3 1761 00177274 8

PHYSICAL SCIENCE IN THE TIME OF NERO



MACMILLAN AND CO., LIMITED
LONDON · BOMBAY · CALCUTTA
MELBOURNE

THE MACMILLAN COMPANY
NEW YORK · BOSTON · CHICAGO
ATLANTA · SAN FRANCISCO

THE MACMILLAN CO. OF CANADA, LTD.
TORONTO

PHYSICAL SCIENCE

IN THE TIME OF NERO

BEING A TRANSLATION OF THE
QUAESTIONES NATURALES OF SENECA

BY

JOHN CLARKE, M.A.

LECTURER ON EDUCATION IN THE UNIVERSITY OF ABERDEEN

WITH NOTES ON THE TREATISE BY

SIR ARCHIBALD GEIKIE

K.C.B., D.C.L., Sc.D., LL.D.

PRESIDENT OF THE ROYAL SOCIETY

10292
27/6

MACMILLAN AND CO., LIMITED
ST. MARTIN'S STREET, LONDON
1910

Q
151
S4

Plurimum ad inveniendum contulit qui speravit posse reperiri.
SENECA, *Q.N.* VI. V. 2.

PREFACE

THIS book is intended primarily for English readers, to most of whom it will probably be at least new. Thomas Lodge, the well-known dramatist, published in 1614 a translation of the whole of Seneca's prose works (except the *Apocolocyntosis*), but no English editor or commentator seems to have turned his attention to the *Quaestiones Naturales*, either before or since. Lodge's translation, a folio volume of nearly a thousand pages, was probably very good for its day, but is now out of date.

The Introduction is designed to give a setting to the translation, and to answer a few of the questions that would naturally occur to the mind of an intelligent reader who was not a classical scholar. In the Index also some details are included that may be helpful to those who have neither time nor opportunity for hunting up historical and other allusions in books of reference. The object has been to make the volume self-interpreting, though it may be that the course has not always been judiciously steered between too little and too much.

The *Quaestiones Naturales* must be regarded as occupying historically an important position. It was the latest deliverance of the classical world

upon the subject of physical speculation. Its currency during the Middle Ages rendered it for many centuries the chief authority in science in Western Europe. Its cosmology represented not only popular but also educated opinion, and became the source of many of the accepted ideas concerning the universe that passed into early modern literature in our own and other countries.

Indebtedness to editors of Seneca and to others, which has been very great, is acknowledged as fully as possible in the Introduction and elsewhere where help has been availed of. The interest taken in the book by various friends is also gratefully acknowledged. Professor Sir Joseph Larmor and Professor J. Arthur Thomson have made several useful suggestions. Professor Herbert J. C. Grierson has very kindly read the proofs and given valuable assistance in other respects. But my chief acknowledgments are due to Sir Archibald Geikie. To him the translation owed its inception: his constant aid and encouragement have enabled me to complete a task from which I should probably have otherwise shrunk. I am indebted to him also for the Commentary appended to the translation, in which the questions treated by Seneca are considered from the point of view of modern Science. It has been to him a labour of love: may our readers enjoy something of the same satisfaction!

J. C.

OLD ABERDEEN,
September 27, 1909.

CONTENTS

PREFACE v

INTRODUCTION xxi

BOOK I

[METEORS, HALO, RAINBOW, MOCK SUN, ETC.]

PREFACE

PAGE

CONTRAST between human (moral) philosophy and divine (natural, physical). The sublime character of the latter which lifts us above the contemplation of the littlenesses of the earth and earthly life to the knowledge of God and His nature. Compared with astronomical conceptions and dimensions the world of man is but as a threshing-floor, the haunt of ants. The mind of man attains its true height in contemplation and investigation of these sublime facts. Some of the problems thus raised 3

CHAP.

I. Meteoric fires—*she-goat*, *kid*, etc. Occasions of their appearance; connection of portent with event. Explanation of the phenomena. They may be due to pressure of the atmosphere. Aristotle attributes them to the effect of terrestrial evaporation: difference of density causes various outbursts of this kind. They are analogous to lightning, but less violent 8

II. *Halos*. Produced by the light of a heavenly body striking the surrounding air and forming a circle as a stone does when thrown into a pond. Formed far away from the heavenly body and comparatively near the earth in the region of the wind. Require a particular state of the atmosphere neither too dense nor too thin. More frequent at night than day for this reason: by day the sun rarefies the air too much by its heat. Method of dissipation gives indication of wind or rain. Calmness a condition of formation, as in the analogous case of water 12

III. *Rainbows*. Generally by day, produced by inequalities of surface and density in clouds. Another species seen in a burst pipe or a fuller at work. Various explanations. Light and shade will not explain the varied colours. Some explain the rainbow as a confused reflection of the sun from individual drops of rain: every bounded surface, large or small, thus reflects—fish-pond and dew-drop equally. Aristotle attributes the confusion of colours to weakness of human sight; parallels may be found in persons whose sight is abnormally weak. As the innumerable drops,

CHAP. PAGE

apparently without intervals, fall, human vision fails to distinguish severally the reflections of the sun, which thus become blended and confused. Vision is similarly deceived in the case of an oar in water, apples in a glass globe, etc., even in the size and movements of the sun himself. At any rate the rainbow requires both sun and cloud, and these opposite to each other. These two in operation produce the varieties of colour . . . 16

IV. That the rainbow is an image is shown by the relation of sun to cloud in position, by the rapidity of formation and dispersion. Artemidorus' explanation of the shape of the cloud (concave), and the consequent position of the red in the rainbow . . 22

V. Arguments to show that the cloud is coloured by the sun, like a dove's neck or a peacock's tail, and that the rainbow is not a *reflection* of the sun. The position (opposite) would be equally necessary in this case. Answer to this contention by Posidonius. The colour effects. Author agrees with Posidonius' position but not his arguments. The only *proof* is the geometrical one. . 23

VI. Arguments from the size—never more than a semicircle—and shape of the bow. As the colour, whether real or reflected, is derived from the sun, so must also the shape be. The size is accounted for by the magnifying power of water, glass, etc. The sun as he appears in the rainbow is seen through moisture . 28

VII. The arguments from the dispersion of the sun's rays through glass (prism). Contention that they confirm author's view . . 30

VIII. The form once more; why it is never larger than a semicircle. A wrong explanation refuted. Explanation of Aristotle's remark as to the seasons of rainbows, in summer only in the morning or evening, in autumn at any time 31

IX. *Streaks* or *weather-galls*. Merely abortive or imperfect rainbows . 33

X. Relations and differences of *halos*, *bows*, and *weather-galls* . . 34

XI. *Mock suns*. Their appearance and position in relation to the sun. They are a reflection of the sun in a suitable medium . . 34

XII. The formation of a mock sun may be compared to the image of the sun in eclipse as seen reflected in a dish of oil or pitch: the medium must be adapted to give the impression. The mock sun requires a certain consistency of cloud, failing which, a different effect is produced—obscuration, dissipation, etc. . . . 35

XIII. There may be two mock suns simultaneously. Some think the one is a reflection of the other, the clouds acting as mirrors set opposite to one another. Mock suns, especially in the South, are a sign of rain 36

XIV. Other celestial fires. "*Cave meteors*," "*Barrel meteors*," "*Chasms*," with a brief description of each. The rapidity of their flight, just as of lightning, deceives the sight. Their origin and cause. They indicate wind 37

XV. *Gleams* (*flashes*, σέλα). Their production and motions, varieties of them. Some do damage. Some are analogous to comets. "*Bearded*," "*torches*," "*cypress*" are different kinds. "*Beams*" and "*barrels*" may be of the same class. A curious case where such an appearance raised an alarm of fire. They are real fires. On the contrary, rainbows and halos are mere reflections. Mirrors have this wonderful power of false presentation . . 39

CHAP. PAGE
XVI. The "mirrored den" of Hostius Quadra 41
XVII. The philosophy of the looking-glass. The evolution of mirrors. Mirrors of full length are now used. They cost a fortune greater than the Senate gave Scipio's daughters. A harmless necessary device has become an instrument of luxury, the adornment of women, the burden of men, nay, part of the kit of the soldier . 44

BOOK II

[THE NATURE OF AIR. THUNDER AND LIGHTNING]

[I.-XI. PREFATORY to treatment of thunder and lightning, descriptive of the nature of the air, in which these phenomena occur.]

I. Divisions of physical science—astronomy, meteorology, geography. Cross divisions, *e.g.* earthquakes, belong to meteorology, being produced by air; so the earth, as a planet, belongs to Astronomy but its properties belong to Geography 51

II. Unity and composition in bodies. The analogy of the seen applies to the unseen. The atmosphere is possessed of unity (*unitas*) . 52

III. Parts and material of bodies distinguished. In the human body blood is both 54

IV. The atmosphere is an integral part of the universe: has unity . 54

V. The earth is both part and material of the universe. From it nourishment is supplied to the latter 55

VI. The atmosphere has unity—is not compact of atoms, otherwise it could not exert tension, which is one of its main features, with endless manifestations 55

VII. There is no vacuum in the air, as the analogy of water shows . 57

VIII. The exertion of tension presupposes tensibility, just as motion does mobility. Its existence in air proved by the effects of air, which tosses about mountains, houses, walls, etc. The propagation of sight and sound proves the same 58

IX. Its tension is seen in raising water, as in the jet in the amphitheatre. Proofs from a ship upborne of water, a quoit flung from a height, sound heard through a wall 59

X. Varieties of density and temperature in the atmosphere: the central layer is coldest 60

XI. The lower parts are most subject to change. The cause of this is in part the earth, in part the sun, moon, and other stars. So much by way of preface to explain the nature of that atmosphere in which thunder and lightning occur 61

XII. *Lightning*, *thunder-bolt*, *thunder*. All agree that they occur in the clouds, but different explanations are given of their cause and relations. Anaxagoras connects them with the ether; Aristotle says they are due to exhalations of various kinds, from the earth, coming in contact with the clouds 62

XIII. The fire cannot be inherent in the clouds and fall from them. When it so comes it is forced 64

CHAP. PAGE

XIV. There is nothing inconsistent with this in the explanation given (I. xv.) of meteors. There may be an analogy with what is observed in cases of fire when isolated groups of houses take fire through gradual accumulation of heat 65

XV. Some (Stoics) think that spontaneous combustion takes place in the air 66

XVI. Difference between a flash of lightning and a bolt . . . 66

XVII. Some explain the noise of thunder as due to hot meeting cold, as in the case of hot iron plunged into water 67

XVIII. Anaximander attributes the effects to air and explains all the phenomena by reference to it 67

XIX. Anaxagoras says it is the ether that acts on the lower atmosphere to produce them : it sends out fire 68

XX. Diogenes of Apollonia thinks that fire and air interact, producing one another, as may be observed in the various phenomena 68

XXI. Authorities discarded : independent explanation. A flash and a bolt are fire in some form : they differ only in degree . . 69

XXII. Analogy of fire on earth : it must apply above. Lightning due either to impact or friction. Hurricanes are a sufficient cause of the former 70

XXIII. Clouds and air may through friction also be a cause. The fires so produced are insubstantial and evanescent 71

XXIV. Fire by reason of its lightness levitates, just as water gravitates. But in the case of a bolt it is forced down, contrary to its nature, like a "weeping" tree 71

XXV. But it is said that wet clouds produce fire. How? . . 72

XXVI. There is no inconsistency in the combination in the same cloud of potential fire and water. A log burns at one end, exudes moisture at the other. An island on each of two occasions was thrown up by fire in the Aegean Sea, fire overcoming water. And clouds are, as a matter of fact, required for lightning : exceptions to this are only apparent 72

XXVII. Different kinds of thunder. The growling and the crashing, with their causes 75

XXVIII. In order to the sound of thunder, clouds of a particular shape must meet in a particular way. A bladder does not burst with a report if cut. A broad simultaneous blow over the whole cloud is necessary to an explosion 76

XXIX. The proper shape and the rupture of the cloud are necessary. Compare drums, etc. 77

XXX. According to some, clouds are not necessary to thunder : witness eruptions of Etna and the overthrow of Cambyses' army, where particles of sand were the medium of the thunder and lightning. But in this case, too, a cloud was formed, it may be, a denser, and more solid than one composed of mere air, before the sound was emitted 77

XXXI. Strange effects of lightning 78

XXXII. Portents and events, their undoubted and widespread connection 79

XXXIII. Thunderbolts. Threefold division of the art of dealing with them 81

CHAP. PAGE

XXXIV. Mistaken views as to the relation of lightning to other presages. The former are of equal, not superior, value . . 82

XXXV. Fate cannot be changed by expiation and entreaty . . 83

XXXVI. "God is not a man" that he should change fate. What is the use, then, of rites? 84

XXXVII. Answer—Fate fixes some things only conditionally: the alternative issues are determined by the conduct, active or passive, of the worshipper 84

XXXVIII. This action of his is likewise a part of fate. The soothsayer, like the physician, is the minister of fate. Discussion of free will deferred 85

XXXIX. Three classes or kinds of thunderbolts, as judged by their indications, according to Caecina 86

XL. These are kinds of prognostications rather than of bolts. The different species of the latter are distinguished by their effects—boring, splitting, burning. Fine distinctions of Latin terms . 87

XLI. A kind that stains or discolours. The Etruscan view of the three kinds of bolt according to *their* division 88

XLII. The Etruscans knew what they were about in attributing certain motives and actions to Jupiter. Their theory was for the benefit of the ignorant mass of humanity 89

XLIII. "Which things are an allegory." An example is set to earthly rulers to be merciful and consider well their judgments . 90

XLIV. Jove does not change his missiles; but there are gradations in the offence to be punished. That is the lesson . . . 91

XLV. By Jove the Etruscans meant, as we do, all that is greatest and best—Fate, Providence, Nature, the Universe 91

XLVI. He is the source of the thunder's power, though he does not superintend each stroke. Why he spares the guilty is another affair, which will be discussed in another place 92

XLVII. An erroneous classification of thunderbolts according to time 92

XLVIII. It must be wrong, because the time is always limited. A better basis of treatment is that of Attalus. Place, time, person, etc., must all be looked into 93

XLIX. Caecina's division, his names and their meanings . . . 94

L. That of Attalus is much better, being based on the true signification 95

LI. The signification of some does not affect, of some does not reach, us 95

LII. The force of lightning as seen in different materials, and at different times in the same material (cf. xxxi.) 96

LIII. Poisonous effects: may be followed up afterwards. Panegyric on philosophy 97

LIV. Returns to Posidonius' (Aristotle's) opinion as to the cause of thunder, an explosion of air 98

LV. The collision of clouds may produce it. Air is the cause in this instance also. Shooting stars are associated with thunder, but this is the exception, not the rule 98

CHAP. PAGE

LVI. Heraclitus and Caecina think sheet lightning an intermittent incipient fire. Change in the pronunciation of the Latin word . 100

LVII. Lightning is probably due to the air turning into fire through rarefaction of the clouds. It is naturally most frequent in summer. Sheet and forked lightning differ in degree, not in kind 100

LVIII. Reasons for rapidity of lightning and its obliquity . . 101

LIX. Every story should have a moral. Death cannot be prevented; why fear it? It is cowardly and silly. Death by lightning is rather an honour than otherwise. Besides, fear is futile . . 102

BOOK III

ON FORMS OF WATER

PREFACE

HAVING begun a mighty task in my old age I must make up for lost time by hurrying on. The magnitude of it is actually an incentive to effort. Such studies are far superior to the historian's task of recording the deeds of the robbers and butchers of mankind. The former raise us above the vicissitudes of fortune. "The principal thing" is to have a pure heart and clean hands, to escape slavery to self. The study of the universe exalts us to this . . . 109

I. The cause of rivers and their varieties. Waters vary in amount at different seasons, in temperature, in medicinal qualities . . 114

II. Varieties of taste, weight, colour, utility to health, consistency . 115

III. Gravitation or the force of air determines the flow of water. Surface and spring water: they may be combined as in Lake Fucinus . 115

IV. Why is the sea not filled nor the earth drained dry by rivers? . 116

V. Some hold that what flows into the sea returns by secret passages cleansed of its salinity 116

VI. Some think rain supplies the rivers, and in proof cite the interior of Africa as contrasted with Gaul and Germany . . . 117

VII. Objections to this argument. Rain does not penetrate more than 10 feet. If the earth is dry, it absorbs the rain; if it is saturated, the rain runs off. Again, rivers rise in rocks and mountains, where what rain ever fell must have run off. Rich wells of "living" water are found in the driest ground at depth. Fountains well out at mountain tops 117

VIII. The interior of the earth is, according to some, a huge receptacle of fresh water 118

IX. Others think the air which is contained within the earth being prevented from circulating turns into water 119

X. But indeed the four elements are all interchangeable . . . 120

XI. Though the supply of water is perennial, rivers and springs are intermittent 121

XII. The abundance of water is no difficulty, since it is a fourth part of the universe 123

CHAP. PAGE
XIII. The relation of water to the other elements. Thales' silly notion that the earth sails in water like a ship at sea . . . 124
XIV. The Egyptians divide each of the elements into male and female 125
XV. The veins of the earth resemble those of the human body. There are likewise the analogies of marrow, mucus, etc., of injuries and of bleeding, of parturition, perspiration, etc. 125
XVI. Intermittent fountains are an illustration of seasonal activity. The great vacant spaces of the earth and their tenants. Underground fish 128
XVII. The incredible wonders of nature are paralleled and even outdone by the excesses of luxury 129
XVIII. The extravagances of luxury, which make a wise man mad . 130
XIX. To return—a sudden eruption of water casts up fish, generally poisonous. This points to the unfailing supply of subterranean water 132
XX. Various tastes of water due to four causes; qualities of water—petrifying, soporific, intoxicating, fatal 133
XXI. The same pestilential influence as taints rivers is perceived in caves: the noxious rivers flow from or through them . . 134
XXII. The Ocean and seas are coeval with the universe. So probably are abnormal rivers like the Danube and the Nile . . . 135
XXIII. Rain and surface water must be added to subterranean . . 135
XXIV. The causes of hot springs 136
XXV. Poisonous rivers. Colouring power of others. Great specific gravity of certain waters, its effects and cause 137
XXVI. Intermittent rivers and springs. Means possessed by river, fount, and sea of purifying themselves 141
XXVII. Digression on the universal deluge which will destroy the world. Nature is niggardly in creation, lavish in destruction. Ovid is unequal in his treatment of this catastrophe . . . 143
XXVIII. Further imaginative pictures of what water can do by way of destruction. Alternative methods of destroying the earth—water and fire 148
XXIX. Further possibilities of the same character. Distinctions of seas, gulfs, etc., will all be obliterated; nature and the works of man will alike be overthrown 150
XXX. Nature shows by the chafing of the sea that she designs to inundate the world. A deluge is part of the fore-ordained plan. But there will be a new earth and a new race of men who will not sin—for a time 154

BOOK IV

CONTAINING A DISCUSSION OF SNOW, HAIL, AND RAIN. [THE NILE]

PREFACE

THE dangers of flattery and its insidiousness. If you must have praise, praise yourself. Lucilius has good cause: he must not,

CHAP. PAGE

however, think too much of himself because he is governor of that historic province Sicily, which has ere now decided the fate of generals and of empires 159

I. Leaving Sicily and its marvels let us deal with the omitted part of the last book, the Nile. There is no real analogy between it and the Danube 166

II. The course of the Nile; its cataracts. The inundation of the river. Its meaning to Egypt. Its denizens; crocodiles and dolphins in conflict. Causes of the overflow: melting of snow; Etesian Winds; drying up of the springs through internal heat of the earth in winter; the attraction of the sun in Africa draws water from the sea to fill up the gap caused by evaporation [none of the accounts apparently accepted] 167

III. Origin of hail; why it differs from snow 177

IV. Causes of snow in winter, hail in spring 179

V. It is said that the cooler air of the North (Scythia, etc.) is stirred by the melting of the snow in spring and floats South, causing hail instead of rain 180

VI. Hail, it is again alleged, is averted by sacrifice. If there is not a victim handy you have merely to prick your finger! 181

VII. This belief in the power of blood was an ancient superstition . 182

VIII. Three causes why the air near the earth is warmest, and therefore produces snow rather than hail 182

IX. Democritus' view—dense bodies are heated most quickly, and retain their heat longest 183

X. The air nearest the earth is denser than elsewhere . . . 184

XI. The tops of mountains, it is urged, should be warmer because nearer the sun. The difference is wholly inappreciable if we adopt the scale of the universe, the true one 184

XII. The comparatively mild air near the earth causes snow, but not hail 186

XIII. The despicable luxury of the effeminate Romans, who bought snow, bathed in it, and must resort even to ice to cool the unnatural feverish thirst born of their indulgence 186

BOOK V

TREATING OF WINDS AND MOVEMENT OF THE ATMOSPHERE

I. DEFINITION of *wind*—air flowing in one direction. The air, like the sea, is always moving, even when it is thought to be still; hence the necessity of the additional qualification—in one direction 193

II. Democritus says wind arises from a multitude of atoms in a small space striving to get free, just like a crowd jostling each other . 194

CHAP. PAGE

III. But wind does not thus depend on density; cloudy or misty weather does not necessarily produce wind, while wind is produced when the morning sun dissipates the air. Democritus is, therefore, wrong 195

IV. Wind arises in two ways—from the interior of the earth by emission—like wind on the stomach !—and from evaporation . . 196

V. The air has inherent power of movement, which is the chief cause of wind, evaporation being a less powerful one. Water has the power of moving and of imparting life to animals and plants . 197

VI. Fire even, the destroyer, sometimes generates life. Air in like manner has a peculiar power of its own 197

VII. *Breezes before dawn* arise from rivers, etc. Do not last long . 198

VIII. The "*gulf*" *wind* (ἐγκολπίας): its origin and duration . . 198

IX. Connection of winds with seasons of the year and with the heat and light of the sun. The sun does not directly cause the winds 200

