuse there is never such a thick curtain of cloud that the sun is not visible at some hour of the day. Such special features will be more suitably related in their places.

So much on the subject of the air.

LXIII. Next comes the earth, the one division of the natural world on which for its merits we have bestowed the venerable title of mother. She belongs to men as the sky belongs to God: she receives us at birth, and gives us nurture after birth, and when once brought forth she upholds us always, and at the last when we have now been disinherited by the rest of nature she embraces us in her bosom and at that very time gives us her maternal shelter; sanctified by no service more than that whereby she makes us also sacred, even bearing our monuments and epitaphs and prolonging our name and extending our memory against the shortness of time; whose divinity is the last which in anger we invoke to lie heavy on those who are now no more, as though we did not know that she is the only element that is never wroth with man. Water rises in mist, freezes into hail, swells in waves, falls headlong in torrents; air becomes thick with clouds and rages with storms; but earth is kind and gentle and indulgent, ever a handmaid in the service of mortals, producing under our compulsion, or lavishing of her own accord, what scents and savours, what juices, what surfaces for the touch, what colours! how honestly she repays the interest lent her! what produce she fosters for our benefit! since for living creatures that are noxious the breath of life is to blame - she is compelled to receive them

when their seed is sown and to maintain them when they have been born; but their harm lies in the evils of those that generate them. When a serpent has stung a man she harbours it no more, and she exacts retribution even on the account of the helpless; she produces medicinal herbs, and is ever fertile for man's benefit; nay, even poisons she may be thought to have invented out of compassion for us, lest, when we were weary of life, hunger, the death most alien to earth's beneficence, should consume us with slow decay, lest precipices should scatter in fragments our lacerated body, lest we should be tortured by the perverted punishment of the noose which imprisons the breath whose departure it is seeking; lest if we sought death in the deep our burial should serve for fodder; lest the torture of the steel should cleave our body. So is it! in mercy did she generate the potion whereof the easiest draught - as men drink when thirsty - might painlessly just blot us out, without injury to the body or loss of blood, in such wise that when dead no birds nor beasts should touch us, and one that had perished for himself should be preserved for the earth. Let us own the truth: what earth has produced as a cure for our ills, we have made into a deadly poison; why, do we not also put her indispensable gift of iron to a similar use? Nor yet should we have any right to complain even if she had engendered poison to serve the purpose of crime. In fact in regard to one of nature's elements we have no gratitude. For what luxuries and for what outrageous uses does she not subserve mankind? She is flung into the sea, or dug away to allow us to let in the channels. Water, iron, wood, fire, stone, growing crops, are employed to torture her at all hours, and much more to make her minister to our luxuries than our sustenance. Yet in order to make the sufferings inflicted on her surface and mere outer skin seem endurable, we probe her entrails, digging into her veins of gold and silver and mines of copper and lead; we actually drive shafts down into the depth to search for gems and certain tiny stones; we drag out her entrails, we seek a jewel merely to be worn upon a finger! How many hands are worn away with toil that a single knuckle may shine resplendent! If any beings of the nether world existed, assuredly even they would have been dug up ere now by the burrowings of avarice and luxury! And can we wonder if earth has also generated some creatures for our harm? since the wild animals, I well believe, are her guardians, and protect her from sacrilegious hands; do not serpents infest our mines, do we not handle veins of gold mingled with the roots of poison? Yet that shows the goddess all the kinder towards us, because all these avenues from which wealth issues lead but to crime and slaughter and warfare, and her whom we besprinkle with our blood we cover with unburied bones, over which nevertheless, when at length our madness has been finally discharged, she draws herself as a veil, and hides even the crimes of mortals. I would reckon this too among the crimes of our ingratitude, that we are ignorant of her nature.

LXIV. But her shape is the first fact about which men's judgement agrees. We do undoubtedly speak of the earth's sphere, and admit that the globe is shut in between poles. Nor yet

in fact do all these lofty mountains and widely spreading plains comprise the outline of a perfect sphere, but a figure whose circuit would produce a perfect sphere if the ends of all the lines were enclosed in a circumference. This is the consequence of the very nature of things, it is not due to the same causes as those we have adduced in the case of the heaven; for in the heaven the convex hollow converges on itself and from all sides rests upon its pivot, the earth, whereas the earth being a solid dense mass rises like an object swelling, and expands outward. The world converges to its centre, whereas the earth radiates outward from its centre, the ceaseless revolution of the world around her forcing her immense globe into the shape of a sphere.