X. Some cite the Etesian Winds as proof that he does. They blow in summer when the snows melt and the moisture is carried South . 201

XI. But as to the effect of the sun, there is no analogy between the Etesian Winds, which do not spring up till late in the day, and the winds which rise at dawn and fall as the day advances . . 202

XII. *Cloud squalls* (ἐκνεφίας). Their formation and combinations . 203

XIII. The breaking up of clouds produces wind. Air, in an effort to get free, or heat, may produce this. Interruption of free passage may produce a whirlwind, just as an obstacle in a river a whirlpool. *Violent whirlwinds* take fire (πρηστήρ). Some winds produce different ones. An analogy holds between air and drops of moisture. A union of forces in air or in dew is necessary to give impulse and produce a current. Air and wind are merely a matter of degree 204

XIV. Mode in which the subterranean winds are generated and make their escape 205

XV. Ancient miners of Philip's saw rivers and vast underground reservoirs. It is some consolation to read such a story, which shows greed is no new vice: the older generations were as reckless as we are in their quest for treasure better hid . . . 207

XVI. The four *cardinal winds*. The full list includes twelve. Their names and directions 208

XVII. The great circles of the earth which give twelve divisions, and therefore prescribe the possible number of the winds . . . 210

XVIII. The uses of wind and the illustration afforded of the wisdom of Providence. The crops are dependent on it. So is commerce. But we make the sea a highway to war and not to peace. We go to seek for death, as if it were not always near. Xerxes, Alexander, Crassus are warnings of the mischievous use of power to cross the sea. Better, perhaps, the winds had never been given at all. But the value of a natural gift must not be estimated by the depraved use of it. Every gift, even sight and speech, man has perverted in the same way 212

BOOK VI

TREATING OF EARTHQUAKES

CHAP. PAGE

I. EARTHQUAKE at Pompeii and the alarm it caused, many giving up Campania as a residence altogether. If the solid earth fail, what can be done? Refuge from tempest and fire and thunderstorm and war is possible, but not from earthquake. But (1) the whole earth is subject to such movement: we cannot escape by changing our ground—Tyre, Asia Minor, Achaia have all suffered. (2) Death is the same in whatever form it come, the circumstances matter not, a stone is all one with a mountain 221

II. We cannot escape death. The hopeless find refuge in despair. The knowledge of our frailty and mortality is our true solace. Death must come, a death with circumstance is rather to be preferred than otherwise. In an earthquake the earth shows itself mortal as men are 225

III. Our fears are due to ignorance. Through lack of a philosophic view of the universe we consider phenomena strange which are merely rare, *e.g.* eclipses. Fear may be removed by knowledge 228

IV. The study of such problems is the very worthiest; it reveals the secrets of nature, and is disinterested. But it is highly profitable at the same time 229

V. Various explanations of *earthquakes* have been suggested. The earlier ones are crude, but not therefore to be despised. Every subject develops as time goes on. Gratitude is due to the investigators who first dared to question nature . . . 230

VI. The cause of earthquakes is by some said to be water. Thales of Miletus explains how this takes place, but he must be wrong: the analogy of a ship sailing the ocean will not apply to the earth (cp. III. xiii.) 231

VII. Water may be the cause, but may operate in quite different ways from those supposed by Thales. Storms, etc., in subterranean seas may cause earthquakes 233

VIII. There must be such subterranean water. The Tigris and Arethusa prove it. Nero, the virtuous and the veracious, sent two officers to investigate the sources of the Nile; their account confirms the assumption 235

IX. Fire is another alleged cause. It either bursts out through opposing obstacles, as in the clouds (Anaxagoras), or burns away the foundation and causes a subsidence at the spot . . . 236

X. Pieces of the earth falling in merely through the decay of age may produce the effect without fire or any external influence. This is Anaximenes' opinion 237

XI. Fire is supposed by some to cause earthquakes by expanding the vapour which it first causes to be given off from the subterranean waters 238

XII. Archelaus sets down the cause as air pressing up the earth's internal wind which is already condensed to bursting point . 239

CHAP. PAGE

XIII. Aristotle and Theophrastus take evaporation to be the cause. Strato, much in the same way, thinks that differences of internal temperature are the cause 240

XIV. By some it is thought that air is the cause, but that its operation, along with water, is like that of blood and air in the vessels of the body. The earth, it is assumed in this case, admits air, which must find an exit. When it does so violently, the result is an earthquake 242

XV. The earth is porous, perforated at many points, and it is thus that the air enters 243

XVI. The earth is full of air, nourishing plants rooted in it, and exhaling enough to feed the sun and the other heavenly bodies. Air is the most movable of elements; therefore the earth, if it is full of air, must also have frequent movements 244

XVII. Obstruction of air, just as of water, causes greater impetuosity when it escapes. Wind is frequently associated with earthquakes, as at Chalcis 245

XVIII. Additional considerations to prove that the great cause of earthquakes is air, *i.e.* wind 247

XIX. Metrodorus of Chios compares the rumbling of an earthquake to the resonance of the voice in a tub; the underground caves impart the sound 248

XX. Various combinations of water and air supposed by Democritus and Epicurus to co-operate to the production of earthquakes . 249

XXI. Air must be the cause. Different kinds of earthquakes . . 251

XXII. First species—shaking of the earth: its causes . . . 252

XXIII. Next comes the form of concussion caused by air. The great Callisthenes, who braved the fury of Alexander and lost his life for it, supports this view. Submarine effects of it are particularly noticeable 253

XXIV. Different explanations may be given of the exact method in which air acts 255

XXV. The striving of the air in subterranean caverns produces a concussion or collapse in the earth above. The area of disturbance is limited, never over 200 miles, as numerous instances prove. The Peneüs and Ladon were thus produced 256

XXVI. The nature of the soil composed of muddy accretions without interstices is said to account for the exemption of Egypt from earthquakes. So Delos in the sea has porous rocks which emit the air easily. But the facts are wrong. There is abundant proof that proximity to the sea is no safeguard against shock . 258

XXVII. A peculiarity of the Campanian earthquake, that it killed 600 sheep, is explained by the emission of pestilential vapour, by which sheep, with their heads close to the ground, naturally were most readily affected 259

XXVIII. Noxious vapours are not, however, peculiar to earthquakes. They are found in several parts of Italy habitually. Such, too, is the origin of new diseases 261

XXIX. Excessive fear drives people mad. Earthquakes split statues and divide kingdoms, *e.g.* Sicily from Italy, Spain from Africa . 262

CHAP. PAGE

XXX. The action of the air accounts for all the detailed phenomena, splitting of walls, houses, towers, statues; also for the prolongation of shocks for several days 263

XXXI. A further proof that air is the agent is to be found in the gradually diminishing violence of the successive shocks. Phenomena in the pavement witnessed by a philosopher who was in his bath 264

XXXII. The moral. Life hangs on a thread; why should one dread the loss of it? The greatness of the cause of death is no source of terror. The hereafter is better and safer than earth. There there is no fear of earthquake or thunderstorm, fire or flood. Fear of death magnifies all human risks. Do not dread death, long for it, and, if necessary, meet it half way 265

BOOK VII

TREATING OF COMETS

I. PHENOMENA, however wonderful, are not noted and admired unless they are uncommon. The sun and moon and starry heavens have no observers, but a Comet at once sets the whole world agog. The nature of the stars is a sublime and likewise a profitable study 271

II. The nature of *Comets* has not been hitherto fully investigated. They are so rare that one wants a record of the movements of all ever observed 273

III. Democritus, Eudoxus, Conon, Epigenes, and Apollonius of Myndus all fail to give any satisfactory account of the matter. Nor had the Egyptians or Chaldaeans investigated them . . 274

IV. Epigenes explains the Comet as due to a conjunction of Saturn with Mars or the Sun: it is akin to whirlwind and "beam" meteors 275

V. But there are essential differences between whirlwind, which is terrestrial, and beams and torches, which are above the clouds. There is a difference of duration also. Beams and Comets, it is true, have been mistaken for one another. It was a Comet, according to Aristotle, that appeared before the destruction of Buris and Helice. The character of the flame differs in the two forms 276

VI. There are two kinds of Comets, according to Epigenes. They are produced by air driven up and setting on fire suitable material above, which takes place every day at the same hour . . 277

VII. But Comets are not concomitants of winds; there is no parallelism in the phenomena. The higher ones, which have an orbit, he attributes to the north wind, but the facts do not square here either 278

VIII. The course and altitude of Comets render the whirlwind explanation impossible 279

IX. The force and duration of whirlwinds are similarly inadequate . 280

CHAP. PAGE

X. The slowness and steadiness of the Comet could not be accounted for on this assumption, nor its general behaviour and shape 281

XI. We must look for some other explanation. Now Comets, it must be premised, appear in all quarters of the sky. Whatever the divisions of them made by the Greeks, they are all of one origin. Some of the ancients thought they were due to the union of two planets 283

XII. Again the facts do not square. Comets and planets appear simultaneously. A conjunction is momentary, a Comet lasts six months sometimes. The planets do not pass much beyond the ecliptic, but Comets appear in every quarter of the sky. And there are other objections 284

XIII. Artemidorus thinks the firmament is solid and has openings for stars. Comets are casual planets, or formed by conjunctions of them. His account is a tissue of barefaced falsehoods . . 286

XIV. How would a solid firmament be supported? No feasible explanation can be offered. Besides, the number of stars is so great—and they may all be "wanderers" if an indefinite number is—that there must be innumerable conjunctions of them, *i.e.* Comets. But, as a matter of fact, Comets are rare . . 287

XV. Again the huge Comets of the times of Demetrius and Attalus would require scores of planetary conjunctions to form them . 288

XVI. Ephorus, a mere chronicler, who takes this view, has nothing to support him. He tries, like others of his set, to embellish his work by narrating marvels. Why did he not tell us what the two stars were into which the Comet resolved itself, as he alleges it did? 289

XVII. Apollonius of Myndus holds the Comet to be a true star (planet) with an erratic course, visible only when it approaches the lower part of its orbit. Different colours of Comets . . 290

XVIII. But Comets do not wax and wane as they approach and recede like planets. Nor do their orbits lie within the ecliptic. Besides, we can see through a Comet but not through a true star (planet) 291

XIX. Zeno the Stoic thinks the light of converging stars gives the appearance of a longer star. Others hold modified forms of the same opinion or analogous views 291

XX. Most of the Stoics hold Comets to be evanescent, and attribute them to friction of the air. Various phenomena are analogous . 292

XXI. Their methods of accounting for varieties of orbits in Comets . 293

XXII. I do not agree with any School. Reasons 295

XXIII. Further arguments showing difference between fires and Comets 295

XXIV. There may be many stars in the universe whose paths have not been traced: Comets are such. No satisfactory explanation has been given of the mind, but its existence is not doubted . 297

XXV. Comets are not yet fully understood. Many things are in the same category. A future age will be amazed at our ignorance of such matters 298

CHAP. PAGE

XXVI. Reasons of apparent movements of Comets. The transparence and shape accounted for 299

XXVII. Parallels to the differences between Comets and other planets 300

XXVIII. Comets give prognostications, but not of immediate events or weather 302

XXIX. Denial of heaviness and slowness of Comets . . . 303

XXX. Humility is as becoming in investigators of the nature of the heavens as in worshippers. God has revealed but a little of Himself to man 304

XXXI. One cannot be surprised that everything has not yet been discovered. We must leave something to succeeding generations. We are not yet fully proficient in vice, though we have striven so long and hard. We still retain, strange to say, some traces of manhood 305

XXXII. We are all given up to low pleasures and vices, and devote our strength to them. Philosophy is kept for wet days. The old teachers have no successors. In fact, we are letting go what they discovered. We at best play with truth, which, as of old, lies at the bottom of the well, and needs the best efforts of young and old, late and early, to bring it to light . . . 307

NOTES BY SIR A. GEIKIE 309

TRANSLATOR'S NOTES ON "AIR," QUOTATIONS, AND GERCKE'S READINGS 344

INDEX 351

INTRODUCTION

SENECA

I. Life

Lucius Annaeus Seneca was the second son of Annaeus Seneca (generally, but apparently without authority, called Marcus Annaeus Seneca) of Corduba (Cordova) in Spain: his mother was a Spanish lady named Helvia. The elder Seneca was himself a man of note. He is known as Seneca the Orator or Rhetorician, in contradistinction to his more famous son, the Philosopher. His works that have come down to us suggest by their titles, *Controversiae* and *Suasoriae*, the rhetorical character of the contents.

Seneca had an elder brother, M. Annaeus Novatus, and a younger one, L. Annaeus Mela (or Mella), father of Lucan the poet (M. Annaeus Lucanus).[1] The family was thus a distinguished one. The poet Martial, himself a Spaniard, speaks of "the house of learned Seneca thrice to be numbered" (iv. 40. 2): the allusion might with equal appropriateness apply either to the three brothers or to the three generations: Seneca the Elder, Seneca, Lucan—father, son, grandson.

The eldest brother of the Senecan family, Novatus, was adopted by a friend of the family, Junius Gallio, by whose name he is known to history. Seneca on more than one occasion makes reference to him in the *Q.N.*, and always in the most laudatory terms. In iv. Pref. 9 *et sqq.*, he pays a high tribute to his character, and a

[1] Lucan, owing to the jealousy of Nero, was induced to join Piso's conspiracy in 65 and suffered the penalty. His heroic poem, the *Pharsalia*, though in many respects crude, is a wonderful production for a man of twenty-six.

further proof of his admiration and affection is afforded by his addressing to him his treatise on *A Happy Life*. Gallio is of interest in another connection. He was proconsul of Achaia during the period of the Apostle Paul's activity there (Acts xviii.), and his conduct on the occasion of a sectarian uproar at Corinth has attached to his name a certain stigma which, perhaps, he does not altogether deserve.

Seneca was born about the beginning of the Christian era, probably in the year 3. By this time the language and the arts of Rome had spread widely over the conquered provinces, in many of which independent centres of culture and literary activity had sprung up. While Rome as the capital and heart of things continued to draw to herself all that was best, or, at any rate, all that was most enterprising and ambitious, her literary and even her political life was largely recruited and maintained by supplies from external sources, such as Spain, Gaul, and Africa.[1]

Seneca was brought by his father to Rome at an early age,[2] and there he was educated and spent practically his whole life. His lot was cast in perilous times, those of Caligula the madman (37-41), Claudius the imbecile (41-54), Nero the monster (54-68). Seneca's early studies were devoted to rhetoric. With such assiduity did he prosecute them, and with such brilliant success were his efforts at the bar crowned, that he speedily awakened the jealousy of Caligula. The hint of danger was taken. By his father's advice he abandoned law in the meantime and devoted himself with equal ardour and enthusiasm to philosophy. Among his philosophic tutors were Attalus, a Stoic, and Sotion, a pupil of the Sextii, the decline of whose school is lamented in the *Q.N.* (307). He first embraced the Stoic doctrine, but finding the tenets

[1] From Spain, besides the Senecas, Lucan and Martial, already mentioned, came Columella, Pomponius Mela, Quintilian, etc. ; from Gaul came many rhetoricians ; Africa sent so many of the same class that by Juvenal's time (*circ.* 100) it could with propriety be designated "nursery of lawyers" (see Teuffel, *Hist. of Rom. Lit.* vol. ii. 6).

[2] His maternal aunt acted as nurse on the occasion : see *Consol. ad Helviam*, xvii.

and practices of this sect not sufficiently severe, he adopted those of the Pythagoreans. His father, a man with a good deal of worldly wisdom, saw the dangers of extreme eccentricities of this kind, which implied a covert condemnation of the whole world. He exhorted his son to live more like other people; he might otherwise be mistaken for a Jew (*i.e.* a Christian)! The young barrister's difficulties were, however, ended for a time by the death of Caligula (41). Seneca, who was now thirty-eight, resumed his practice at the bar, and opened a school for youths of noble birth, which was largely attended. About this time also he obtained the quaestorship, the duties of which introduced a young man into public service and enabled him to obtain some insight into the financial methods of the Empire.

His re-entry on public life was, however, destined to be the prelude to another disaster. Indeed, all through his subsequent life his interests were so involved with the affairs of the rulers of the State that he must always stand on slippery ground. The fact is, Seneca's abilities were too great for his position. He was a man of the most brilliant parts, "one of those ardent natures the virgin soil of whose talent shows a luxurious richness unknown to the harassed brains of an old civilisation" (Cruttwell, *Hist. of Rom. Liter.* p. 378). In an age of absolute and suspicious tyranny all eminence is obnoxious to the ruling powers. It is a standing reproach to them, hence a source of fear and alarm, a menace as they imagine, and an incentive to disloyalty. During the very first year of Claudius' reign Seneca was banished to Corsica, where the next eight years find him. It was the outcome of a Court intrigue. Messalina, wife of the Emperor, was apparently jealous of the influence of Claudius' nieces, Julia and Agrippina, whom he had just recalled from banishment. Julia was again banished, and Seneca, on the ground of an alleged improper intimacy with her, was made to share her disgrace. His banishment was really a blessing in disguise. He employed assiduously the period of enforced leisure, devoting himself again to philosophy,

and returning to his first love, Stoicism. Here he perfected his study, and probably elaborated most of those doctrines with which his writings abound. In Cruttwell's words, he "struck out the mild and catholic form" of the Stoic philosophy "which has made his teaching, with all its imperfections, the purest and noblest of antiquity" (*op. cit.* 379). To this period, too, belong some of what may be called his earlier works, already showing remarkable power.

His exile had been compassed by the notorious Messalina, the third wife of Claudius. On her fall Claudius married, as his fourth wife, his niece, the still more notorious Agrippina,[1] daughter of Germanicus Caesar and sister of Caligula and of Julia. One of Agrippina's first acts was to have Seneca recalled and appointed tutor to the young Nero, her son by a former marriage and now heir-apparent to the throne. This was in 48, when Nero was but eleven years of age, and henceforth to the end of his life Seneca's fortunes are closely associated with those of Nero, "a name to all succeeding ages curst." To be tutor to a prince means much if the pupil is docile. If he prove headstrong and at the same time vicious, as Nero speedily did, the choice of the tutor is an unenviable one, either to follow his pupil and palliate his conduct, or else to resist at the risk of position and influence and, it may be eventually, of life. With Seneca at first all went well. The prince was amenable, the tuition seemed to bear good fruit. The teacher was faithful to his charge, and loyal to the prince's mother, Agrippina, to whom he owed his office and influence. Mother and son were still in accord. To the philosopher there was no conflict of duty, no necessity for the choice of one of two evils.

In 54 the vacillating Claudius was poisoned by Agrippina, and Nero succeeded to the throne. For a time the government was virtually in the hands of Seneca and of Burrus, also an excellent man, commander of the

[1] This lady must not be confounded with her mother, who bore the same name.

praetorian guards. In these earlier years the young Emperor gained a reputation for justice and moderation which has thrown a halo round that golden quinquennium. His tutor must in fairness receive a portion of the credit. He seems to have been throughout imbued with an honest desire to promote virtue and good government and to check such vicious propensities as a youth with Nero's antecedents was not unlikely to develop ; but whether the means adopted were always unimpeachable seems more open to question. Seneca's own interests were apparently not neglected. In 50 he had been made praetor ; shortly after he was raised to the consulship. Within the short space of four years from his appointment as Nero's master he had attained a position of commanding influence in the State, and had amassed a colossal fortune (nearly £3,000,000 it is said). The latter he attributed to the unsolicited generosity of his master, but his enemies and detractors had quite a different version of the matter.

For more than a decade after Nero's succession Seneca's life is part of the history of the Roman Empire. The philosopher had become, as it appeared, *de facto* king and a new era seemed to have arisen on mankind. Philosophers, it is true, have neither in ancient nor in modern times shone in the sphere of action. The troubled sea of practical politics is strewn with the wrecks of philosophic reputations. Still, even before the age of the Antonines, Seneca, if any man, might have been the exception to prove the rule. He was a man of versatile genius, he had had a practical training, he was a man of affairs. The facts show that he had a true conception of the necessities as well as of the duties of government. But he was placed in an impossible situation. Agrippina wished to rule her son, and her chosen means was through his tutor. Nero, on the other hand, once he had tasted the sweets of power, determined not to be ruled by his mother, but to make her instrument his tool. The condition of unstable equilibrium could not long continue.

The conflict came to a head through a disgraceful intrigue of Nero's about the year 59. Seneca had to

make his choice, and never was choice more difficult. To Agrippina he owed everything—life, position, fortune, his past belonged to her. But he saw that Nero was to be the winner in the struggle; his safety, his hopes, his future lay with the ruling power. He may have felt that expostulation was vain and resistance fruitless. He does not appear to have attempted either. He decided to cast in his lot with the Emperor. When Nero finally decided to get rid of his mother, Seneca not only adhered to the plan but consented to vilify her memory by composing the letter to the Senate, in which the matricide sought to justify his act. It was the great treason of his life. In a critical situation he had chosen a wrong course, and it cannot have been without a pang, a sense of moral cowardice and tergiversation. He had sacrificed self-respect, he had lost philosophic caste.

After the murder of his mother, Nero abandoned himself to the wildest excesses and extravagances. The philosopher had perforce to follow in his wake, and humiliating enough he must have felt the part he was obliged to play. Still, he and Burrus continued to act as a sort of drag, conspiring with what of conscience was left to Nero in checking his headlong course. The beginning of the end, so far as Seneca was concerned, came with the death in 63 of Burrus, his constant friend and ally. Various indications now showed that the tyrant was anxious to be freed from the last remaining restraint. The philosopher felt his position was insecure. The man who had murdered his mother, not to mention his (step-)brother and his wife—two of his other victims—was not likely to have great compunction in ridding himself of his tutor. Seneca sought to anticipate the storm by abandoning politics, retiring from Court, and surrendering his estates. Nero refused the offer, and expressed profusely his continued regard for his tutor; shortly afterwards he displayed the sincerity of his professions by an insidious attempt to poison him! The philosopher then renounced all his state, adopted a voluntary poverty, and by putting into practice his

professed tenets of the simple life endeavoured to avoid a repetition of the risk at least of poison. His diet was herbs, his drink, water from the fountain. But it was only a matter of time now. The occasion for which the Emperor was on the watch came in 65. In that year Piso's conspiracy was formed against the Emperor's life, and Seneca was accused, falsely so far as we can judge, of complicity. He was ordered to prepare for death, which, according to the custom of the day, allowed the victim the choice of means, and was usually a voluntary opening of the veins in order to bleed to death. Tacitus has with characteristic power and pathos depicted the scene (*Annals*, xv. 61-4). No act of his life, it would seem, became Seneca better than the leaving of it. His death was worthy of a philosopher and a Stoic. With the utmost calmness, amid a throng of mourning, sympathising friends, he faced his fate, and yet with the studied pose of a man who had conned the part. The age was one of posturing. Men were always under the eye of the informer and the spy, and learnt to act their part accordingly. The " meditation of death " must often have occupied the philosopher's latter days. He was a second Socrates consigned to an unjust end ; the last scene was enacted with all the dignity, composure, and even cheerfulness of his great prototype. The cock due to Aesculapius has a parallel more worthy of the occasion in the libation to Jupiter the Liberator. The supreme act atoned for many weaknesses and failures.

Though Seneca was not without many detractors,[1] his worth as a man is attested by many proofs. His young wife Paulina desired to share his fate, and opened her veins along with her husband. By Nero's orders she was saved, but she continued to the end of her life to bear in her unnatural pallor the marks of her devotion. Tacitus, writing at a distance of thirty or forty years, describes the character of Seneca in terms of commendation and esteem. No doubt the historian had himself borne

[1] Dio Cassius is often very caustic in his criticisms, but even he recognises Seneca's sterling merit and services to the state.

the yoke of the savage Domitian, and knew what life under a tyrant meant. But withal he was too acute an observer and too impartial a critic to be blinded by any mere sentimental sympathy. He understood and appreciated Seneca, to whose genuine worth his testimony is the most enduring tribute.

The age of Seneca, whose "life almost coincides with the Julio-Claudian tyranny," has been made to re-live for us in Professor Dill's *Roman Society from Nero to Marcus Aurelius*, which ought to be studied by those who desire to understand more of Seneca as statesman, philosopher, and man.[1] In addition to a short account and criticism of the *Quaestiones Naturales* (pp. 300 *et sqq.*), the chapter (Book III. ch. i. pp. 289-333) on "The Philosophic Director" is particularly illuminating. The following tribute from it may fittingly close our brief sketch :—

"The man who approaches Seneca thinking only of scandals gleaned from Tacitus and Dio Cassius, and frozen by a criticism which cannot feel the power of genius, spiritual imagination, and a profound moral experience, behind a rhetoric sometimes forced and extravagant, had better leave him alone. The Christianity of the twentieth century might well hail with delight the advent of such a preacher, and would certainly forget all the accusations of prurient gossip in the accession of an immense and fascinating spiritual force. The man with any historical imagination must be struck with amazement that such spiritual detachment, such lofty moral ideals, so pure an enthusiasm for the salvation of souls, should emerge from a palace reeking with all the crimes of the haunted races of Greek legend" (*op. cit.* p. 295).

II. Writings

Seneca was a voluminous writer. Most of his works partake more or less of a philosophical character. In a class by themselves may be placed the ten tragedies,

[1] Mr. Henderson's *The Life and Principate of the Emperor Nero* should also be studied.

together with some verses, attributed to him. The titles, *Medea*, *Hercules Furens*, *Hippolytus*, *Agamemnon*, etc., suggest the Greek subjects as well as the plays of the same names by Euripides and Aeschylus. The treatment of the themes is all Seneca's own. Moral maxims abound ; the plays are homiletic and were never designed to be acted.

One of the plays is of special interest as dealing with current topics. This is the *Octavia*, whose chief character is Nero's wife of that name, exiled by him in order to make room for the licentious Poppaea Sabina. Seneca himself is introduced as one of the characters, deploring the vices of the age and the unhappiness of those set in high position. If the play is genuine, which has been doubted on the ground of references in it that seem to apply to Nero's death, it goes to prove that Seneca used very plain language toward his master and pupil. In any case, it shows what the relation of Seneca to Nero was generally supposed to be. Tacitus (xv. 61) represents Seneca as telling Nero by messenger that the latter has had more frequent experience of his independence than of his servility, and the *Octavia* is fair comment upon his statement.

Here is a specimen of the dialogue :—

Nero. Fortune has put everything in my power.
Seneca. Distrust her favours : she is a fickle goddess.
N. To fail to see all that one may do, betrays the coward.
S. The credit lies in doing not what one may, but what one ought.
N. The crowd tramples on a feeble prince.
S. They will crush a hated one :

and so forth. Seneca's last remark may be a prophecy—some would say after the event. The play contains other allusions which suggest some of the actual details of Nero's end.

The prose works include :

(*a*) Philosophical Essays such as *Anger*, *Clemency*, *Benefits*, *Calmness of Mind*, *A Happy Life*, *The Shortness of Life*, *Providence*, or *Why Providence allows troubles to*

afflict the Just, The Constancy of the Sage, The Leisure of the Sage.

(*b*) Letters, or rather Treatises, of Condolence, the so-called *Consolations*, addressed respectively *to his Mother Helvia ; to Marcia*, the daughter of Cordus, on the death of her son ; *to Polybius*, the powerful freedman of Claudius, on the loss of his brother.

(*c*) *Letters to Lucilius*, a hundred and twenty-four in number.

(*d*) *Apocolocyntosis*—a lampoon on the deceased Emperor Claudius. On such occasions deification (apotheosis) was accorded to the late ruler, and he was received into the number of the gods. This skit describes the reception of Claudius in heaven and his expulsion thence to the lower regions, with his trial and sentence there. *Pumpkinification* is the nearest English translation of the title.[1]

(*e*) *Quaestiones Naturales.*

(*f*) Works no longer extant, the only one of them that concerns us being that on *Earthquakes*, referred to as a work of his youth in *Q.N.* 230.

(*g*) A spurious work, as is now on all hands conceded, is the correspondence between Seneca and St. Paul. In his opposition to popular beliefs and superstitions, and in the purity of his moral tenets, Seneca approached some of the Christian doctrines, and it was no improbable supposition that at the Court of Nero he might have became acquainted with the Apostle of the Gentiles.[2] But the assumption of a correspondence of this kind is another affair. Its genuineness was believed from the time of Jerome (400) till the sixteenth century.

Seneca is generally considered to appear at his best in the *Consolation to his Mother Helvia* and in the *Epistles to Lucilius*, which are therefore usually ranked as amongst his finest works. The latter work, which from the outset

[1] One would have expected that Claudius' fate would be to be enrolled among—the Pumpkins. But the piece as we have it contains no allusion to this.

[2] See Mr. Henderson's *Life and Principate of Nero*, 286-7, and Mr. Glover's *The Conflict of Religions in the Early Roman Empire*, 149.

was designed for publication, is not an ordinary correspondence on the current affairs and interests of everyday life like Cicero's Letters, but is philosophic in character; it covers a wide range of moral discussion and reflection, and is full of admirable maxims. Many of its sentiments have become commonplaces; their almost hackneyed character detracts perhaps somewhat from our appreciation of their intrinsic merit. On the other hand, the spitefulness of the *Apocolocyntosis*, the servility of the *Consolation to Polybius*, and the flattery of the *Clemency*, which was addressed to Nero, show the reverse of Seneca's character. Of the characteristics of his style, however, and of his position in Roman literature—one of commanding importance—this is not the place to speak. His works reflect truly enough both the iron and the miry clay which entered into his mental and moral composition.

III. "Quaestiones Naturales"

This work stands in a category by itself. It raises a number of difficult problems, in which every reader of it, whether classical scholar or not, is interested.

The historical title, *Natural Questions*, is convenient, though, without explanation, a little misleading. The nearest rendering of the Latin form *Quaestiones Naturales* is Physical Inquiries, or Investigations in the Domain of Physics, or, as in the title, what we should now call Physical Science. The terms Physics and Science had a very different connotation in that age and in ours. Plutarch, almost a younger contemporary of Seneca, gravely discusses in a work with a similar title such questions as Why shepherds give their sheep salt, Why horses' hair is superior to mares' for casting-lines, and even, Why a dog runs after a stone rather than after the person who threw it! The extent of such a title is determined pretty much by the range of topics an author decides to include. In Seneca's case, as it happens,

the branches chiefly dealt with are Astronomy and Meteorology, together with certain portions of what may be designated as Physical Geography including Seismology.

Science was in that day synonymous with Philosophy, or at any rate Philosophy embraced all that could claim to be Science. Learning was homogeneous; its subdivisions had not yet been separated or differentiated.

The treatise was addressed in a quasi-epistolary form to Lucilius Junior, procurator[1] of Sicily. Most of our knowledge of him is derived from Seneca, who, besides the *Q.N.*, addressed to him his *Epistles* and his tract on *Providence.* Lucilius seems to have been a *protégé* of Seneca, and rising from the ranks under his fostering care and guidance, not only to have attained a position of influence, but also to have achieved literary distinction. His philosophical predilections were toward Epicureanism, but he was a man of high principle and character, though not exempt from dangerous temptations at various points in his career. His public labours had associated him with Sicily, and the themes of his writings, chiefly poems as it would appear, had been drawn from the same quarter. He is, not without probability, supposed to have been the author of the anonymous didactic poem *Aetna*, for long attributed to Virgil, a work which presents many interesting parallelisms to the *Q.N.* both in its science and its philosophy. Seneca's Epistle lxxix. contains a special charge to Lucilius, who was at the time making a circuit of his province, to report the facts concerning Charybdis—Seneca knew all there was to know about Scylla—and to investigate in detail the present condition of Aetna. The letter goes on to banter Lucilius upon the inclusion of Aetna in the poem on which he was engaged—no doubt the work referred to in *Q.N.* 114, 142; cf. 167. The whole question is discussed with full knowledge by Professor Robinson Ellis in the Introduction (xxxvi-xlviii) to his

[1] The procurator was in this case practically governor. In some instances he was the representative of a chief governor (*praeses*) to whom he was subject, *e.g.* Pontius Pilate was procurator of Judaea under the Governor of Syria.

edition of the *Aetna,* to which reference should be made. For other allusions to Lucilius in Seneca see, besides the *Q.N.*, Epistles xix. xxvi. xxxiv. etc.

The *Q.N.* was composed probably about the year 63 or 64. We might content ourselves with the statement of the fact, did not the circumstances of composition throw light upon difficulties of arrangement and sequence which can scarcely be passed unnoticed. The evidence on which we have to rely is chiefly internal. The exact date of Lucilius' procuratorship in Sicily (159) is unknown, but the consulship of Regulus and Virginius, which witnessed the Campanian earthquake (221), fell in 63, that is, some two years before Seneca's death. The allusions in the Preface to Book III. (109) are still more direct and convincing. The writer was drawing near his end, pressed hard on the rear by old age, with every necessity and incentive to hurry on the completion of his task.

On the other hand, the mission despatched by Nero to the sources of the Nile (235-6) would naturally point to an earlier date during the more promising years of his reign—unless indeed, as is by no means improbable, the complimentary reference to the emperor's virtues be a piece of adulation. A similar reference recurs in connection with the comet in Nero's reign (290), the date of which must (after Tacitus) be assigned to the year 61.

The Elder Pliny, writing in 77, about a dozen years after Seneca's death, adds to each Book of his *Natural History* an exhaustive list of the authorities, native and foreign, that he had used. Book II. deals with many of the subjects of the *Q.N.*, of which it is in some places an expansion, but in most little more than an epitome.[1] And yet no mention of Seneca occurs in the list of

[1] See particularly Pliny's treatment of Comets (ii. xxii.), Winds (xliv.-l.), Lightning (liii.), Floating Islands (xcvi.). But most striking of all is the reproduction (lxiii.) of Seneca's remark (208 end of c. xv.), "If any nether gods existed, they would have been dug up long ere this in the mines sunk by our avarice and luxury." The two authors had hit upon the same thought, and Seneca had happened to use it first. Or it may have been a current witticism in an age of unbelief.

authorities attached, which seems strange if the work had then been given to the world.[1]

We read in the Sixth Book of the *Q.N.* (230) that the author had previously, when a young man, composed a work upon Earthquakes. This, taken in connection with what precedes, and with what we know of the author's character and interests, affords some ground for the conjecture that he may have worked intermittently at the subject at various periods of life. But no doubt the arrangement of the materials and the completion of the work belong to his latter years. He had by this time lost his hold upon Nero, and had practically retired from political activity. His trust in princes had been found misplaced. He was disappointed if not embittered. The discussion of public affairs was precluded. It was dangerous even to let one's thoughts rest upon them. But there were consolations for political disappointment and inactivity. Recourse might be made to the contemplation of those great works and workings of Nature which are exempt from the caprices of human passion. The study of Nature was equally fitted to humble and to console; to it Seneca betook himself for refuge.[2]

The *Q.N.* may, thus, have been composed at different dates, materials for it being gathered at various times as opportunity offered. But the final arrangement and systematisation belong to the last years of the author's life, about the years 63 or 64. The publication may not have taken place until some time subsequently, and may have been carried out by Lucilius, who was Seneca's literary executor. So much is certain, that the work as we have it is not the work as it left the author's hand.

Much time and ingenuity have been bestowed on

[1] Seneca's name does occur in the lists attached to Books VI. IX. and XXXVI.; the first is geographical, dealing with Asia and Africa, the second has for subject fishes and aquatic life in general, while the third deals with the natural history of stones.

[2] "The Stoics affected to despise physical studies, or at any rate to postpone them to morals. Seneca shared this edifying but far from scientific persuasion. But after his final withdrawal from court, as the wonders of nature forced themselves on his notice, he reconsidered his old prejudice, and entered with ardour on the contemplation of physical phenomena" (Cruttwell, *op. cit.* 381).

attempts to restore the *Q.N.* to what may be supposed to have been its original form. The most casual reading of it as it stands, shows that it is full of inequalities. If the clue could only be recovered, much of its difficulty and obscurity would disappear. As it is, it abounds in abrupt transitions, interruptions of the logical sequence, repetitions, excrescences, and even irrelevancies and inconsistencies, which it can hardly be supposed that an author would have allowed to remain in a treatise prepared for publication.

One or two considerations derived from the present arrangement will serve to throw light upon this point. In the first place, Book IV., as we have it, is evidently composite. Between Chaps. II. and III. there is a deep hiatus. In the former chapter the discussion of the Nile is cut short, and the author's own view is not even indicated, much less established ; while the latter opens so abruptly as at least to suggest that it may have originally been preceded by something with which it stood in organic sequence.

Again, the several Books do not conform to the author's division of the subject as set forth in the opening of Book II. (51), but follow—or precede—one another anyhow.

Then, three of the Books (I. III. IV.) have a formal Preface, while the others have not, though in them, too, with the exception of the Sixth, the opening chapter is introductory in character.

Any attempt to restore a more intelligible order must depend for its success on the extent to which we may assume Seneca to have been a methodiser. In Book II. i., he certainly states very distinctly the divisions of his subject—(*a*) things in the heavens, (*b*) things between heaven and earth, (*c*) things on the earth. But it by no means follows that he himself maintained this order of treatment, or that he always exhausted one subject before passing on to the next. The division evidently enumerates the subjects in order of dignity or worth, and may have little, if any, relation to the order of their discussion ; in fact, in

Book II. he goes on immediately to deal with meteorology, his second and not his first topic.

Bernhardt (*Die Anschauung des Seneca vom Universum*, p. 7) frankly accepts the traditional order of the Books, and finds its explanation in the distinction between phenomena and elements. The first three Books deal with the phenomena of heaven, air, earth, respectively; the last four respectively with the elements—water, air, earth, fire. This is ingenious, if not altogether convincing.

The most recent editor, Professor Gercke, divides Book IV. into its two constituents, IV. (*a*) = IV. Pref.-ii., IV. (*b*) = IV. iii.-xiii., and arranges the Books in ascending scale thus: Earth III. IV. (*a*); Air IV. (*b*), II. V. VI.; Heaven VII. I. There seems great probability, almost amounting to certainty, that there were originally eight Books, as he supposes. But a consistent and fairly natural order might perhaps be restored with less violence to the accepted form than his scheme involves. Books III. and IV. (*a*) seem to have been misplaced or transposed, being placed after Book II. instead of after Book VI., where they originally stood; Book IV. (*a*) had somehow got mutilated, which the more easily led to the confusion. Book IV. (*b*) also suffered somewhat in the process. Thus the original order may have been I. II. IV. (*b*), V. VI.; III. IV. (*a*); VII.; the first five Books deal with Meteorology, including Seismology (air), the next two with Physical Geography (earth), the last Book with Astronomy (heaven). A single change of the order is thus all that is required; but, of course, the regrettable gap after IV. (*a*) remains.

Even with this rearrangement the sequence leaves something to be desired. But it must be borne in mind that the author makes a claim to philosophic liberty (178), and that in no case can the rules of modern requirement be applied to him.

Of course, if the assumption of methodical arrangement be unfounded, and the author composed just as the humour took him, the existing order may be all right: it is as good as any other fortuitous collocation. Some have

supposed that the work was left unfinished at the author's death, but of this we have no proof.

The language of the Preface to Book III. has been taken by some to imply that this was the opening of the whole work. Whether this is so must remain to some extent matter of opinion. It may, however, be pointed out (*a*) that the claim of the Preface to Book I. seems at least equally strong, (*b*) that the language of § 4 of the Preface to Book III. (110), "how much is unaccomplished of my plan, though not of my life," seems inapplicable to a work that was not begun or merely beginning. There was a remnant of the work and a remnant of life, but they were disproportionate, the one large, the other small. This was a reminder to hurry on to completion a work with which, *ex hypothesi*, some progress had already been made.

When all has been said, we must, for practical purposes, accept the book as it has been handed down to us and make what we can of it. The difficulties are not exhausted even when the pristine order is restored. What is true of the work as a whole is true of it also in detail. The text is full of uncertainties and corruptions. The work was popular and was frequently copied, and this naturally gave rise to variations, which, being improved upon by succeeding generations of copyists, in course of time rendered the text in many places very obscure if not unmeaning. The nature of the subject matter, frequently little understood, no doubt facilitated and hastened the process of corruption. Hence the translator has at every turn to decide first *what*, and then *how*, he shall translate.[1]

An added difficulty is the form of address to Lucilius. The adoption of the epistolary style, whatever its other advantages, has not, it must be admitted, conduced to the lucidity of the argument. Science does not readily lend itself to exposition by dialogue, and the

[1] Gercke says (Preface, xlvi) that the traditional text of the *Q.N.* is utterly corrupt and still requires the united efforts of many earnest scholars for its restoration. He writes as recently as two years ago (1907), and has himself probably made the most considerable contribution of all the editors to the correction of the text; but he modestly calls himself only a pioneer.

trouble is aggravated when, in addition to the correspondent, an imaginary opponent is from time to time introduced and indifferently addressed in the second person, or referred to in the third. To make matters still worse, the author frequently conceals himself behind the mask of one or other of the disputants, irrespective of pronouns. Finally, he employs "we" sometimes of himself and his correspondent, sometimes of his philosophic sect, the Stoics, sometimes of his nation, the Romans, sometimes of his kind, man in general!

IV. Seneca's Method of Treatment of Subject

In order to appreciate Seneca's treatment of his subject we must understand something of his philosophical tenets. He was in the main a Stoic, but with such a strong tendency toward independence that he may be considered an Eclectic. The Stoics, whether or not they originated, at any rate recognised and adopted the threefold division of philosophy—Physics, Ethics, Logic [1]—which was originated among the Greeks and handed down by them to the Romans, who were in this department their pupils. Seneca is typical of the Stoics in regarding Ethics as of supreme importance. On Logic he did not apparently set any great store, though he must have been a diligent student of the cognate branch, Rhetoric. Physics, as we have seen, did not claim much attention from him in early life; only as he approached the mature age of threescore did his study of it become more detailed and systematic. No clear line of demarcation existed in his mind, or for the matter of that in his age, between philosophy and

[1] See Professor Davidson's *The Stoic Creed*, p. 42, where it is pointed out that each of these may be subdivided so as to bring the number up to six—Physics and Theology, Ethics and Politics, Logic and Rhetoric. See also Seneca, Epist. lxxxix., where the division is discussed. For further information on the subject, the article on the Stoics in the *Encyclopaedia Britannica* and any of the histories of philosophy, *e.g.* Erdmann or Zeller, may be consulted.

science. Yet there is considerable internal evidence in the *Q.N.* that his pursuit of such studies was in part an outcome of the true scientific spirit, and that he possessed in no ordinary degree the scientific imagination. Still, when all due allowance is made for this, it remains true that Seneca was moralist first and physicist or scientist afterwards. Physics led to theology,[1] and had thus a direct bearing on man's destiny and fate. Had there been no Ethics, whose interests were involved in a knowledge of the universe, its parts, its function, and its author, the impelling motive for the study of Physics would have been removed. Possibly when his political career was closed by the death of Burrus in 63, Seneca might in any case have devoted some of his leisure to a subject which offered such opportunities of exalted contemplation. But it was his ethical aims that added the chief zest to the pursuit.[2] As the various departments of knowledge had not assumed definite divergent forms, there was nothing incongruous to his mind in the mixture, or as he might have regarded it, the union, of what to us seem so different from one another as Physics and Ethics. The facts of nature had, in his view, to be brought into connection with the lessons that may be derived from them. In so many words he tells us (102) that every study must have a moral attached to it, or to put it otherwise, that physical phenomena must be made the occasion for driving home some general truth, establishing some ethical position, clinching an argument, reprobating a vice. The conclusion of each Book of the *Q.N.* contains the practical application of the lessons to be derived from its subject: there are not infrequent digressions, too, for the same or a cognate purpose. The author's moral zeal sometimes ran off with him, and he felt constrained to break off for the time his discussion of scientific truths and to assume the rôle of the moralist and reformer.[3]

[1] Cf. Professor Burnet's *Early Greek Philosophy* for illustration of this in earlier times.