LXV. Here there is a mighty battle between learning on one side and the common herd on the other: the theory being that human beings are distributed all round the earth and stand with their feet pointing towards each other, and that the top of the sky is alike for them all and the earth trodden under foot at the centre in the same way from any direction, while ordinary people enquire why the persons on the opposite side don't fall off - just as if it were not reasonable that the people on the other side wonder that we do not fall off. There is an intermediate theory that is acceptable even to the unlearned crowd - that the earth is of the shape of an irregular globe, resembling a pine cone, yet nevertheless is inhabited all round. But what is the good of this theory when there arises another marvel, that the earth herself hangs suspended and does not fall and carry us with it? As if forsooth there were any doubt about the force of breath, especially when shut up inside the world, or as if it were possible for the earth to fall when nature opposes, and denies it any place to fall to! For just as the sole abode of fires is in the element of fire, and of waters in water, and of breath in breath, so earth, barred out by all the other elements, has no place except in itself. Yet it is surprising that with this vast level expanse of sea and plains the resulting formation is a globe. This view has the support of Dicaearchus, a savant of the first rank, who with the support of royal patrons took the measurement of mountains, and published that the highest of them was Pelion, with an altitude of 1250 paces, inferring that this was no portion of the earth's general sphericity. To me this seems a questionable guess, as I know that some peaks of the Alps rise to a great height, not less than 50,000 paces.

But what the crowd most debates is if it must believe that the conformation of the waters also rises in a curve. Nevertheless nothing else in the natural world is more visibly manifest. For (1) hanging drops of liquid always take the shape of small round globes; (2) when dropped on dust or placed on the downy surface of leaves they are seen to be absolutely spherical; (3) in goblets when filled the surface curves upward most at the centre, though owing to the transparency of the liquid and its fluidity tending to find its own level this is more easily discovered by theory than by observation; and (4) a still more remarkable fact is that when a very little additional liquid is poured into a cup that has already been filled the surplus overflows, but the opposite happens when weighty solids, often as many as 20 coins, are put into it,

presumably because these pass inside the liquid and raise its surface to a peak, whereas liquids poured on to the upward curving surface slip off. (5) The same cause explains why the land is not visible from the deck of a ship when in sight from the masthead; and why as a vessel passes far into the distance, if some shining object is tied to the top of the mast it appears slowly to sink and finally it is hidden from sight. Lastly (6) what other conformation could have caused the ocean, which we acknowledge to be at the extreme outside, to cohere and not fall away, if there is no boundary beyond to enclose it? The very question as to how, although the sea is globular in shape, its edge does not fall away, itself ranks with the marvellous. On the other side the Greek investigators, greatly to their delight and to their glory, prove by subtle mathematical reasoning that it cannot possibly be the case that the seas are really flat and have the shape that they appear to have. For, they argue, while it is the case that water travels downward from an elevation, and this is its admitted nature, and nobody doubts that the water on any coast has reached the farthest point allowed by the slope of the earth, it is manifest beyond doubt that the lower an object is the nearer it is to the centre of the earth, and that all the lines drawn from the centre to the nearest bodies of water are shorter than those drawn from the edge of these waters to the farthest point in the sea: it therefore follows that all the water from every direction converges towards the centre, this pressure inward being the cause of its not falling off.

LXVI. The reason for this formation must be thought to be the inability of earth when absolutely dry to cohere of itself and without moisture, and of water in its turn to remain still without being held up by earth; the intention of the Artificer of nature must have been to unite earth and water in a mutual embrace, earth opening her bosom and water penetrating her entire frame by means of a network of veins radiating within and without, above and below, the water bursting out even at the tops of mountain ridges, to which it is driven and squeezed out by the weight of the earth, and spurts out like a jet of water from a pipe, and is so far from being in danger of falling down that it leaps upward to all the loftiest elevations. This theory shows clearly why the seas do not increase in bulk with the daily accession of so many rivers. The consequence is that the earth at every point of its globe is encircled and engirdled by sea flowing round it, and this does not need theoretical investigation, but has already been ascertained by experience.