[2] Cf. footnote 2 to p. xxxiv.

[3] The method was not obsolete for many centuries, even if it is yet wholly dead. On more than one occasion the study of Natural History has been

The reader of the *Q.N.* need not, therefore, regard as matter of surprise this curious medley of science and morality, which is of the very essence of the author's principles and purpose. Seneca performs this part of his task with evident relish. He is always ready to improve the occasion, and will even go out of his way to find it. His censure of vice, his denunciation of luxury and self-indulgence, his castigation of immorality, seem to afford him a kind of morbid satisfaction. Even a note of insincerity may sometimes be suspected. He is rather too ready to display his own acquaintance with all the refinements of the vices of "good society": perhaps it was the fault of his age to gloat over unsavoury details that a moralist would now be more anxious to conceal than to reveal.[1]

With Seneca as moralist, however, we are not here directly concerned. But what attitude are we to assume toward his Science? It need scarcely be said that of Science in the twentieth century sense, the first century of our era knew very little. Its greatest weakness was that it possessed practically no means of interrogating nature save those afforded by the human senses. The sundial was known, but the thermometer, the barometer, the telescope, and even the microscope, had still to be invented. Experiment except in the most rudimentary form was impossible. Observation was the only method available, and it lost much of its value from the necessary looseness and inaccuracy attaching to it. Seneca was fully alive to the necessity of procuring correct data. He records his own observation when digging among his vines (117); he had visited the Sabine country to see a floating island (139); he had evidently watched closely rainbow, lightning, meteors, comets, etc., etc. He laid

advocated on account of the abundance of figures of speech that may be drawn from it! Erasmus esteemed it because of the light it threw on the classics; his insensibility to the wonders of natural forces and processes provoked Luther's remark that "Erasmus looks upon external objects as cows look upon a new gate."

[1] "There are pictures of voluptuous ease and jaded satiety which may be the work of a keen sympathetic observation, but which may also be the expression of repentant memory" (Dill, *op. cit.* p. 298).

friends like Lucilius under contribution, and he insists on the necessity for keeping records of observation, especially when the phenomenon is comparatively rare, as a Comet (274). Besides, he draws not only upon the history of his country, but also upon the learning of other nations—Greeks, Babylonians, and Egyptians—records which for the most part are no longer extant. The *Q.N.* thus embodies many out-of-the-way facts which otherwise would be unknown to us. Accuracy is nearly always a relative term: approximate accuracy is the most we can look for in that age. Seneca's contribution of data is curious, interesting, and valuable.

Again, in arguing from facts, or supposed facts, Seneca is entitled to credit for his method if not always for his results. A great merit is that he endeavours to account for the phenomena observed, he habitually raises the causal issue, and he is not satisfied until he has passed in review all the considerations involved in the observation or problem. He is scrupulous in always giving the other side a hearing, and in discussing views with which he disagrees, even though only to reject them. On the negative side he is generally fairly convincing, and succeeds in showing the fallacies involved in a proposition. But on the constructive side he is many times ingeniously perverse, curiously blind to the inadequacy of the theories which he himself advances, and which he would readily have confuted in an opponent. Sometimes he adopts an error already current, as old as Aristotle or older; sometimes he advances a fresh one of his own. But even his errors are instructive, and represent a phase of progress. The line of progress is zigzag. Only after errors have been exhausted does the truth emerge and advance become possible.

The amenities of ancient science seem to have been somewhat scanty. A mistake, a false inference, an erroneous view, is met with the lie direct. The moral stigma of falsehood is, at any rate in certain instances, attached to such a deviation from fact. Nor is this all. The whole character must be bad if a man has "lied."

The authors, whom Seneca calls chroniclers, and particularly Epigenes, are in one passage quite fiercely attacked (289). In justice to Seneca it must be said that he is hardly more polite toward himself. The words on p. 154, § 2, rendered, "I can give my own word, etc.," read literally, "I'm a liar if water does not meet us, etc." Perhaps, therefore, it is only a manner of speaking. In the early days of public education in Britain a Government report recorded as a proof of moral progress the substitution in some parts of the country of "I beg your pardon" for "You're a liar!" The child seems to have here re-lived the history of the race.

Seneca had a wide outlook, too, and a splendid scientific faith. With prophetic eye he sees the day when an astronomer will arise to demonstrate the nature and orbit of Comets[1] (299); he is content to let posterity have a share of the credit! Nor is his humility less than his confidence. His lessons may still usefully be taken home; we imagine we have pierced to nature's inmost sanctum, yet we are still loitering round her outer court (306); let us not despise the day of small things, the investigation of nature's marvels requires generations of workers and ages of work; there will come a day when all will be revealed, when posterity will smile at our feeble and clumsy efforts and wonder how we missed such obvious truths (298). The ancients must be treated leniently; it was a large contribution to discovery to have conceived the hope of its possibility (231). Seneca maintained and promoted this belief in ultimate success. He displays throughout the same alert, buoyant, enthusiastic confidence, together with patient, reverent search for truth in nature and truth about God.

Seneca nowhere gives us a reasoned connected exposition of the views entertained by him regarding the Universe as a whole or the relation of its parts. Only "by parcels" and inference can we glean them from scattered remarks and comments that he makes in the course of his work.

[1] The fulfilment, or at least the beginning of the fulfilment, of this prediction may be dated from Newton in 1680.

In Physics even more than in Ethics he was an Eclectic; he criticises freely, and occasionally rejects entirely, the opinions of his own school, the Stoics, at one point going so far as to call them silly (181, cf. 295). He claims authority, too, for his own research, and asserts the right to hypothesise for himself: he is hopeful, if not certain, of discovery (304). He frequently quotes rival opinions without indicating his own. He is familiar with conflicting theories which he does not attempt, or fails in his attempt, to harmonise. And in the end one is tempted to ask whether he himself had reached any consistent comprehensive cosmical scheme. There is much that is quaint and interesting and ingenious, but it seems doubtful whether an attempt to construct from the *Q.N.* a complete cosmology would in the end repay the labour. The scheme might prove self-contradictory; it would in any case be full of error, and there would in no case be the assurance that it was all Seneca's own. This seems sufficient reason for declining the task. If one care to pursue it further, helpful information may be obtained from Bernhardt's *brochure* (*Die Anschauung, etc.*) already referred to, while a discussion of the whole subject will be found in Crouslé's Thesis, written in Latin, *De L. Annaei Senecae Nat. Quaest.*, which for fulness and fairness leaves nothing to be desired.[1] In the Commentary and Notes at the end of the volume Seneca's scientific opinions and methods are discussed by Sir Archibald Geikie.

V. Some of Seneca's Predecessors and Contemporaries

The history of ancient Science is a very tangled and abstruse subject, a portion of the history of ancient

[1] Ideler's *Meteorologia veterum Graecorum et Romanorum*, which forms the Prolegomena to his edition of Aristotle's *Meteorology*, but is printed as a separate volume, also contains much curious information on this recondite subject.

Philosophy, which lies as much outside the scope of the present work as beyond the powers of the writer. Still, Seneca cannot be altogether detached from what preceded him. In order to throw light upon his work, it may be permissible to pass in rapid review a few of the chief sources from which he drew. Our starting-point may be Aristotle.

Aristotle is with good reason named "the master of those who know" (Dante, *H.* iv.). He may be said to have summed up the knowledge of the ancient world, at least as far as Greece is concerned, on all subjects. If not the founder of Science any more than of Philosophy, he recapitulated so fully all that went before that he became the fountain-head and source from which all succeeding workers mainly drew. He systematised the existing materials, adding his own criticisms and observations, and illuminating the whole with the strong light of his unrivalled powers. He drew upon many authorities whose works are now lost, the leading names among them being familiar from the *Q.N.*—Thales, Anaximander, Pythagoras, and the rest. The extent and variety of the material may, perhaps, best be understood from a work like Professor Burnet's *Early Greek Philosophy*, to which reference should be made. A reasoned consecutive account will there be found of the individual contributions made to philosophy (including science) by the early Greek thinkers. Long before Aristotle's time numerous physical theories had been propounded, and had been supported by their authors with great acuteness of argument; hardly any question had been left unasked that related to matter, motion, or mind. "We may smile, if we please, at the strange medley of childish fancy and true scientific insight. . . . But we shall do well to remember at the same time that even now it is just such hardy anticipations of experience that make scientific progress possible, and that nearly every one of the early inquirers . . . made some permanent addition to the store of positive knowledge, besides opening up new views of the world in every direction" (*op. cit.* 29).

Seneca probably possessed fuller details of the investigations and speculations of these early workers than we now do. The existing materials are contained in Professor Diels' *Die Fragmente der Vorsokratiker*, with which his other great work, the *Doxographi Graeci*, should be compared.[1]

The chief work of Aristotle upon which Seneca drew was the *Meteorologica*. The extent to which its subject coincided with that of the *Q.N.* may be inferred from a glance at its contents. The *Meteorologica* is divided into four Books, arranged thus :—

I. Scope and relations of Meteorology. The four elementary bodies—earth, water, fire, air—and their relations. Celestial fires. Shooting stars. Comets. The Milky Way. Clouds. Fog. Dew. Hoar-frost. Rain. Snow. Hail. Wind. Formation of rivers. Change in land through action of rivers : effects on movements of races.

II. The sea and its salinity. Theory of the winds, their varieties, positions, etc. Earthquakes and their explanation. Lightning and thunder.

III. Lightning, thunder, and similar phenomena. Halo and rainbow. Mock sun and cognate appearances. Exhalation and its influence.

IV. Theory of the elements (= ingredients or first principles) ; two active—hot and cold, two passive—dry and moist. Their effect on bodies. Cohesion, Liquefaction, Solidification, Coagulation, Fusion, Solubility, and other properties. Homogeneous and non-homogeneous bodies. Effects of temperature. Place of this work in author's scheme.

Another work that goes under Aristotle's name, but is now generally considered spurious, is the *De Mundo* (*the Universe*), which in part repeats the subjects of the latter part of the *Meteorology*. Seneca may also have drawn on the *De Coelo* (*the Heavens*), whose subject covers portions of the *Q.N.* He refers more than a dozen of times to Aristotle by name, but it was not customary to

[1] These are, of course, only for the classical scholar.

refer to individual works. There are numerous instances in which Aristotle is his authority, though no specific mention of him occurs.

Theophrastus, the pupil of Aristotle, and his successor as head of the Academy, is also frequently referred to in the *Q.N.* His master bequeathed to him his library and original manuscripts, and Theophrastus was himself also a voluminous writer.

Among his extant works on Science, we have treatises or tracts dealing with Fire; Winds; Stones; Signs of Rain, Wind, Storm, and Fine Weather; not to mention Colours, Odours, etc., and an extensive work on Plants and their History. His work on Perception and Percepts is said to be a chapter of a larger work on the history of philosophy. At any rate, it records and discusses the opinions of earlier writers on the subjects to which the title refers. For his further views on Physics, and the lost treatise on the subject, see Diels, *Dox. Graec.* 119 *et sqq.*, and 473 *et sqq.*

Aratus, who flourished about 280-270 B.C., wrote two poems (in Greek) entitled respectively *Phaenomena*,[1] an introduction to the knowledge of the constellations; and *Prognostics*, a method of forecasting the weather from astronomical phenomena. Aratus scarcely ranks as a scientific writer, but Seneca refers to his opinions on one occasion in the *Q.N.* He was apparently held in high esteem by the Romans, for he found a translator (in part) in Cicero, and an imitator in Virgil (*Georgics*).

Plutarch stands in a somewhat different relation to Seneca. He was a little subsequent in date, but there is a sort of parallelism between the two, both in their scientific and their more general interests. Besides the *Physical Causes*, already referred to, Plutarch made a compilation in five Books—at least it goes under his name—of the Tenets of the Philosophers (*Placita Philosophorum*) regarding a vast number of physical, especially

[1] It is from this poem (l. 5) that Paul quotes (Acts xvii. 28), "For we are also his offspring." Aratus was a native of Soli in Cilicia, and therefore a compatriot of Paul.

astronomical and physiological, subjects. Diels (*op. cit.* 65) scouts the idea of the genuineness of the "wretched epitome," and assigns it to the middle of the second century. Whether this be so or not does not much affect its value for us. The existence of the work shows the nature of the material which was available in Seneca's age. The work is a kind of distant echo of Theophrastus' lost treatise and preserves many opinions of the older philosophers, of which, to say the least of it, we should otherwise have been less fully informed. The parallelism of the *Placita* to the *Q.N.* will appear from a few of the titles. Books II. and III. of the former reproduce a long array of opinions of Thales, Empedocles, Anaxagoras, Diogenes, Anaximenes, Democritus, Xenophanes, Xenocrates, not to mention Plato, Aristotle, the Pythagoreans, the Stoics, etc., etc., regarding such subjects as Eclipses, the Milky Way, Comets, Earthquakes, Clouds, Winds, Thunder and Lightning, etc., etc.

Plutarch also has questions regarding Aratus *Prognostics*, and a Miscellanea of discussions on allied subjects.

Of Latin writers two have special bearing on Seneca. Lucretius (95-51 B.C.), in his great poem on Nature (*De Rerum Natura*), has expounded the Epicurean view of the universe. In so far as science is capable of metrical and poetical exposition, he ranks high among scientific writers; while the recent resuscitation of the atomic theory lends special interest to his views. The Romans were always a practical and not a speculative nation, and any deviation from the type, such as Lucretius or Seneca, becomes especially noteworthy and valuable. Numerous parallelisms between them have been brought out in the Commentary and Notes appended to this Translation.

Pliny the Elder stands in respect of date in much the same relation to Seneca as Plutarch does. His great work on Natural History, which was addressed to the reigning Emperor, Vespasian, was published in the year 77, that is, about a dozen years after Seneca's death. We have already glanced at the bearing of this date upon

that of the publication of the *Q.N.* We are now concerned rather with the relation of the contents of the two works. Gibbon (*Decline and Fall*, chap. xiii.) speaks of "that immense register where Pliny has deposited the discoveries, the arts, and the errors of mankind." Nor is the description unjust. The work is of portentous length, extending to thirty-seven Books; it treats of an enormous variety of subjects, physical, geological, geographical, ethnographical, botanical, medical, etc., many of which are now quite dissociated from the title, *Natural History*. Pliny seems to have read everything that existed in writing on the various subjects included, and his array of authorities attached to the contents of each Book is very imposing.[1] But unfortunately his judgment does not appear to have been equal to his industry. Everything is recorded, credible and incredible, whether derived from trustworthy literature or based on mere report: a more uncritical congeries of truth and error it would be difficult to imagine.

Book II. deals with the constitution of the universe, including astronomical and meteorological phenomena, such as Meteors, Halos, Eclipses, Winds, Earthquakes, Rain, etc., etc. Many of these cover the same ground as the *Q.N.* Among the domestic authors cited for this Book are M. Varro, Livy, Cornelius Nepos, Caecina, "who wrote on the Etruscan cult"; among the foreign authors are Plato, Anaximander, Democritus, Archimedes, Aristotle, etc., etc. The omission of Seneca from the Latin list is balanced by that of Theophrastus from the Greek list. It is, of course, unsafe to build any theory on a merely negative basis. Obviously Pliny had read at any rate portions of these authors, to whom he elsewhere refers, and may, through mere oversight or negligence, have omitted specific mention of them here: he usually refers to authors and not to their individual works. If, at the time of the composition of Book II., which may

[1] He claims to have read about 2000 volumes of 100 choice authors, but his lists seem to include a much larger number of names—146 Roman and 327 foreign writers. See Teuffel, *Rom. Lit.* vol. ii., under Pliny the Elder. Cf. Dill, *op. cit.* p. 146 and *note*.

have been considerably earlier than the date of publication of the whole work, he did not know of Seneca's *Q.N.*, then the inference seems inevitable that there were current a collection or collections of the opinions (δόξαι) of the older philosophers which were common property to any one interested in such matters. The *Placita* attributed to Plutarch, though its present form may be much later than Pliny's time, may have been derived from sources of this kind. We shall not be far wrong in supposing that, in addition to the works still extant, there was a mass of material available to Seneca and Pliny alike which represented the traditional views on physical and allied subjects handed down from the old Greek philosophy. Most of the Latin authors, seventeen in number in all, cited by Pliny on Book II. are now known to us only by name; of those whose works remain, Varro is the only one whom we should consider likely to furnish much material for the topic in hand.

Of Pliny's lists in general it may be said that they indicate that a good many writers even among the Romans had been attracted by subjects of a scientific or quasi-scientific character, if we may not venture to say that their works can rank as science even in the modified sense in which the term is applicable to Seneca or Pliny. It is in keeping with the character of the people that practical sciences like agriculture (Varro, Columella) and architecture (Vitruvius), not to mention cookery, should have received special attention. These authors, with others like Manilius (*Astronomica*) and Pomponius Mela (geography), however interesting in themselves, have only an indirect and sometimes only a remote bearing on the Physical Science of their day.

VI. The "Quaestiones Naturales" in the Middle Ages

The *Q.N.* is a landmark in the progress of Physical Science. From Aristotle and Theophrastus there is a great gap until we reach Seneca: the gap is still greater

between Seneca and the Renascence, from which the era of true science is to be dated. The *Q.N.* is the last word spoken on the subject by the classical world, and practically the only work of its kind that survives to us in Latin. Various commentators on Aristotle and Seneca have, probably unconsciously, appeared as champions of either author's claim to be considered as *the* authority in Science during the Middle Ages. All the materials for forming an unbiassed judgment are to be found in Dr. Sandys' *History of Classical Scholarship* (vol. i.).

Seneca possessed one or two initial advantages. In the first place, Latin, in which he wrote, was understood and spoken throughout the world, whereas for many centuries Greek was over large tracts of it, particularly in the West, an unknown tongue. Again, Seneca was for long supposed to be a Christian, claimed by the early fathers as "one of us," and ranked by Jerome among the *Ecclesiastical Writers.* There was not therefore the same prejudice against his works as is known to have existed in the early Christian centuries against pagan authors, especially against the poets.

As a matter of fact, the knowledge of Aristotle's works, at any rate in the West, seems to have been derived in the first instance from Arabic translations made in the ninth century and brought to Spain about the twelfth century, while from 1204 onwards he was known in Latin translations made direct from the Greek MSS., which were now accessible. "In Roger Bacon's day, notwithstanding his eagerness for promoting the study of Aristotle in the original Greek, it was the *Latin* Aristotle alone that was studied in the schools" (Sandys, *op. cit.* 575). That was about the year 1267. Seneca seems to have been well known, chiefly as a moralist, through the Middle Ages. He "was famous as the author of the *Naturales Quaestiones*" (*ib.* 627 [1]) also. Saint-Hilaire's claim, therefore (Arist. *Meteor.* Pref. ii. iii.), "that Aristotle laid down the law on Meteorology, as in everything else, from the age of Alexander right up to the Renascence," must

[1] See, besides, pp. 387, 541, 547, 560, 569, etc.

be accepted with some qualification. There seems room for Ruhkopf's explanation (*Q.N.* Pref.) that Seneca's work was, and continued to be, the sole fountain whence Natural Philosophy derived its source and drew its supplies during many centuries, "until Aristotle's books were transmitted for public use into Western Europe."

By the thirteenth century Aristotle had come fully into vogue, and the references to his teaching in Dante (1265-1321), said to number upwards of 300, show what a hold he had obtained upon the greatest man of the age. The "moral Seneca" is also known to Dante, and placed by him in the same region of the unseen world (*H.* iv.), but the references to his teaching are insignificant by comparison (less than ten). Dr. Sandys states (*op. cit.* 591 *n.*) that the references to Aristotle are mainly to the *Ethics*, *Physics*, *Metaphysics*, and *De Anima.*

But we are now on the eve of the Renascence, whose "morning-star . . . arose in the person of Petrarch" (*op. cit.* 650), early in the fourteenth century (1304-1374). Greek scholarship was reviving in the West, and Petrarch studied the language in his later days. But his inspiration was derived in the first instance from Latin, "the philosophical works of Cicero and the moral letters of Seneca" (*op. cit.* ii. 4). The latter he cites as many as sixty times (*ib.* 7), and he was also familiar with the Senecan tragedies (*ib.* 6).

From this and from the general course of history we seem justified in believing that during the Middle Ages, in default of any general knowledge of Aristotle, Seneca was the chief authority on Physical Science. The views transmitted by him, for they were comparatively seldom altogether his own, having obtained currency, found their way into literature, and probably went far to colour the conceptions entertained on the subject in all the earlier literature of Modern Europe. Later, when Aristotle's works became more widely known, his authority became supreme alike in philosophy and in science. Nor does the temporary ascendancy of Seneca, though historically very important, carry with it any pre-

sumption of rivalry, not to say superiority, to Aristotle. Seneca may best be regarded as pupil and interpreter of Aristotle, in so far as the two come into competition. His date, the language employed as his medium, his position, his reputation as a Christian, and his activity in other fields, all conspired to give him a position in the Middle Ages which is not necessarily the measure of his intrinsic merit as compared with Aristotle.

VII. The Present Translation

From what has preceded, it will appear that the path of the translator of the *Quaestiones Naturales* is beset with snares. At best he has a choice of difficulties. It may perhaps, therefore, be well to say a word or two upon the method in which these have been dealt with on the present occasion.

A translator's prime duty is to follow his author, for which purpose he must first understand him, a requirement not very easily here fulfilled. The texts of the *Q.N.* vary greatly, as already indicated, and it is no easy matter to select any one that might be consistently followed. The most recent and best text, the Teubner, edited by Gercke, has strong claims, and had it been my good fortune to have it by me when the translation was made, I should have been tempted to adopt it *simpliciter*, even though in many details it departs somewhat violently from the accepted arrangement. As it was, it did not come to hand until the translation was finished and paged for publication, so that full use could not be made of it. In a few cases its corrections had been anticipated; in some its readings have been adopted; some that could not be incorporated are referred to in a note on the subject.

The text being settled, the translator must, if possible, put himself in the author's position and obtain his point of view.

In science, particularly, the *milieu* of the author must be caught if his thoughts are to be accurately

reproduced. The danger of attributing to Seneca ideas that were unknown to him and that are due to modern analysis and discovery has to be constantly present to one's mind. For example, "homogeneity," "elasticity," "electricity," "gas," "explosion," etc., are a few of the terms that his language suggests, but that would probably convey a wrong impression of his conception of the phenomena to which they relate. They have been thus ruled out. Nor is Seneca consistent in the use of the terms he employs; he has no scientific vocabulary. In a separate note attention is called to his words for "air" and "atmosphere"; but there are many other terms that belong to the same category. These are, for instance, three words for "thick" or "dense," *crassus*, *densus*, *spissus*, which he seems to use almost indifferently, at any rate without any precise discrimination. So with terms like "*impetus*" (impulse, onset) "*impulsus*" (shove, impulse), "*ictus*" (stroke, blow), "*vis*" (force, quantity, amount), "*curro*" (to run (river), to revolve (heavenly body)), and its compounds, *eo* (to go), and its compounds, etc., etc.

Apart from any peculiarity of Seneca, Latin allows the use of adjectives and pronouns, whose distinctive gender points their reference, where English requires substantives or their equivalent. Latin, too, often conveys by mere suggestion where English requires explicit expression. This is particularly so with connectives, where a separate clause may be required to develop the *nuance* of a subtle collocation. In general, assuming—and it is no great stretch—that the author meant to express *something*, whether right or wrong, I have endeavoured to ascertain what that something was and to convey it to the English reader. In doing so I have had no scruple in using more words than Latin, or in making explicit what I conceived to be implicit, or in varying the rendering of the same term to suit the context and idiom. Ambiguity has, as far as possible, been avoided and even removed. At the same time the author has been followed as closely and faithfully as may be. Where he repeats a term purposely, as he frequently does, the repetition is

retained, though a variant might have sounded more euphonious. Probably, in some cases—it may be in a good many—the meaning has been misconceived; certainly, there will be difference of opinion in regard to readings adopted for translation, where one had to be taken and two or more almost equally good had to be left out. Ruhkopf was the text chiefly used; in addition Koeler and the Variorum Edition of Bouillet were constantly at hand, and I have been much indebted to all three in questions of interpretation. Nisard's French Translation has also been of some service, indirectly by suggestion perhaps rather than directly; in a few passages the translation is from a different text from that printed on the same page. The old Tauchnitz text has been habitually consulted, while Gercke's text has been carefully collated throughout. The latter does not mention Ruhkopf at all in his Bibliography—surely an involuntary omission. There is a useful Bibliography also in Bouillet, but the date of his Edition is as far back as 1830. To my regret I have not been able to procure Lagrange's famous French Translation, and the same remark applies to several German works of repute. Lodge's Translation (1614) was not of any service for my purpose.

THE NATURAL QUESTIONS OF L. ANNAEUS SENECA ADDRESSED TO LUCILIUS

BOOK I

[METEORS, HALO, RAINBOW, MOCK SUN, ETC.]

PREFACE

LUCILIUS, my much esteemed friend—While a great 1
gulf separates philosophy from the other learned arts, there is to my mind an equally wide gulf in philosophy itself between the portion which relates to human conduct and that which deals with the nature and power of heaven. The latter is more exalted and more speculative, it allows itself wide liberty. It is not satisfied with mere observation, it surmises that there is a greater and fairer realm placed by nature beyond human sight. Between these two divisions of philosophy, in short, there is as wide a gulf as between their subjects, God and man.

The one teaches us what should be done 2
on earth;[1] the other, what is done in heaven. The one dispels our errors and flashes a light by which to thread the mazes of life; the other far transcends this gloom in which we grope, rescues us from the darkness, and leads us to the very source of light itself. For myself, I am grateful to nature, not so much when I see her on the side that is open to the world, as when I am permitted to enter her shrine. Then one may seek to know of what stuff the universe is made, who is its author or guardian, what is the nature of God. Is

[1] In other words, the principles of human conduct.

He wholly absorbed in Himself, or does He sometimes regard us? does He do something daily, or has He done once for all? is He a portion of the world, or the whole world? may He issue new decrees even to-day and thus modify the laws of fate, or is it an infringement of His majesty and an acknowledgment of error to alter what has once been
3 made? for surely the same must always please Him who can be pleased only with what is best. Nor yet withal is His freedom or power diminished, for He is a law unto Himself.

Life would have been a useless gift, were I not admitted to the study of such themes. What cause for joy would it be to be set merely in the number of those who live? In order to digest food and drink? To repair a diseased, enfeebled body, that would perish unless it were continually refilled, and thus lead the life of a sick man's attendant? To fear death, to which our very birth destines us? Away with the priceless boon!
4 Life is not worth the heat and the sweat. How despicable a creature is man, unless he rise above the earth! What great thing can we do as long as we have to wrestle with our passions? Even if we prevail, we but conquer monsters. What cause have we to esteem ourselves because we are not quite so bad as the very worst? I can see no great reason for self-satisfaction because one's strength is rather above the average of those in the same hospital. You are still far from good health and vigour. Or, again, you have escaped vices of soul, the hypocrite's brow, the flatterer's speech fashioned to serve another's will, the dissembler's heart, the miser's spirit, which robs all, but yet mortifies itself. You are a prey neither to luxury, which loses basely

and repairs its losses still more basely; nor to ambition, which leads to place of worth only by 5
unworthy means. But yet you have accomplished nothing. You have escaped many perils, but not yet [that of] self! The virtue we aim at raises to a splendid eminence; not so much because escape from vice is in itself a blessed thing, but rather because the soul is emancipated, prepared for the knowledge of heavenly things, and rendered worthy of entering into communion with God.

The full consummation of human felicity is attained when, all vice trampled under foot, the soul seeks the heights and reaches the inner recesses of nature. What joy then to roam through the very stars, to look down with derision on the gilded saloons of the rich and the whole earth with its store of gold! Gold, did I say? Yes, all the gold the earth ever produced and sent into currency, and all that she keeps hidden in secret to glut the avarice of posterity. Only when one has surveyed the whole 6
universe can one truly despise grand colonnades, ceilings glittering with ivory, trim groves and cooling streams transported into wealthy mansions. From above, one can now look down upon this narrow world, covered for the most part by sea, and, even where it rises above the sea, an ugly waste either parched or frozen. The philosopher says to himself: Is this the plot that so many tribes portion out by fire and sword? How ludicrous are their frontiers! The Dacian must not pass the lower Danube; 7
the Strymon must shut off the Thracians; the Euphrates must be the barrier of the Parthians; the Danube must form the boundary between Sarmatian and Roman; the Rhine must set a limit to Germany; the Pyrenees must raise their chain

between Gallic and Spanish provinces; between Egypt and Ethiopia a desert of barren sands must stretch! Why, if ants are ever endowed with human intelligence, will not they in like manner portion out a threshing-floor into many provinces?

8 But when you rise to what is truly great, then, as often as you see armies marching forth with floating banners, and the cavalry now scouting in front, now massed on the flanks, as if some great design were toward, you will pleasantly remark:

> The black swarm is hurrying through the plains.

That host is a throng of ants, its evolutions are in a back garden. In what do we excel the ants, save in the measure of the puny little body? That is a mere point in which you sail, and war, and dispose your kingdoms. Your kingdoms are lilliputian even when they stretch from Ocean to Ocean.

9 Only on high are the domains spacious; to their possession the mind is admitted, provided always that it bring with it no taint of the body, but wipe off all stain and pass forth like an armed man, lightly equipped, nimble, modest in his wants. When the soul reaches those regions, it receives nourishment and growth; as if freed from the shackles of earth, it returns to the true source of its

10 being. A proof of its divine origin is furnished by the pleasure it derives from what is divine; here it feels itself at home, not in a strange land. Without alarm it views the setting of the stars and their rising, and the mazy orbits of the heavenly bodies that yet move all in unison. It notes when each star first shows its light on earth, when it attains its meridian height, observes its orbit and the limits of its descent. An interested spectator, it

examines and investigates every detail. And why should it not? It feels that they are akin to itself. Then contempt for the narrow limits of its former 11
dwelling succeeds. For what after all is the space that lies from India to the farthest shores of Spain? A few days' journey if a prosperous wind waft the vessel. But that heavenly region affords a route during full thirty years to the swiftest of the planets, rushing with untiring velocity, never once halting.

Here at last the soul comes to learn what it has long sought, it begins to know God. But what is 12
God? The universal intelligence. What is God, did I say? All that you see and all that you cannot see. His greatness exceeds the bounds of thought. Render Him His true greatness and He is all in all, He is at once within and without His works. What, then, is the difference between the divine nature and the human? In us the better 13
part is spirit, in Him there is nothing except spirit. He is wholly reason: though mortal eyes are so sealed by error that men believe this frame of things to be but a fortuitous concourse of atoms, the sport of chance. And yet than this universe could aught be fairer, more carefully adjusted, more consistent in plan? But men will have it that it is tossed about at random in the confusion of thunder, cloud, and storm, and the other forces by which the earth and its purlieus are haunted.

Nor is this merely the madness of vulgar error; even the philosophers are tainted by it. Men 14
there are who think that they themselves have a mind, one, too, that foresees and orders events in detail whether relating to themselves or to others. But this frame of things, in which we men along with the rest of creation are set, they

deem void of counsel, hurried hither and thither at random; or at best, nature, they suppose, does not know what her own aim is. How profitable then, think you, will it be to ascertain the truth on such questions and exactly to define each position! For example, what is the extent of the power of God? Does He create matter or does He employ matter already given? Does the pre-existing archetype give shape to matter, or does the matter determine the shape? Can God perform anything He wishes, or does material fail Him in many cases, just as a great artist often produces inferior work, not through any defect in his art, but because the material on which it is exercised is refractory? To search into such things, to learn them, to meditate upon them—why, is it not in effect to transcend the limits of mortality and to be enrolled a citizen of a higher state? What good will it do you, you ask. Well, if nothing else, I shall, at any rate, know that measured by divine standard all earthly things are mean. But of this more anon.

I

To come now to my purpose—listen to the explanation offered by Natural Philosophy concerning *the Fires* which the atmosphere drives athwart. Their oblique course and amazing velocity furnish proof that they are thrust out with great violence. Evidently they do not come forth of themselves, they are shot out. There are many different forms of them. A certain kind of them Aristotle calls a She-Goat. If you ask me why, I must retort by asking you first to explain why they are also called Kids.

It will, perhaps, be more to the purpose not to 2
cross-examine one another with questions such as:
What does such and such an author say? Answer
me. Better examine the cause of the phenomenon
itself than form surmises as to why Aristotle has
applied the name She-Goat to a ball of fire. This
was the shape of the one as big as the moon that
appeared when Paulus was engaged in the war
against Perseus. In our own days we have more
than once seen a huge ball-shaped flame which
broke up in the very middle of its course. We 3
saw a similar portent about the time of the death
of the late Emperor Augustus. We again saw one
when Sejanus was executed. A warning of the
same kind preceded the death of Germanicus.

You may, perhaps, exclaim: Are you then so
benighted as to suppose that the gods send out
previous intimation of the death of great men? Do
you imagine that anything on earth is so great
that the Universe should perceive its loss? That
question must be reserved for another season. We
shall then see whether a fixed succession is observed
in all events, and whether one event is so bound up
with another that what precedes is either cause or
at least token of what follows. We shall then 4
see, too, whether the gods trouble themselves about
human concerns, and whether the mere series of
events reveals by unmistakable signs what its effects
must be. Meantime, I venture the opinion that
fires of the class referred to are produced by violent
friction of the atmosphere. The pressure inclines
toward one or other side, and as there is no yielding
there, an internal struggle ensues. From violent
action of this kind arise the different varieties of
fires—beams, balls, torches, and gleams. When the

shock is less severe, and the atmosphere is merely grazed, as it were, smaller lights are emitted,

> And the flying stars drag their hairy tail.

5 Then their thin fires mark a slender path, which they prolong across the sky. For that reason no night is without sights of the kind; no great movement of the atmosphere is required to produce them. In fact, to put it shortly, they are due to the very same cause as thunderbolts, only they require less force.

Clouds that encounter each other with little force cause flashes of lightning; if impelled by greater
6 violence, thunderbolts. Aristotle offers the following explanation: The earth gives forth many different exhalations, some moist, some dry, some cold, some containing the seeds of fire. And little wonder if the earth's evaporation is of all varied kinds. Why, even in the heavens the colour of objects does not show uniform; the red of the Dog-star is brighter,
7 that of Mars duller; Jupiter has no red, his sheen is prolonged into pure light. Well, in the great abundance of minute bodies emitted by the earth and driven up to the higher regions, of necessity some of the elements that reach the clouds furnish material for fires. They do not require any collision in order to burn, the breath of the sun's rays is sufficient to kindle them. So with us, shavings
8 sprinkled with sulphur catch fire at some distance. Probably, therefore, tinder of this kind gathering within the clouds is easily kindled; greater or less fires are produced just as there has been more or less substance in the elements.

On the other hand, to suppose either that actual stars fall or leap across the sky, or that some portion of them is taken away or pared off,

is sheer folly. If this had been so, they would 9
ere this have disappeared. For there is not a single night on which there is not a very large number of stars that seem to break up as they pass across the sky. Yet they are all found again in their wonted places: each one maintains its size unimpaired. It follows, therefore, that the fires referred to have their origin below the stars, and that, being without solid foundation on fixed abode, they quickly perish. Why, then, you ask, do they not cross the sky by day as well as by night? 10
The next thing you will say will be that there are no stars by day because they are not visible! The stars are, of course, there, but obscured by the sun's brightness. Similarly, meteor fires like torches cross the sky by day too, but they are hidden by the brightness of the daylight. If, as sometimes happens, a burst of light shoots out strong enough to assert its brilliance even in the face of day, then they do become visible. In fact, 11
our own age has more than once seen torches by day, some rushing from east to west, others from west to east.

Sailors consider it a sign of storm when there are many shooting stars. If their appearance really is a sign of wind, they must occur in the quarter where wind is found, in other words, in the atmosphere which lies between the earth and the moon. In violent storms at sea there sometimes appear, as it were, stars settling on the sails. The sailors who are in jeopardy then suppose that they are being aided by the power of 12
Castor and Pollux. They have really ground for better hope in this appearance, because it makes plain that the storm is breaking, and the wind

falling. Otherwise the fires would flit about without settling. When Gylippus was on the voyage to Syracuse, a star appeared, resting on the very tip of his lance. In the camp of the Romans at times pikes appeared to be on fire, no doubt because fires of this kind glided down on to them: these fires are
13 often wont to strike animals and trees, just like thunderbolts. If, however, they are discharged with less force, they merely glide down and settle, and do not inflict stroke or wound. Again, some are forced out from among clouds, others come from a clear sky, if the atmosphere has got into a condition to emit fire. In like manner, it occasionally thunders with a clear sky, and from the same cause as with a cloudy one, the atmosphere undergoing internal collision. Even when the air is comparatively clear and dry, it may become condensed, and form bodies similar to clouds, the clashing of which
14 causes the sound of the thunder. From time to time, therefore, arise meteors like beams and like shields, and the semblance of vast fires over the sky, if a force similar in kind but greater in degree encounter suitable material.

II

1 LET us now see how the brightness is produced that sometimes envelops the heavenly bodies. History has put on record that, on the day of the late Emperor Augustus' entrance into Rome on his return from Apollonia, a parti-coloured circle, such as is wont to be seen in a rainbow, appeared round the sun. The Greeks call this a *Halo*; our most appropriate name for it is a Crown.

Let me explain how it is formed. When a stone 2
is thrown into a pond, the water is observed to part in numerous circles, which, very narrow at first, gradually widen out more and more until the impulse disappears, lost in the surface of the smooth water beyond. Let us suppose something of the same kind to occur in the atmosphere. When condensed it is capable of receiving an impact: the light of sun, moon, or any heavenly body encountering it forces it to recede in the form of circles. Moisture, be it observed, and air, and everything else that takes shape from a blow, is driven into the same form as that possessed by the object that strikes it. Now every kind of light is 3
round. Therefore, the air when struck by light will assume this form. Accordingly the Greeks gave the name Threshing-floor (*i.e.* Halo) to a brightness of this kind, because spaces set apart for threshing corn were, as a rule, round.

Be the better name threshing-floors, or be it crowns, there is no reason to suppose that they are formed in the neighbourhood of the heavenly bodies. They are a very long distance from them, though as seen from the earth they seem to touch and encircle them. In reality such an 4
image is formed not very far from the earth, but the wonted frailty of human vision is deceptive, and we imagine the ring is formed close round the heavenly body itself. But no such thing could possibly occur in the neighbourhood of the sun and stars, as there is nothing but thin ether there. It is only when bodies have become rough and dense that shape can be impressed upon them. In subtle bodies there is no point on which form can lay hold or to which it can adhere. A phenomenon of the

same nature as the halo may often be witnessed in baths, because the atmosphere is thick and dark: it is most frequent when the wind is in the south, when the air is heaviest and most dense.

5 Halos sometimes are dissolved gradually and fade away, sometimes they are broken up on one side. In the latter case seafaring men look for wind in the direction in which the circle of the crown has been broken. If the parting is on the north, there will be a north wind, if on the west, zephyrs will follow. This is a proof that these crowns are formed in the region of the sky in which the winds are usually formed. The upper regions of air have no crowns because they
6 have no winds either. An additional proof of the connection of winds and halos is afforded by the fact that the halo is never formed unless the atmosphere is at rest, and the wind, as it were, inactive. Under other circumstances it is not usually observed.

The atmosphere when it is at rest may be fashioned to any pattern by being driven or drawn in any direction. But when it is in motion, light cannot even strike it. It takes no shape and offers no resistance, because the part first affected is always
7 dissipated by the motion. Therefore it is that no heavenly body can ever be surrounded by a figure of the kind referred to unless when the atmosphere is dense and motionless, and so preserves the ray of round light that strikes upon it. Nor is it without good reason. Recollect the analogy mentioned a little ago. A pebble thrown into a pond or lake or any other circumscribed piece of water produces innumerable circles; but it has not the same effect if thrown into a river. And why so? Because in the latter case the water as it hurries on prevents

the formation of any definite figure. So in the atmo- 8
sphere the same thing happens ; when it is stationary, it may receive a pattern ; when it rushes in rapid motion, it evades all control, warding off every blow and every form as it approaches. When these crowns, of which I have spoken, have disappeared uniformly on all sides, and vanished in their own tracks, it is an indication of equilibrium in the atmosphere : there is perfect quietness and you may then 9
look out for rain. When they break up at one side, it means wind in that quarter. If they burst at several points, a storm is brewing. The reason of this may be gathered from the explanations I have now given. If the ring fade all round, it is evident that the atmosphere is equable, and therefore calm. But if it is broken through on one side, evidently there must be an inclination of the air in that direction : hence that quarter will produce wind. But when the halo is rent and torn on all sides, plainly an attack is being made on it from several quarters at once, and a disquieted atmosphere is assailing it on this side and on that. So this disturbance of the heavens, 10
the repeated effort and striving in all directions, betokens evidently that a storm is coming up with sudden shiftings of the wind.

These crowns may be observed generally by night round the moon and other stars, but very seldom by day ; in fact, so rarely in the latter case, that certain of the Greeks have denied that they appear at all by day. But history proves that they do. The cause of the infrequency of their appearance by day is that the sun's light is stronger then, and the atmosphere itself when stirred and warmed by it is less dense. The moon's power, on the other hand, is feebler, and is therefore more

11 easily resisted by the surrounding air. The rest of the heavenly bodies are equally weak, and unable by their own force to burst through the atmosphere. So their shape is impressed and retained in the more solid and less yielding medium. For, in order to produce the phenomenon, the atmosphere must neither be so thick as to exclude or dissipate the light that streams in on it, nor yet so thin and rare as to furnish no hold to the rays that fall upon it. This particular consistency is obtained at night: the sluggish air is at that time struck with the faint light from moon or stars without violence or rudeness, and, being thicker than it is wont to be by day, is tinged thereby.

III

1 On the contrary, *the Rainbow* does not occur by night, except on very rare occasions, inasmuch as the moon has not sufficient strength to pierce the clouds and suffuse them with hues such as they receive from the brilliant light of the sun. The shape and varied colours of the rainbow are due to the peculiarities of different kinds of clouds. Some parts of the clouds are swollen, others hollow; some are too dense to transmit sunlight,
2 others too rare to exclude it. This difference in consistency causes alternations of light and shade, and produces that marvellous variety presented by the rainbow. Another explanation is offered in instances like the following: When a pipe bursts anywhere, the water is observed to be forced by pressure through the small opening; the drops seen against a slanting sun reproduce the appearance of the rainbow. Again, if you will at any

time watch a fuller at work, you will observe the same appearance: when he has filled his mouth with water and spirts it lightly on the clothes stretched on pegs, the air thus besprinkled exhibits plainly the various colours that shine in the bow. One cannot doubt that the reason of 3
this lies in the moisture. For a rainbow never occurs except when there are clouds about.