LXVII. Today the whole of the West is navigated from Cadiz and the Straits of Gibraltar all round Spain and France. But the larger part of the Northern Ocean was explored under the patronage of his late Majesty Augustus, when a fleet sailed round Germany to the promontory of the Cimbri and thence seeing a vast sea in front of them or learning of it by report, reached the region of Scythia and localities numb with excessive moisture. On this account it is extremely improbable that there is no sea in those parts, as there is a superabundance of the moist element there. But next, on the Eastward side, the whole quarter under the same

star stretching from the Indian Ocean to the Caspian Sea was navigated throughout by the Macedonian forces in the reigns of Seleucus and Antiochus, who desired that it should be called both Seleucis and Antiochis after themselves. And many coasts of Ocean round the Caspian have been explored, and very nearly the whole of the North has been completely traversed from one side to the other by galleys, so that similarly also there is now overwhelming proof, leaving no room for conjecture, of the existence of the Maeotic Marsh, whether it be a gulf of that Ocean, as I notice many have believed, or an overflow from it from which it is separated off by a narrow space. On the other side of Cadiz, from the same Western point, a great part of the Southern gulf is navigated today in the circuit of Mauretania. Indeed the greater part of it Alexander the Great's eastern conquests also explored as far as the Arabian gulf; in which, when Augustus's son Gaius Caesar was operating there, it is said that figureheads of ships from Spanish wrecks were identified. Also when the power of Carthage flourished, Hanno sailed round from Cadiz to the extremity of Arabia, and published a memoir of his voyage, as did Himilco when despatched at the same date to explore the outer coasts of Europe. Moreover we have it on the authority of Cornelius Nepos that a certain contemporary of his named Eudoxus when flying from King Lathyrus emerged from the Arabian Gulf and sailed right round to Cadiz; and much before him Caelius Antipater states that he had seen someone who had gone on a trading voyage from Spain to Ethiopia. Nepos also records as to the northern circuit that Quintus Metellus Celer, colleague of Afranius in the consulship but at the time pro-consul of Gaul, received from the King of the Swabians a present of some Indians, who on a trade voyage had been carried off their course by storms to Germany. Thus there are seas encircling the globe on every side and dividing it in two, so robbing us of half the world, since there is no region affording a passage from there to here or from here to there. This reflexion serves to expose the vanity of mortals, and appears to demand that I should display to the eye and exhibit the extent of this whole indefinite region in which men severally find no satisfaction.

LXVIII. In the first place it is apparently reckoned as forming one half of the globe - just as if no part were cut off for the ocean itself, which surrounding and encircling the whole of it, and pouring forth and reabsorbing the waters and pasturing and all the moisture that goes to form the clouds, the stars themselves with all their numbers and their mighty size, can be supposed to occupy a space - of what extent, pray? The freehold owned by that mighty mass is bound to be enormous - without limit! Add that of what is left more than half is taken by the sky. For this has five divisions called zones, and all that lies beneath the two outermost zones that surround the poles at either end - both the pole named from the Seven Oxen and the one opposite to it called after Auster - is all crushed under cruel frost and everlasting cold. In both regions perpetual mist prevails, and a light that the invisibility of the milder stars renders niggardly and that is only white with hoarfrost. But the middle portion of

the lands, where the sun's orbit is, is scorched by its flames and burnt up by the proximity of its heat: this is the torrid zone. There are only two temperate zones between the torrid one and the frozen ones, and these have no communication with each other because of the fiery heat of the heavenly body.

Thus the sky has stolen three quarters of the earth. The extent of the trespass of ocean is unascertained; but even the one portion left to us suffers perhaps an even greater loss, inasmuch as the same ocean, spreading out, as we shall describe, into a number of bays, advances with its threatening roar so close to the inner seas that there is only a distance of 115 miles between the Arabian Gulf and the Egyptian Sea and of 375 between the Caspian and the Black Sea; and also with its inner channels through so many seas whereby it sunders Africa, Europe and Asia, it occupies - what area of the land? Calculate moreover the dimensions of all those rivers and vast swamps, add also the lakes and pools, and next the ridges too that rise into the heaven and are precipitous even to the eye, next the forests and steep glens, and the deserts and areas for a thousand reasons left deserted; subtract all these portions from the earth or rather from this pin-prick, as the majority of thinkers have taught, in the world - for in the whole universe the earth is nothing else: and this is the substance of our glory, this is its habitation, here it is that we fill positions of power and covet wealth, and throw mankind into an uproar, and launch even civil wars and slaughter one another to make the land more spacious! And to pass over the collective insanities of the nations, this is the land in which we expel the tenants next to us and add a spade-full of turf to our own estate by stealing from our neighbour's - to the end that he who has marked out his acres most widely and banished his neighbours beyond all record may rejoice in owning - how small a fraction of the earth's surface? or, when he has stretched his boundaries to the full measure of his avarice, may still retain - what portion, pray, of his estate when he is dead?