Let us inquire how it is produced. Some authorities say that there are certain drops of water that transmit light, while some are too compact to be translucent. Thus the brightness is the effect of the former; the shadow, of the latter; by the intermingling of the two is formed the rainbow, part of which is bright, to wit, that which admits sunlight, part darker, namely, that which has shut out the light and cast a shadow from itself over the objects nearest it. Others again deny that 4
this is so. Shade and light, they say, might be the cause if the rainbow had only two colours, and thus was made up of light and shade.

But now, though there gleam a thousand diverse hues,
Their changes withal elude the eyes that behold.
The hues that touch seem actually one, yet the edges are quite different.

In it sight detects something that is red, something that is orange, something that is blue; and there are other colours too, laid on in finest lines just like a skilful painting, so that, as the poet remarks above, it is impossible to discover whether the colours differ from one another until the last of them is compared with the first. The junction of 5
colour with colour deceives the sight: with such marvellous skill does nature starting from what is like end in what is totally unlike. What good, then,

do the two alleged colours, light and shade, do in a case of this kind, when the presence of an endless variety must be accounted for? Again, certain authorities are of opinion that the following is the method of formation of the rainbow: In the quarter of the sky where rain is falling, they say, the drops of falling rain are so many mirrors; from each mirror, therefore, is reflected an image of the sun. By and by, many, in fact, countless, images, descending and crossing abruptly, are all blended together. Therefore the rainbow is just a blending of a great number of images of the sun.
6 They appeal to the following argument in proof of this: On a clear day, say they, set out a thousand basins, and they will all contain images of the sun. Or arrange single drops of water on single leaves; they will each have an image of the sun. On the other hand, an immense pond will have no more than one image. Why so? Just because every smooth surface that is fenced off, and surrounded by its own boundaries, is a mirror. Again, divide a pond of very large size into several small ponds by inserting partition walls; it will show as many images of the sun as it has divisions. Leave it as it was, spreading out to its full extent, and it
7 will show but one reflection of him. The small extent of the liquid or pond makes no manner of difference. If the surface is circumscribed, it forms a mirror. Well then, those countless drops, which are carried down by a falling shower, are so many mirrors, and contain so many reflections of the sun. To an observer right in front of them they present the appearance of being mixed up: the intervals which part them from each other are not distinguished, their mere distance from the observer

prevents discrimination of them. By and by instead of individual drops there is seen a single blurred mass that contains them all.

Aristotle agrees with this opinion. His words are: Beams of light are reflected by sight from every smooth surface. Now, nothing is 8
smoother than water and air. Therefore, our sight is reflected back on us from thick air. Indeed, where the vision is dull and feeble, the slightest stroke of air checks it. Some people suffer from an affection which causes them to think that they are meeting their own image, and they see everywhere the reflection of themselves. And why? Because the power of their eyes is so weak that it cannot overcome the resistance of even the nearest layer of the atmosphere. What dense air effects in ordinary cases, any kind of air is sufficient to effect in the cases referred to by Aristotle. For whatever the nature of the air, it is strong enough to defeat weak sight. Now, much more is our vision reflected upon us by water because it is denser and cannot be pierced; it absolutely stops the rays from our eyes, and turns them back to the source whence they proceeded. Well then, 9
when there are numerous raindrops, they are just so many mirrors. But on account of their smallness they express the sun's colour without distinct shape. By and by when the same colour is reflected in the countless drops that fall without intermission, it begins to take on the appearance not of numerous images with intervals between, but of a single, long, uninterrupted image.

But how, you may object, can you tell me that there are many thousands of images there, where I can

10 see none at all? Besides, as there is but one colour in the sun, why are there different colours in the reflections of him? These objections which you have put forward, as well as others that no less call for refutation, I will endeavour to refute. And let me say, first of all, that nothing is more deceptive than our eyesight, not merely in objects whose careful examination is prevented by distance in position,[1] but even in objects seen close at hand. An oar, though quite whole, presents the appearance of being broken when seen in clear shallow water. Apples seen through glass appear much
11 larger than they really are. In long colonnades, pillars set at intervals present an apparently unbroken continuity of line. Or go back to the case of the sun himself; his orb, which reason proves to be larger than the whole earth, is so contracted by human sight that some of the philosophers have maintained that it is only a foot in diameter. He is, we know, the swiftest of all luminaries, yet none of us can see him move; nor should we believe that he does advance, were it not evident from time to time that he has advanced. The world itself glides on with headlong speed; within an instant of time it unfolds its risings and its settings, yet none
12 of us is aware of its movement. What cause, then, is there for wonder if our eyesight cannot separate the drops of the rain showers, and loses the distinction of the images on account of the vast distance at which they are beheld? At any rate no one can doubt this, that the rainbow is a reflection of the sun, formed in a hollow cloud full of moisture. This is made plain from the simple fact that the image is never seen except opposite the sun,

[1] The received text gives "diversity of colours."

high up or low down, in inverse relation, just as he sinks or elevates his course. When he descends, it is higher; when he is high in the heavens, it is more sunken. A cloud of the required kind is 13
often at the side of the sun without producing a rainbow, because it does not catch his image straight in front.

As to the variegation in colour, it is due simply to its double source, derived partly from the sun, partly from the moist cloud. The moisture produces lines now blue, now green, now purple-like, and orange or red—the two shades, dull and bright, combining to produce this diversity. So also, a purple garment does not always come 14
out in exactly the same tint from the same dye. Differences depend upon the length of time it has been steeped, the consistency and the amount of moisture in the dye it has imbibed: it may be dipped and boiled more than once, or it may have received only one immersion. In like manner then, when there are the two elements, sun and cloud, in other words, object and mirror, it is little wonder that as many varieties of colour are generated as can be produced from them in higher or lower tone in countless different categories. For example, there 15
is one colour that proceeds from the light of fire, another from a light that is duller and less violent than fire. In other details concerning the rainbow the method of inquiry is full of uncertainty; there is nothing concrete to lay hold upon, and conjecture must be ventured in every direction. But in this question of its origin doubt is precluded; for it is evident that the causes of the rainbow are two in number, sun and cloud. The bow never appears when the sky is clear, and never when it is so

cloudy as to hide the sun. It must, therefore, unquestionably arise from these, failing either of which it cannot come into being.

IV

1 A FURTHER consideration must be mentioned, which is just as manifest as the preceding, to prove that the reflection is given back after the fashion of a mirror; it is never given back save from straight opposite to the sun, that is,[1] unless on one side stands the object to be reflected, and on the other the mirror that reveals it. Proofs are adduced by the mathematicians that are not merely convincing but that compel belief of this. Nor can doubt be left in any mind that the rainbow is an image of the sun, imperfectly reflected owing to the defective
2 shape of the mirror. But meantime let us recall other proofs that may, so to speak, be picked up in the street without any reference to mathematics. Among the proofs of this origin of the bow I place the extreme rapidity of its emergence. In a single moment the huge form with its thousand lines is inwoven in the texture of the heavens, and just as rapidly does it fade. Now, nothing is returned so quickly as an image from a mirror. The mirror does not create anything, it merely
3 reveals it. Artemidorus of Parium tells us further even the kind of cloud required to reflect such an image of the sun. If you make a concave mirror, he says, that is, one resembling half of a ball cut through the middle, and take your stand outside the centre, then those who stand beside you will

[1] In a writer less prone to repetition the words to the end of the sentence would seem the insertion of a copyist.

appear in the reflection inverted and nearer to you than to the mirror. The very same thing, according to him, takes place when we look at a round hollow cloud from the side: the image of the sun detaches itself from the cloud, and is nearer us and more turned in our direction. Therefore the red colour is from the sun, the dark blue is from the cloud: the other hues are produced by a blending of these two. 4

V

BUT there are arguments on the other side. About mirrors there are two opinions; some people think that only phantoms are seen in them; in other words, the shape of our bodies, an emanation separated from our bodies. Others, however, affirm that images do not exist in the mirror, but that it is the very bodies that are seen, the eyesight being bent back and reflected on itself again. Now, the point is not how do we see whatever it is we see: the question is, how the image should resemble the original in the cloud as in a mirror.[1] Could anything be more unlike than the sun and a rainbow in which neither the colour nor the shape nor the size of the sun is to be seen? A bow is far larger and, in the bright part, far redder than the sun: in the other colours, too, it is different from him. Besides, when you insist on comparing a mirror to the atmosphere (*i.e.* as embodied in a cloud), you must show me in the latter the same smoothness of texture, the same levelness of surface, the same 1 2

[1] The reading of the MSS. is admittedly corrupt. I have followed Ruhkopf's conjecture, though without conviction. The argument seems to require *dissimilis* = unlike, or *non similis* (cf. c. v. 13), instead of *similis* = like ("resemble" in the text): in that case the meaning would be: how an image unlike the original ought to be reflected from the cloud as from a mirror. Cf. § 13 below.

brightness as in the former. But surely no clouds resemble mirrors to this extent. We often pass through the middle of clouds without seeing ourselves in them. People who climb to the tops of
3 mountains look down on cloud, but cannot make out their reflection in it. True enough, but it is separate drops that are separate mirrors, says my opponent. Admitted. Still, I deny that a cloud consists of fully formed drops. It no doubt contains the elements from which the drops are formed, but not as drops. Clouds do not contain even water, but only the material to form water. Granting, for the sake of argument, that there *are* countless drops in the clouds and that they can reflect an object, yet they do not all produce one and the same reflection, but each
4 its own. Further, you may join mirrors to one another, but they will not unite to form a single reflection : each portion will enclose a likeness of the object. Some mirrors are composed of a large number of very small parts. Set before them one man and a whole people is reflected, each portion producing an image of its own. The portions of the mirror thus united and placed side by side none the less keep their images separate, and out of one man make
5 a crowd. But they do not blend in one that troop ; they separate and distinguish the individual faces. Now, a rainbow is bounded by a single outline, the whole presents but one representation.

Well, but, says our opponent, is not the water that is scattered from a burst pipe, or that is tossed up by the oar, wont to exhibit something similar to these colours that are seen in the bow? True, but not for the reason which you wish to bring out, to wit, that each single droplet receives

an image of the sun. As a matter of fact, the 6
drops fall too quickly to be able to form such an image. The medium must be stationary in order to receive the impression of what is to be reproduced.

How, then, it may be asked, does it come about? The drops, I reply, receive the colour, but not the image of the sun. Besides, as Nero Caesar says very elegantly:

> The neck of Venus' dove glitters as the bird tosses its head,

and so the neck of the peacock shines with varied colours as often as it is turned hither and thither. Are we, therefore, to say that feathers of this kind, 7
whose every turn passes into new colours, are mirrors? Well, clouds differ in character from mirrors no less than the birds mentioned, and as chameleons and the other animals whose colour changes. In the latter case the cause is sometimes subjective: the creatures when inflamed with anger or passion vary their hue through the suffusion of moisture: at other times the position of the light, direct or slanting, gives the colour its particular hue. What resemblance, I say, is there between mirrors 8
and clouds? Whereas those are not translucent, these transmit light. Those are dense and compact, these are rare. Mirrors are of uniform material throughout, clouds are made up of various elements brought together at random, and therefore are full of internal strife, and cannot long hold together. Consider further; at sunrise one sees a certain portion of the sky ruddy; at other times one sees clouds of fiery red. This particular colour is received by the clouds from encountering the sun: what, then, is there to prevent the many colours of the bow being derived by them in the same way

from him, even though they do not possess the
9 power of mirrors? A little ago, my opponent retorts, you advanced the argument that the rainbow is always produced opposite the sun, because an image could not be reflected from a mirror unless the object were in front of it. We agree in this point, he adds. Yes, for just as the object whose image is to be transferred to the mirror must be set opposite the mirror, in like manner, in order that the clouds may be tinged by the sun's rays, the sun must occupy a suitable position. He does not produce the same effect if his light streams in on all sides; there must be a proper incidence of the rays to produce the effect. Such are the reasons alleged by those who will have it that the rainbow is a coloured cloud.

Posidonius and those who are of opinion that the phenomenon is produced by reflection as from
10 a mirror, answer their arguments thus: If there were any real colour in a bow, it would persist, and be seen more distinctly, the nearer it is. As it is, the image of the bow is clear only in the distance; it is lost as it begins to approach. I do not agree with this argument in refutation, though I approve the main sentiment which it supports. And I will tell you why. The cloud *is* coloured, but in such a way that the colour cannot be seen from every point. And no more can the cloud itself: for no one who is in it
11 can see it. What wonder, then, if its colour cannot be seen by one to whom itself is not visible? And yet, although the cloud is not seen, it is there: and so is the colour. It is, therefore, no proof of the deceptiveness of the colour that it ceases to be

manifest when one approaches it. For, I repeat, the same happens to the clouds themselves: they are not all a sham merely because under certain conditions they cease to be visible. Besides, when you are told that the cloud is dyed by the sun, it does not mean that that colour of his is mingled, as it were, with a hard, firm, durable body, but with a liquid unstable body that is incapable of more than a very brief impress. Let me add that there 12
are certain artificial colours which display their virtue at a distance. The better and richer the Tyrian purple is, the higher up you must hold it to display its full blaze. It does not cease to possess its colour simply because it does not reveal its best shade in any and every position in which it is exhibited. I am of the same opinion as Posidonius in holding that the bow is formed in a cloud shaped like a hollow round mirror, whose form is that of a section through a ball. This cannot be 13
proved without the aid of geometry: the mathematical proofs leave no doubt that the bow is an image of the sun, but one that does not resemble it. Nor, indeed, are all objects faithfully represented in mirrors. There are some mirrors one is terrified to let one's eyes rest upon, such is the misshapen and distorted image they reproduce of those who gaze upon them. They deform the likeness they preserve withal. Some, again, there are, a glance at 14
which causes great self-satisfaction in one's strength: the arms are enormously increased, and the appearance of the whole body is enlarged to superhuman proportions. There are mirrors that turn faces to the right, and mirrors that turn them to the left, others twist and even invert them. What wonder, then, that a mirror of this kind should be formed in

a cloud by which a defective appearance of the sun should be presented?

VI

1 Among the other arguments it must be mentioned that a rainbow never is seen greater than a semicircle: the higher the sun is, too, the smaller is the bow. As our countryman Virgil says:

> And deep drinks
> The mighty bow,

when rain is brewing. But the threat the bow conveys is not the same whatever the quarter it has
2 shown itself in. If it rises toward the south, it will bring a heavy fall. The rain in that quarter, such is its force, cannot be mastered by the strongest midday sun. If it shine toward the west, there will be only a dew or a light rain. If it rise in the east or thereabouts, it prognosticates fine weather. If, however, the bow is the sun's reflection, why does it appear of far larger size than the sun himself? Just because there is a kind of mirror that exhibits objects on a far larger scale than that on which they are presented to it, increasing their form to a portentous magnitude: and in turn there is another kind that reduces the size. And tell me this again, why does an image assume the form of a circle if
3 it does not answer to a circle? You may, perhaps, tell me why the colour of the bow is varied: why its shape is what it is, you will not be able to tell me except by citing some model after which it is formed. Now, other model there is none save that of the sun; when you admit that the rainbow receives its colour from him, it follows that it

receives its shape also from him. In short, you and I are agreed that those colours by which its quarter of the heaven is adorned proceed from the sun. But on one point we are not agreed: you say that the colour is real; I maintain that it is only apparent. Whichever it is, real or apparent, it comes from the sun. On your assumption its sudden cessation cannot be explained, seeing that all other bright lights in the sky are dispelled gradually. Its sudden appearance and, at the same 4
time, its sudden extinction make for my contention. For it is a peculiarity of a mirror that the reflection in it is not built up piecemeal, but all at once comes fully into being. Every image in it is destroyed, too, with as great rapidity as it was formed. For to the construction or removal of the images nothing is required but the presentation and withdrawal of the objects.

In the rainbow-cloud whose nature is in question, there is no proper substance or material: there is only a sham and a likeness without reality. Will you be convinced that this is so? 5
The proof is, the rainbow will cease if you conceal the sun. Place another cloud, I repeat, in front of the sun, and all the bright hues of the bow are gone. But what is to be said, you may ask, in explanation of the size of the bow which is considerably greater than that of the sun? I have already said that there are certain mirrors that multiply every object they reflect. I may now add that every object much exceeds its natural size when seen through water. Letters, however small and dim, are comparatively large and distinct when seen through a glass globe filled with water. Apples floating in a glass vessel seem more beauti-

6 ful than they are in reality. The stars appear bigger if seen through a cloud, because our vision is blurred in the moisture, and cannot accurately grasp its object. This will become plain to demonstration if you fill a cup with water and throw a ring into it. While the ring lies right at the bottom its appearance is visible on the surface of the
7 water. Anything, in fact, that is seen through moisture appears far larger than in reality it is. What wonder that the image of the sun, being seen in a moist cloud, should be reproduced on a scale larger than the original, and that for the two reasons indicated? The cloud contains the two elements, one like glass, which can transmit light, and one also of the character of water; at any rate, if it does not just yet contain the actual water, it is now forming it, its nature is already such as can easily be changed into water.

VII

1 As you have mentioned glass, some one interposes, I can draw from this same material an argument to confute you. Glass sticks are manufactured, either fluted or bulging,[1] with many corners like a club. If one of these sticks is placed obliquely in the path of the sun's rays, it sends back the colour which is wont to be seen in the rainbow. This proves that there is not here an image of the sun, but an imitation of his colour
2 from reflection. Now, in this argument there are many points that make for my view. First of all, it is plain that there must be some smooth surface like a mirror to reflect the sun. Secondly, it is

[1] Another reading gives "twisted."

plain that no colour is formed in the rod, but only a false appearance of colour, such as I mentioned above, which the neck of a pigeon, as it is bent hither and thither, alternately puts on and off. This, I say, is seen likewise in the case of a mirror, which assumes no real colour, but only a certain imitation of the colour of a foreign body.

Still, this one point requires explanation; it is 3
not the sun's image that is beheld in that glass stick, because it is not capable of expressing it accurately. True enough it tries to reproduce the image, because the material is smooth and suitable for this purpose. But it fails because its shape is unsymmetrical. If it had been suitably constructed, it would reflect as many images of the sun as it had faces. But since the sides are not distinctly separated from each other, and not bright enough to serve as mirrors, the images are only incipient, not fully expressed; they get confused through being crowded together, and are reduced to the appearance of a single band of colour.

VIII

But to return—why does the bow not complete 1
the full circle in its form, but appear as only a semi-circle when stretched to the full extent of its greatest span? Some are of opinion that the reason is that the sun, being much higher than the clouds, strikes them only on the upper side. Hence their lower parts are not touched by his light. Receiving the sun only on one side, the clouds reproduce only one portion of him, and this is never more than a half. There is very little force

2 in this contention. My reason for saying so? The sun, even though he is on the upper side, yet strikes, and therefore colours, the whole cloud. How could it be otherwise? His rays are wont to be transmitted through the clouds and to penetrate any density in them. Further, the proof they advance is flatly in opposition to their main proposition. For if the sun is higher than the clouds, and his beams, therefore, shed only on their upper side, the bow would never come down as far
3 as the earth. Yet it does descend to the very ground. Besides, the bow is never seen except opposite to, not below, the sun. The fact is, the sun's highness or lowness does not affect the matter: the side of the cloud that faces him is struck by him throughout its whole extent.

Furthermore, sometimes even the setting sun produces a rainbow; surely at that time, being near[1] the earth, he strikes the clouds on their lower side. And yet then, too, the bow is only a semicircle, though the clouds receive the sunlight on their lower and
4 darker portions. The Stoics, who hold that the light is reflected in the cloud as in a mirror, make the cloud hollow like the section of a ball. Such a mirror, being but part of a circle, cannot, they think, reproduce a whole circle. I give my adherence to the proposition, but I cannot agree to the argument in its support. For, if the whole figure of a circle placed opposite a concave mirror is reproduced in it, then there can surely be nothing to prevent the whole of a ball being seen in a semi-
5 circular mirror. Besides, we have already shown that complete rings resembling a rainbow surround the

[1] The common reading makes this adjective refer to clouds—the clouds which are near the earth.

sun and the moon at times. Why should the circle be complete in the halo, but never in the rainbow? And then again, why should the clouds that receive the sunlight be always hollow ones, and not sometimes flat or bulging?

Aristotle says that rainbows are formed, after the autumnal equinox, at any hour of the day, but in summer only either in the early part of the day, or when the sun has begun to sink. The cause of this is obvious. In the first place, about midday the great 6
heat of the sun dispels the clouds: he cannot be reflected in the clouds which he breaks up. But in the early morning and as he sinks toward the west, his rays have less power, and can thus be resisted and reflected by the clouds. In the second place, the sun is not wont to form a bow except when he faces the clouds in which it is formed. When the 7
days are shortening in autumn, his rays are always slanting. Therefore, he has some clouds facing him that he can strike, at any part of the day, even at the hour at which he attains his meridian height. But in the summer season he sails right overhead. Therefore, in the great altitude of his midday course, he looks down on the earth too directly to encounter any clouds. He has them at that period all beneath him.

IX

I MUST now go on to speak of *Streaks* (watergalls, 1
sun-dogs), which are as bright and varied as the rainbow, and commonly received by us as equally indicative of rain. No great labour need be spent in explaining them, for they are just incomplete 2
rainbows. They have the variegated appearance

of the bow, but none of its curve. They lie in a straight line. They are formed near the sun, as a rule, in a moist cloud that has begun to break up. Thus, they have the same colour as is found in the rainbow, but there is a difference in the shape, due to the corresponding difference in the clouds over which they stretch.

X

THERE is a similar variety of colours in *Halos.* But there is this difference in the various phenomena: Halos are formed at any point in the sky, wherever there is a heavenly body; rainbows are not found except opposite the sun; streaks, only in the neighbourhood of the sun. I may express their difference in another way: Bisect a halo and you have a rainbow; make it a straight line and you have a streak. In all three there is the same multiplicity of colours, the scale running from dark blue to orange. Streaks, then, are found only close to the sun. Rainbows are all either solar or lunar. Halos are seen with all the heavenly bodies.

XI

1 ANOTHER kind of streak is visible when thin rays of bright light equidistant from one another are shot out through narrow apertures in the clouds. These, too, are a prognostication of rain. How am I to express myself here? What shall I call them? Images of the sun? The chroniclers call them merely suns, and have put on record that they have
2 been seen in twos and threes. The Greeks call

them *Mock Suns* (parelia = beside the sun), because they are generally seen in proximity to the sun, and somewhat resemble the sun. They do not give a complete reproduction of the sun, but exhibit only his size and shape. They are dull, however, and languid without any of his heat. What name are we to apply to them? Shall I do as Virgil did—hesitating about the name, employ the very name which causes the hesitation?

> And by what name[1] shall I call you,
> Rhaetian wine? But yet you must not seek to compete with the Falernian bins.

There is no objection to my calling these, mock suns. They are, in fact, images of the sun formed 3
in a thick cloud close to him after the fashion of a mirror. Some writers define a mock sun as a cloud, round, bright, and resembling the sun. The mock sun follows the sun, and is never left farther behind him in his orbit than it was at its first appearance. None of us, I suppose, is surprised at seeing a reflection of the sun in some fountain or quiet lake. Well, his disc may be reflected in the heavens just as readily as on earth, if only the material is suitable to produce the reflection.

XII

WHENEVER we wish to observe an eclipse of the 1
sun, we place on the ground basins filled with oil or pitch. The thick liquid is not easily disturbed, and therefore retains the images it receives. Images, I may observe, cannot be seen except in a

[1] He has altered Virgil's word "carmine" to "nomine" to suit his meaning, or, as the editors say, *lapsu memoriae.*

liquid at rest. Then we are in the habit of noting how the moon obstructs the sun, and by the interposition of her body hides his, which is so much larger, sometimes partially, if it so fall out that she only encounter a portion of his orb, sometimes completely.
2 The latter is called a total eclipse: it quite shuts out the light and shows us the stars; it occurs when the centre of the two bodies lies in the same straight line. Now, just as the image of both sun and moon can be seen on earth, so it is in the case of mock suns in the atmosphere. The still air is so compact and yet clear that it can receive the sun's likeness. Other clouds receive it, but let it go if they are either in motion, or thin, or black. The moving clouds disperse it, the rare let it slip, the black and impure do not take the impress of it, just as on earth soiled objects do not reflect an image.

XIII

1 Mock suns are wont to be formed in pairs and on the same principle. There is nothing, in fact, to prevent the formation of as many as there are clouds suitable for exhibiting an image of the sun. Some writers are inclined to hold that when two such phantoms are visible, one arises directly from the sun, the other from his image. For, to use an illustration from common experience, when several mirrors are so arranged that one is in sight of the other, all reflect the same image; but only one is directly from the original, the rest are reflections
2 of images. The nature of the object presented to the mirror makes no difference in the effect. Whatever it sees it reproduces. So, up on high there, if

some chance has so disposed the clouds that they face one another, one of them reflects the image of the sun, the other the image of his image. The clouds that produce this effect must be dense, smooth, bright and flat, analogous in character to the sun. All phantoms of this kind are white and resemble so many discs of the moon, for the reason that the sun's light that they receive and reflect back is always oblique. If the cloud, on the con- 3
trary, is beneath the sun and too near him, his rays dispel it: or again, if situated too far away, it does not reflect them nor produce any image. In ordinary experience in the same way mirrors withdrawn to a distance from us do not reproduce our features because our sight cannot carry back to us from them.

These suns, too—to employ the name given by the chroniclers,—are an indication of rain, especially if they have their position in a southern quarter, from which the most heavily-charged clouds chiefly come up. When such an image surrounds the sun on both sides, then, if we are to believe Aratus, a storm is brewing.

XIV

It is now high time that I ran over the other 1
varieties of celestial fires, whose forms are diverse one from the other. Sometimes there is a shooting star, sometimes there are glowing lights, which are occasionally stationary, sticking to one spot, and at times able to rush through the air. Several species of these may be observed. There are, for example, *Bothynae* (cave-like meteors) when within an outer circle there is a blazing gulf in the sky like a

circular grotto excavated in it. Then there are *Pithitae* (barrel-shaped meteors) when a vast circular mass of fire like a cask either rushes through the
2 sky, or blazes away in one spot. There are *Chasmata* (chasms), too, when there is a subsidence of some portion of the heavens, which sends out hissing flame, as it were, from its hidden recesses. There are also a great number of colours in all these. Some are of brightest red, some of light insubstantial flame, some of white light, some glittering, some with a uniform glow of orange without sparks or rays. We see, therefore,

The stars' long tracks that gleam white behind.

3 These stars, for so they appear to be, dart forth and flit across the sky, and by reason of their extraordinary rapidity seem to leave a long trail of fire. Our sight cannot follow their course, and wherever their career leads we imagine the heaven is all on fire. Such is the swiftness of their flight that its separate portions are not distinguished and it can be grasped only as a whole. We are aware rather of the quarter in which the star
4 appears than of its route. It, therefore, seems to mark its entire course with a line of continuous fire, because the slowness of our vision fails to keep pace with the stages of its career and sees at the same moment the start and the finish ; as happens in a flash of lightning, the fire seems a long train because the meteor traverses its path rapidly and the space through which it falls presents itself to our eyes as a whole. But, as a matter of fact, the fire does not extend itself all through the space
5 crossed by the meteor. Nor have such long thin bodies strength enough for the effort. How, then,

it may be asked, do they issue forth? The answer is, the fire is kindled by the friction of the atmosphere and is urged headlong by the wind. Still, it does not always arise from wind or friction. Sometimes its origin is due to certain peculiar conditions in the atmosphere; for on high there are many elements, dry and hot and earthy, among which fire is generated. It then streams down in pursuit of fuel to sustain it, and therefore is hurried rapidly along. The reason for the differences of colour it 6
presents lies in the nature of the material set on fire and in the degree of violence of the conflagration. A falling body of this kind betokens wind, which may be looked for in the quarter in which the meteor has burst out.

XV

How, some one further inquires, are those bright
gleams of light which the Greeks call *Sela* (luminosities) produced? In many ways, people say. They may arise from the violence of the winds, or from the fervent heat of the upper heavens. Fire is a very widely diffused element there, and sometimes catches the lower regions if they are combustible. The mere motion of the stars in their courses may kindle fire, and convey it to all that lies beneath them. Nay, is it not quite possible that the atmosphere should drive up even to the ether the germs of fire, from which may arise a glow or burning or darting resembling a star? Some of these gleams rush headlong like 2
shooting stars, some remain fixed in their place, emitting light sufficient to dispel darkness and re-

instate daylight, until their fuel is used up, and they gradually grow dimmer, and by and by, just like a flame which is dying out, are by gradual subsidence
3 reduced to nothingness. Some of these appear in the clouds, some above them: in such cases the thick air nearer the earth feeds them for a long time, but eventually forces them right up to the stars. Certain of these last no considerable time: they straightway dart across the sky, or are extinguished just at their point of origin. These are called gleams because their appearance is fitful and short-lived, though their fall is not always unattended by injury: they have often caused as much damage as lightning. One has seen houses struck by them, what the Greeks call *astrapoplecta*[1] (=star-struck).
4 Those that have a longer career and a stronger fire which follows the motion of the heavens, or those that pursue an orbit of their own, are regarded by the Stoic philosophers as Comets: of which more anon. Different kinds of these are *pogoniae* (bearded), *lampades* (torches), and *cyparissiae* (like cypress trees), and all the rest of them: they have a thin tail of fire. It is doubtful whether beams (*trabes*) and the rare barrel-meteors (*pithitae*) should be
5 placed in this category or not. Such meteors require a great mass of fire, since their immense orb sometimes surpasses in size that of the morning sun.

Among these should certainly be placed a phenomenon of which we often read in the chronicles —the heavens appeared to be on fire. The blaze of it is occasionally so high as to mount to the very stars; occasionally it is so low as to present the
6 appearance of a distant fire. In the reign of

[1] The term might also mean *struck by lightning*. A commoner reading gives the meaning: which, when grazed by this means, the Greeks called plecta (=struck).

Tiberius Caesar the fire brigade hurried off to the relief of the colony at Ostia, supposing it to be in flames; during the greater part of the night there had been a dull glow in the sky, which appeared to proceed from a thick smoky fire. No one has any doubt that these burnings in the heavens contain flame as really as they display it: they have a certain substance in them. As to those for- 7
merly discussed, I mean rainbows and halos, it is a question whether they deceive the sight and consist of an illusion; or really contain what appears in them. I and those who think with me cannot convince ourselves that the rainbow and halo have a basis of any definite material in them. For we judge that in a mirror there is nothing but a deception: the mirror only pretends to show a foreign body. What is revealed does not exist *in* the mirror. 8
Otherwise it would not come out of it, nor would it be forthwith obscured by another image: nor would innumerable forms now fade from it, now be received by it. What follows, then? That these are mere phantoms and the insubstantial imitation of real bodies. Indeed, in certain instances, people have so arranged mirrors that the objects have been distorted and degraded in the reflection. For, as I have already said, there are some mirrors that twist the faces of those who look into them, some that enormously increase them until they exceed all size and proportions of these bodies of ours.

XVI

At this point I wish to tell you a little story 1
to show you how unscrupulous lust is in seizing

every instrument that will rouse passion: so resourceful is it in goading to madness its own morbid fury. There was one Hostius Quadra whose obscenity formed a model for everything that was lewd on the stage. He was rich and avaricious, a very slave to his millions. He was eventually murdered by his own slaves, but the late Emperor Augustus considered his murder undeserving of punishment, and as good as declared that he had
2 been justly slain. This man's lust knew no distinction of sex. Among other things, he had mirrors constructed of the kind just mentioned, that reflected images of abnormal size, causing, for example, a finger to exceed the size of an arm in length and thickness. He so arranged his mirrors that he could see all his accomplices' movements, and could gloat over the imagined proportions
3 of his own body. He raised a levy of scamps like himself in all the public baths, where he chose men of the regulation height; this but whetted his appetite to have his scenes of riot reproduced in false unnatural proportions. Go to, you that say the mirror was invented for purposes of adornment! I could not soil my pen by recording the foul words and deeds of that monster: he deserved to be torn by his own jaws. To aggravate his guilt, mirrors faced him on every side that he might be a witness of
4 his own infamy. Deeds of darkness, which lie heavy on the conscience, the imputation of which ordinary men will indignantly spurn, weighed so lightly with him that he thrust them before his face, and into his very eyes. Crimes, in faith, usually dread the sight of themselves. Even in those lost to shame, and exposed to every insult, the eye is still delicately susceptible. But that beast thought his unparalleled

wickedness but a trifle; he summoned his eyes to witness it. Aye, not content with seeing his sin, he surrounded himself with mirrors to multiply and group his scenes of vice. Even when he could not 5
see directly, he employed the reflecting power of the mirrors to reveal scenes of revolting and abominable iniquity. The filthy blackguard left nothing 6
that could be called a deed of *darkness*. He had no dread of the daylight, but complacently applauded himself in all his bestial vice. Now, don't you think he would have liked to have his portrait painted in that attitude? The ministers of public vice draw the veil of modesty over them in part: in fact, a house of ill-fame is in some degree shame-faced. But that brute had made an exhibition of 7
his obscenity, and presented to his own sight what the darkest night is not deep enough to hide. I will be out and out bad, was the monster's resolve; my eyes must share my lust, they must witness and super-intend! By my art I will defeat nature's shyness: 8
nobody must imagine that I do not know what I am about! Nature is niggardly to man, she is more generous to the cattle. I will find means to thwart her, and to indulge my little weakness. My lust shall go one better than nature. I will construct a mirrored chamber that will reflect shapes of enormous size. I only wish I could make the size real; 9
but I must be content with the belief of it. My vice must see more than it can compass, and must rest content with wonder at its own restraint.

Away with such a fellow! Perchance he met a speedy death even before he could gloat over the sight. He richly deserved to be offered up as a victim before his own mirror-idol.

XVII

1 Go now and laugh at the philosophers for discussing the nature of the mirror and inquiring why our face is reflected in it, and is turned toward us too. What did nature mean by giving us real bodies and then ordaining that phantoms of them also should be visible? What was her purpose in providing material of the sort capable of receiving and return-
2 ing images? Not, I trow, that we men might use a looking-glass to pluck out the straggling hairs of our beard and polish up our face. Nature has never at any point merely provided resources for luxury. First of all, her motive was to show us the sun with his glare dulled, since our eyes are too weak to gaze at him direct, and without something to reflect him we should be
3 wholly ignorant of his shape. No doubt one may study him as he rises and as he sets. But we should know nothing of his true figure as he shines in fierce noonday brightness, without his softening ruddy glow, unless an image of him could be mirrored in some liquid where he shines less directly and is more easy to observe. In the second place, we should be unable to see or investigate the conjunction of two heavenly bodies, by which the daylight is wont to be interrupted, unless we could examine the reflections of sun and moon in basins on the ground with comparative freedom.
4 In the third place, mirrors were discovered in order that man might come to know himself.

Many benefits have ensued; first, the knowledge of self, after that, devices to secure specific results. The comely man was taught to shun conduct that

would degrade him. The uncomely learned that bodily defects must be compensated by virtue of character. The young man was reminded by his vigour that youth was the time for learning and for performing daring deeds of chivalry. The grey-beard was warned to have respect for his hoary hair and turn his thoughts sometimes to death. It was for 5
this that even objects in nature have afforded us the opportunity of seeing ourselves.[1] A clear fountain or a smooth stone gives each back his image. In the poet's words :

> Lately I saw myself on the shore,
> When the sea stood calm without a breath of wind.

What, think you, was the style of life of the people who dressed at a mirror of this kind ? The age was unsophisticated, satisfied with what supplies chance presented. It did not as yet degrade a boon into a vice, or turn nature's invention to purposes of lust and luxury. At first, chance revealed to each his 6
form. In due time the inherent self-love of mankind endeared the sight of their own figure, and they came to look more frequently into the mirror held up by nature in which they had first beheld their image. Later on, when a worse race of men ransacked the very bowels of the earth for treasure better hid more deeply, iron first came into use; its production might have caused no damage had the world produced only that one metal. But then 7
in good earnest were brought to light the other precious banes of earth. Their smooth surface presented the image of their possessors, who had in view some quite different purpose. One saw his

[1] The meaning may be, In addition, *i.e.* to artificial mirrors, objects in nature, etc.

reflection in a cup, another in a brass vessel procured for some ordinary use. Presently a round mirror was constructed specially to render this service : it was not as yet of polished silver, but of a common brittle ware.

The men of ancient days lived a homely life ; they thought themselves smart enough if they washed off in the stream of the river the dirt contracted in their work. But even then they bestowed pains on dressing their hair and combing out their flowing beards.
8 In this part of the toilet each attended to himself and at the same time helped his neighbour. The thick streaming hair of the men, which it was of old the fashion to wear, was, of course, combed out by the wives. But sometimes they thought themselves handsome enough without any such artistic hand, and they just shook it out for themselves as spirited animals do their mane. Afterwards, when luxury had now gained sway, embossed mirrors of gold and silver of full-length size were made, and at last they were actually adorned with precious stones. One of these has ere now cost a woman more than the amount of a dowry given in the old days at the public expense to the penniless daughters of famous
9 generals. Do you suppose Scipio's daughters bought mirrors chased with gold from the iron money that their dowry was paid in? Happy the poverty that gave occasion to earn such a title to glory! The Senate would not have dowered them if they had been able to afford mirrors. Whoever the man was to whom the Senate acted the part of father-in-law, he knew that he had got a wife that was above suspicion. Nowadays the whole of the dowry that the Roman people gave Scipio would not be enough to buy a single looking-glass for

some of the loose, silly daughters of our freedmen! Luxury has been gradually developed merely by the possession of wealth, and has now gone to oppressive lengths; therewith vices have received an immense accession of strength. In short, everything has got so mixed up through our perverted refinements that all that used to be regarded as the decoration of women has become part and parcel of the outfit of man; I am understating, it is now an essential portion of a soldier's kit. The mirror was introduced for the sake of the toilet; nowadays there is no vice to which it is not an indispensable adjunct.

BOOK II

[THE NATURE OF AIR. THUNDER AND LIGHTNING]

I

EVERY inquiry into the nature and constitution of 1
the universe falls into three divisions—astronomy, meteorology, and geography. The first investigates the nature of the heavenly bodies, the size and shape of the fires that ring-in the world. It inquires whether the heavens are solid, composed of strong rigid material, or woven of a fine thin stuff; whether they receive or impart motion; whether the heavenly bodies are beneath them or fixed in their texture; in what manner the sun maintains the succession of the seasons; whether he returns upon his track or not, and all the other questions of a similar character. The second division deals with what lies 2
between heaven and earth, to wit, clouds, rain, snow, and

> Thunder that frights the heart of man:

in short, all that the atmosphere does or suffers. This subject is called meteorology (*sublimia* = raised on high), because it deals with phenomena exalted above the low earth. The third part inquires about waters, lands, trees, crops, or to use a legal phrase, everything that is contained in the soil.

How comes it, you ask me, that you have put the 3
question of earthquakes in the division under which you are going to treat of thunder and lightning? For that is my plan. Well, the earthquake is due

to air, and air is the atmosphere in violent motion. Now, though the air may enter the earth in order to produce earthquakes, the treatment of earthquakes does not fall under geography, but more properly belongs to meteorology, which deals with the sphere to which nature has assigned the atmosphere. I can tell you something that will sound stranger still: I must speak of the earth when dealing with
4 the heavenly bodies. Why? you ask. For this reason: we discuss in their own proper place, as part of geography, the properties of the earth, for example, whether it is broad, projecting unequally in a huge bulge to one side, or whether it all assumes the shape of a ball, gathering up its parts into a globe; whether it binds its waters or is itself bound by them; whether it is an animal or a lifeless mass without feeling, full of air no doubt, but not its own
5 breath. These, and all other questions of the kind, as often as they crop up, will be relegated to geography, and be placed in the lowest category. But when the question comes to be the situation of the earth, the part of the universe in which it has settled, its position with respect to the heavens and heavenly bodies, then the inquiry will take its place in the higher category,[1] and obtain higher rank so to speak.

II

1 HAVING described the three divisions into which all the material of nature falls, I must add a few general remarks on the subject. And this must be premised, that the atmosphere belongs to the class of bodies that possess unity. What exactly this means, and

[1] Viz. that of the heavenly bodies which constitute the subject matter of astronomy.

why it must be laid down as an axiom, will appear if I go back a little, and entering more fully into the subject, tell you that certain bodies are continuous, and certain formed by a union of different elements.[1] Continuity may be defined as 2
unbroken union of parts one with another. Unity is continuity without a break; it is the contact of two bodies joined to one another. There can be no shadow of doubt that of the bodies around us which we see and handle, and which are either perceived or perceive, certain are composite. They are so 3
either through nexus or through mere accumulation; take as illustrations a rope, corn, a ship. Again, there are bodies that are not composite, as a tree, a stone. You must, therefore, grant that likewise among the objects that elude sense, and are grasped only by thought, some are possessed of unity[2] [while some arise from junction of parts]. See how careful I am of your susceptibilities. If I 4
had chosen to employ the jargon of philosophy, I might have got out of the difficulty by merely saying "united bodies." You must, in turn, be duly grateful for this concession to your weakness! What am I driving at? This: if at any time I speak of "unity" in this connection, bear in mind that it is not used of number, but has reference to the composition of a body that coheres through no external aid, but by its own unity. To this category the atmosphere belongs.

[1] This difficult passage, according to Gercke's text, runs: You will understand the meaning of this, and the necessity for my axiomatic position if I take up the argument a little farther back, and say that there is one kind of body possessing unity, another that is continuous, and another that is formed by junction. For junction is the contact of two bodies joined one to another, continuity is the uninterrupted joining of parts one to another, unity is continuity without junction (*i.e.* without a break).

[2] That is, are not composite.

III

1 THE universe embraces all the objects that fall, or that can fall, under our cognisance. Of these some are its parts, the remaining ones must form its material. Nature, just like every manual art every-
2 where, requires material. Let me make this a little plainer. In ourselves the parts are hand, bones, sinews, eyes; the material is the sap of the digested food, which will be distributed for the nourishment of the parts. Again, blood is in a certain sense a part of us, but still it is material as well. For it goes to form other parts, and, none the less, it is among the parts that go to make up the whole body.

IV

1 So the atmosphere is a part, a most necessary one, of the world. This it is that joins heaven and earth, separating highest and lowest in such a way as yet to unite them. It separates by coming in between, it unites by rendering possible communication between the two. It transmits to the higher regions what it receives from the earth; and again, it transfuses terrestrial objects with the influences of the heavenly bodies. I call it a part of the world in the same sense as animals and trees are
2 parts. The whole class of animals and trees forms part of the universe, since it has to be taken in to make up the whole, and without it the universe is not complete. A single animal or tree is a quasi-part: though it is lost, that from which it is lost is still entire. Now the atmosphere, as I have

been saying, adheres both to sky and earth. In both it is inborn. Whatever is an inborn part of anything else possesses unity, for without unity nothing can be born.

V

THE earth is at once part and material of the world. 1
You are not, I think, more likely to ask why it is a part than why the sky is a part. The one is just as essential as the other to the existence of the whole, which they go to make up, and from which [from the one no less than from the other][1] sustenance is provided for all animals and crops and stars. From 2
the earth all the strength of every man, all the energy of the world with its ceaseless demands, are supplied. Hence proceeds the force that, by day and by night, sustains in their labours so many stars, so active and so eager, and that provides their food. The universal nature derives from this source what suffices for its nourishment. The world has appropriated all that it requires throughout eternity. To adopt a tiny illustration of a great subject: eggs enclose within them as much moisture as they require for the completion of the creature that is to be hatched.

VI

THE atmosphere is in unbroken contact with the earth, 1
in such close juxtaposition that it must always occupy the space that she has just quitted. It is a part, as I have said, of the universe. At the same time it

[1] The words in brackets are in all probability spurious, the addition of some commentator. The whole passage is very uncertain.

receives all that the earth sends forth for the nourishment of the heavenly bodies; so that, of course, it should be understood in this connection as material rather than part. It is these earthy elements that cause its fickleness and constant turmoil. Some authorities believe the atmosphere to be composed of separate bodies as dust is, but they are sadly in
2 error. For there can never be internal effort in a body held together in any other way than by unity,[1] since the elements must be in agreement in order to contribute their united strength toward the tension. Now, the atmosphere, if assumed to be cut up into atoms, must be dispersed. Scattered elements cannot hold together as one body. But, as a matter of fact, the tension of the atmosphere is proved by inflated objects that will not yield to a blow. It is proved, too, by weights carried up to a great height merely by the support of the wind. It is proved by the sound of voices sinking or swelling according to the stirring (= vibration) of the air. For
3 what is voice save tension of the air moulded by a stroke of the tongue so as to become audible? What is all running and motion? Are they not the effects of tense air? This it is that imparts strength to the sinews, and endows the runner with his speed. When, being violently stirred, it has twisted itself into an eddy, it uproots trees and woods, carries
4 aloft and shatters whole buildings. When the sea lies all peaceful, the air raises it in waves. Or, to descend to less violent manifestations, what song can be sung without tension of breath? Or, take horns and trumpets, or those organs that by means of hydraulic pressure can produce a greater volume of sound than the mouth is capable of doing: is it not

[1] Or, except in a body of uniform texture.

through atmospheric tension that they display their functions? Or, let us note what an enormous force 5
is exerted in secret by quite tiny seeds, whose smallness has allowed them to find a lodgment in the clefts of stones. Their slender diminutive roots gather strength enough to dislodge huge boulders, split statues, and cleave crags and rocks. And to 6
what is this due but air tension, without which there is no strength, over which no strength can prevail? The unity of the atmosphere may, in fact, be inferred from the mere coherence of our bodies. What else is it that holds them together save air? What else is it by which the soul is stirred (literally, moved)?[1] What constitutes that motion if it be 7
not tension? What tension can there be except from unity? What unity could there be unless it were in the air? What else, too, brings forth from the earth its fruits and slender grain, and sets erect the verdant trees, and stretches out their branches, or sets them on high, but the tension and unity of air?

VII

Some writers believe that the air is rent and sepa- 1
rated into small parts with void spaces, as they suppose, between. They consider the easy flight of birds through it a proof that it has not a compact body, but has large empty spaces: fowls, great and small, pass through it without difficulty. But this is a mistake. For water also affords the same easy 2
motion, and there is no doubt of its unity. When it receives bodies, it always retreats in the direction

[1] Nisard translates, What imparts movement, in man, to the vital principle?

opposite to them. This the Stoics call displacement, in Greek it is peristasis,[1] which takes place in air just as it does in water. For it literally stands round every body by which it is pressed. There is no need to assume an admixture of vacuum with the element. But more of this another time.

VIII

1 FROM what has been said it must be inferred that in nature there exists a principle of activity of enormous force. For there is nothing that does not become more active through tension; and it is no less true, nothing will be found capable of tension from another body unless it have in itself capacity of tension.[2] In the same way we say that nothing could be moved by another body without possessing the quality of mobility in itself. But what element can be conceived more likely to possess tension in
2 itself than air? Will any one deny that it can be subject to that force after seeing how it tosses about the earth with its mountains, houses, and walls and towers, and great cities with their inhabitants, seas, and whole coast-lines? The tension of air is proved, too, by its velocity and expansion. Illustrations of these properties are common: in an instant the eye extends its sight over many miles;

[1] *περίστασις* = a standing around. The Latin equivalent in the text is *circumstantia*, rendered "displacement."

[2] The reading at several points is so uncertain that one cannot be at all sure of the meaning. Probably the whole passage is very corrupt. So far as the main theme is concerned, the argument seems to be, As mobility is a presupposition of motion, so tensibility is a necessary condition of actual tension produced in a body by another body. One is tempted to employ "elasticity," but the term contains implications with which the author was apparently unfamiliar.

a single voice resounds at the same moment through whole cities; light does not creep forth little by little, but is shed simultaneously over the whole world.

IX

AGAIN, how could water be subject to tension 1
without the aid of air? You entertain no doubt, I suppose, that the jet of water in the amphitheatre, which is thrown from the centre of the arena to the highest pinnacle, is accompanied by tension of the water? And yet neither hand[1] nor any other engine can send or force water more effectively than air. It lends itself readily to the influence of 2
the air, by the compelling force of which within the pipe it is raised. Its nature is to flow down, but under pressure it mounts and accomplishes great results contrary to its nature. Yes, and do not heavily laden vessels also prove that it is the resistance of air, not of water, that prevents their sinking? The water of itself would give way, and would be unable to bear up the burthens, were it not itself upborne. So, too, a quoit thrown from 3
a height into a pond does not fall straight in, but recoils, and that merely because the air bears it back. In what way, again, could the sound of a voice be transmitted through the thick barrier of a wall unless the solid masonry contained some air to receive and transmit the sound from without? The tension of the air, of course, affects not only what is exposed, but what is concealed and enclosed as well. This is easy for it to do, since it is never 4
divided, but maintains an unbroken continuity even

[1] A conjecture widely adopted gives "crane."

through the centre of objects by which it appears to be parted. The interposition of walls and high mountains renders it impassable by us, but is no obstacle to itself. The air is there all the same,[1] but a portion is enclosed and we cannot follow it through ; that's all.

X

1 THUS the air passes through the middle of an obstacle by which it is apparently divided. It not merely surrounds and encircles all objects, but permeates them likewise. It is shed abroad from the bright ether on high down to the very earth. It is nimbler and rarer and more exalted than the earth, and no less so than the waters of earth ; but, on the contrary, it is thicker and heavier than the ether, and is naturally cold and dark, its light and heat coming from without. It is not of the same specific quality in every region, but borrows
2 its qualities from its surroundings. The highest part of it is extremely dry and hot, and so, very rare also, from the proximity of the eternal fires, the endless motions of the stars, and the constant revolution of the heavens. But the lowest portion next the earth is dense and dark, because it forms a receptacle for the exhalations of the earth. The intermediate portion, in dryness and rarity, runs to neither extreme as compared with the highest
3 and lowest strata, but is colder than either. The reason is this : The higher parts are affected by the heat of the heavenly bodies that are close by; and again the lower parts are warmed in the first

[1] The general sense is clear, but the particular text is uncertain.

place by the earth's breath which is charged with heat, while in addition the sun's rays are reflected from the ground, and as far as the reflection extends it renders the atmosphere kindlier and more genial. Besides, the temperature of the lower air is raised by the warm breath of all animals, trees, and crops, whose life is dependent on heat. Add 4
to this also fires on the earth, not merely the artificial ones about which we know, but also those concealed beneath it, some of which have ere this broken out, and myriads of which are blazing away in the hidden depths incessantly. Add, too, that all the fertile parts of the earth have some degree of heat which is exhaled into the air : heat is a condition of generation, the frigid is sterile. So, then, the middle portion of the atmosphere being remote from all these influences abides in its native cold : for air is by nature chilly.

XI

Such being the divisions of the atmosphere, I 1
may observe that in its lowest layer it is most variable, unstable, and changeful. It is near the earth that the air is, so to speak, most enterprising and most long-suffering, as it tosses or is tossed. But withal, it is not all affected in the same way, but at different times at different points its different parts are in unrest and turmoil. The reasons of the changefulness and inconstancy are in part derived from the earth : her position turning hither and thither is a potent factor in determining the quality of the atmosphere. Other reasons are due to the heavenly bodies, chiefly the sun, whose course

directs the year, whose solstices determine winter
2 and summer. Next in importance is the moon's influence. But even the other stars produce an effect alike on the earth and on the air that rests upon the face of the earth. Their rising or their corresponding setting and their disturbances cause now cold, now rain, now other damage such as earth is subject to.

It was necessary for me to make these preliminary remarks before going on to speak of thunder and thunderbolts and lightnings. For as these phenomena occur in the atmosphere, I had to explain the nature of the latter, that it might more readily appear what active or passive capacities it possessed.

XII

1 THERE are, I have just said, three phenomena—lightnings, thunderbolts, thunderings: the last is simultaneous in occurrence with the others, but its sound reaches us subsequently. Lightning (*i.e.* sheet) merely reveals fire, the thunderbolt (forked lightning) actually despatches it on its mission. The former is, so to speak, a threatening and feint without a blow, the latter a stroke and a blow. There are some of the facts connected with the phenomena of thunder and lightning on which there is general agreement, others on which there
2 is much diversity of opinion. For example, there is agreement that they occur in the clouds and issue from the clouds; further, it is agreed that lightning of both kinds is either composed of fire or at any rate presents the appearance of fire. But to pass on to the points which are disputed—

some authorities believe that the fire is actually resident in the clouds, some that it is merely produced for the occasion, and that it does not exist until it issues out. But yet there is no agreement as to what brings out the fire. One explains it 3
as due to light. Again, a certain author says that the sun's rays accumulate through recurrent intersection, and kindle the fire. Anaxagoras asserts that it is distilled from the ether, that from such heat in the sky many sparks fall which the clouds enclose and retain for a long time.

Aristotle supposes that the fire does not gather in the clouds any long time previously, but rather that it bursts out at the same instant as it is formed. His opinion runs thus : Two elements of the world, 4
land and water, lie in its lower part ; each exhales its peculiar emanation. The vapour of earth is dry, resembling smoke, and produces wind, thunder, and lightning ; the breath of water, on the other hand, is moist, and produces rain and snow. But that dry vapour from the earth, to which [as mentioned] winds owe their origin, on account of its accumulation in large masses, is subject to violent lateral pressure when it is condensed for the formation of clouds. Thereupon it strikes the 5
adjacent clouds over a larger surface, and the blow reverberates loudly [in thunder]. The effect is analogous to that produced by the crackling of flame from the moisture contained in green unseasoned firewood. In this case the air enclosed in the wood has some moisture in it, and when it accumulates it bursts out in the flame. So likewise the air which, as I said a little ago, is driven out through a collision of two clouds, cannot burst or leap out without noise. The sound varies 6

according to the variety of impact in the clouds; the larger cavity in some clouds, the smaller in others account for the variety. That air violently driven out is fire, which is called sheet lightning when it forms a fitful flame of no great violence. We see the flash before we can hear the sound: eyesight is swifter than hearing, and far outstrips it.

XIII

1 THE mistakenness of the opinion that the fire is stored up in the clouds may be inferred from many considerations. For example, if the fire merely falls from the sky, why does it not do so every day from the glowing mass that is constantly up there? Then, again, the theory gives no explanation of the downward course of the fire, an element which naturally rises. Fires on earth from which embers fall belong to a different category; the embers possess a certain amount of weight, which carries them down. Fire cannot descend in the same way,
2 but must be forced or conducted down. Nothing analogous to a terrestrial fire can take place in that pure ethereal fire which contains nothing that can carry it down to earth. Otherwise, if any portion of it fall down, the whole is endangered; for anything susceptible of gradual diminution piecemeal may evidently also fall in a mass. Besides, if an element whose lightness habitually prevents its fall contain any weight in its hidden depths, how could it maintain itself in the place whence it fell? But, it is urged, are not certain forms of fire wont to descend into the lower parts of air very much like these bolts of lightning that we are investi-

gating? Admitted. Only they are conveyed, they 3
do not proceed of themselves. Some force not resident in the ether carries them down. For in the ether no violent compulsion, no breach, no interruption of the wonted continuity, can occur. It preserves a fixed succession; its fire cleansed of impurity claims the upper regions as its own, and performs its functions in preservation of the universe with beautiful precision. It cannot leave its place, no, nor even be thrust from it by external force, because no disturbing body can find lodgment in ether. Its fixed and ordered composition renders conflict impossible.

XIV

Some of your friends the philosophers, a critic may 1
say to me, in giving an explanation of shooting stars have told us that some parts of the atmosphere contract fire which is drawn from these same higher regions, and that the fires are kindled by the glow of the ether. Yes, but I reply that it makes all the difference whether the fire is alleged to fall from the ether, which is incompatible with its nature; or whether it is asserted that from its fierce glow the heat leaps the boundary between it and the lower regions, firing them by its power. For on the latter assumption, the fire does not fall from the upper region, which is impossible, but is kindled in the lower. Surely, too, when a widely 2
spread conflagration occurs in one of our cities, we see detached blocks which have for long been heated by the fire from a distance at last catch fire of themselves. So in the upper atmosphere, which is endowed with the power of drawing fire,

in all probability there are cases of ignition from the heat of the superposed ether. In nature there is never a sudden transition from one element to a totally different one. Hence there must be some congruity between lowest ether and highest atmosphere; conversely highest atmosphere cannot be wholly dissimilar to lowest ether On the confines the two elements pass so imperceptibly into one another that at a particular point there might well be doubt whether one is in atmosphere or in ether.

XV

Some of the Stoics believe that air, being interchangeable with other elements such as fire and water, does not derive from without a fresh cause of fire; it kindles itself by its internal motion. Then in dissipating masses of thick, compact clouds it necessarily emits a loud noise from the bursting of such large bodies. Besides, the very conflict of the resisting clouds contributes to the energy of the fire. In the same way the hand contributes to the cutting power of an instrument, but the actual cutting is done by the steel.

XVI

Let me now explain the difference between the flash and the bolt of lightning which you naturally wish to know. The flash is the fire widely spread out, the bolt is the condensed fire hurled with violence. Let me use a homely illustration. We sometimes join our two hands in order to take up

water in them ; then we squeeze our palms together and squirt out the water like a syringe. Imagine something like this to take place in the clouds. When they are compressed the restricted space drives out the air between them, setting it on fire at the same time, and hurling it forth like a cannon ball. The missiles from our balistae [1] and scorpions [1] give forth a loud noise as they are hurled.

XVII

A CERTAIN number of writers are of opinion that the air of itself emits a report as it traverses the cold and moist regions. Iron, they point out, when heated cannot be dipped in moisture without noise. A mass of heated metal when plunged in water causes a loud sputtering as it is cooled ; so, according to Anaximenes, air meeting cloud produces peals of thunder ; then as it rushes struggling through the obstructions that bar its way it kindles the flame of lightning merely by its escape.

XVIII

ANAXIMANDER refers all the phenomena of thunder to air. Peals of thunder are, he says, the sounds of blows on a cloud. He explains the inequality of the peals by the inequality of the blows. To the question, why it thunders in a clear sky also, he answers that even in absence of cloud the atmosphere is shaken and rent by the bursting forth of air. But why is there thunder sometimes and yet

[1] The ancient counterparts of cannon.

no lightning? The rarity and feebleness of the air render it incapable of producing flame, while yet sufficient to produce sound. Lightning, according to him, then, is really a disturbance where the atmosphere is merely parted and rushes hither and thither, displaying a faint fire that will not issue from its place. As for the thunderbolt, it is the career of the more active and denser air.

XIX

1 ANAXAGORAS says all the phenomena correspond to the descent of some force from the ether to the
2 lower regions. So when the fire encounters cold clouds it emits a sound; when it cleaves them there is a flash; less violence in the fires produces lightning, greater, thunderbolts.

XX

1 DIOGENES of Apollonia asserts that thunder arises in some cases from fire, in some from air. Fire precedes those it produces, to herald them. Those that are attended with rattling noise, but without flash, are produced by air. Either sound or flash, I grant, can and sometimes does occur without the other. Still, their powers are not distinct, each may be produced by each. For will any one say that air borne with great violence, when it can
2 produce sound, will not also produce fire? Will not every one grant, too, that fire as well as air may sometimes burst the clouds without darting from them, for example, if it has burst through a

few of the clouds, but is buried beneath an accumulation of them? So fire will pass into air, and lose its shining appearance in cutting through some cloudy obstacles and kindling what is within. Add now another inevitable result — the rush of the thunderbolt sends out blasts of air and drives them before it, and raises a wind behind it through the great extent of its impact on the atmosphere. Thus, through the vibration caused by the wind which the fire drives in front of it, all objects quiver before they are actually struck by the bolt of lightning.

XXI

We must now dismiss our tutors and try to walk 1
alone as we pass on from what is admitted to what is debatable in this subject. What is to be classed as admitted? It is admitted that the thunderbolt is fire of some kind; similarly with the lightning flash, which is simply flame ready to become a bolt if it had more strength. The difference between the two is not in character but in force. The fiery nature of the bolt is proved by its heat. Apart from that, its effects prove it, for it has often been the cause of great conflagrations. Forests and 2
portions of cities have been burnt to ashes by it. Even objects that are not struck are yet seen to be scorched, some are discoloured as if by smoky grime. Then, again, everything that lightning strikes has the smell of sulphur. And so it is beyond dispute that both phenomena are a form of fire, and that they differ merely in their method of movement. A flash is a bolt that has not strength 3
to carry it down to the earth. And conversely you

may say that the bolt is a flash that has been conveyed right down to the ground. It is not for the purpose of refinement of terms that I deal at some length with them, but in order to prove the phenomena related and of the same category and character. A bolt is something more than a flash. Inverting the statement, a flash is all but a bolt.

XXII

1 Now that it is agreed that the two things are both fire, let us see how fire arises on earth, for no doubt the same method prevails aloft. There are two common methods of producing fire—one by striking it out, as, for example, from a stone; the other by the more tedious method of friction, as when two pieces of wood are rubbed together for some time. It is, of course, not every kind of substance that gives the desired result; you must choose one suitable for giving out fire, for example, laurel, ivy, and other trees familiar to shepherds for this purpose. Probably, therefore, clouds may in the same way emit fire either from a blow or from
2 friction. Consider for a moment the force with which squalls rush forth, the impetuous eddying revolution of the whirlwind. Anything that encounters a missile from an engine of war is scattered and removed and driven far from its position. What wonder, then, that such violence in the wind extracts fire either from some external object or merely from itself? You can readily see what a glow all neighbouring bodies grazed by its passage must receive. But the force of storms cannot for a moment be compared with the energy of the

heavenly bodies, whose immense power is beyond question.

XXIII

PERCHANCE, too, when the wind only blows softly 1
and exerts no great force, the clouds, wafted against each other, will emit fire strong enough to show a gleam, though not to issue from them. Less force is required for lightning than for the thunderbolt. We found above what a glow the friction of certain woods caused. Now when the air, which is inter- 2
changeable with fire, [has been changed in full force into fire and][1] undergoes friction, it is credible and even probable that fire is struck out, but of an evanescent and transitory character, as it arises from no solid material and has no fuel in which it can lodge. It therefore quickly passes ; its duration is no longer than its route and course ; it has nothing to support it when hurled forth into space.

XXIV

BUT how, you ask me, when you philosophers say 1
that it is the nature of fire to rise, does the bolt seek the earth? Perhaps what you said about fire is not true? It seems to take its course down as well as up.

Both my statements, I reply, may be true. Fire naturally does rise and mounts if nothing prevents it, just as water naturally gravitates downwards. But water if affected by a force which drives it uphill is pressed up in the direction from which it was precipitated in rain. In like manner the same

[1] These words seem of more than doubtful genuineness.

force as launched the bolt from the cloud causes it
2 to fall to the ground. Something of the same kind happens to these celestial fires as to trees when bent. The topmost branches if slender may be dragged down so as to touch the ground; but when you let them go, they rebound to their original position. You must not regard the condition which an object involuntarily assumes as characteristic of it. If you allow fire to go where it will, it will return to the sky, the abode of all the lightest bodies. But when there is anything to carry it down and divert it from its natural course, that is not a mark of its disposition but a token of its subjection.

XXV

You and your friends say, an objector interposes, that clouds emit fire through mutual friction when they are moist, indeed wet. How can such clouds produce fire, which is no more likely to be generated by a cloud than by pure water?

XXVI

1 Well, first of all, the fire which is thus produced is, as it is found in the clouds, not water, but thick air, adapted for the generating of water; it is not yet changed into it, but is already inclined toward, and ready for, the change. There is no ground for supposing that water is first gathered in the clouds and afterwards shed from them. It falls simultaneously with its formation. But in the second place,

though I grant that the cloud is moist and charged with fully formed water, still there is nothing to prevent fire being drawn from what is moist, yes—and what will surprise you more to learn—out of pure moisture. Some authorities have actually 2
affirmed that nothing can be converted into fire without a prior change into water. A cloud, then, without prejudice to the water it may contain, may emit fire at some part of it, just as often one end of a log is blazing while the other exudes moisture. I do not deny that fire and water are opposing elements and that the one destroys the other. But where the fire is stronger than the water it wins the day. On the other hand, where there is a superabundant supply of moisture, then fire is powerless. That is why green wood won't burn. The result depends, therefore, on the quantity of water present. If it is small, no effectual resist- 3
ance is offered, the fire is not prevented. Why, according to Posidonius' account, when an island rose in the Aegean Sea long ago in our forefathers' days, the sea was lashed into foam for a long time previously and sent up smoke from its depths. At last fire was emitted, not continuously, but in flames shooting out at intervals, after the fashion of thunderbolts, just as often as the fervent heat of what lay below had overcome the weight of water above it. By and by boulders were thrown up and 4
rocks, part of them still unimpaired, which the air had thrust out before their calcination, part of them corroded by the fire and changed to light pumice; at last the cone of a blasted mountain issued from the waves. Subsequently, there was an addition to its height, and the rock grew in extent into an island. The same thing happened within our

own recollection during the second consulship of Valerius Asiaticus.

5 Why have I narrated these incidents? My purpose was to make it evident that neither is fire necessarily extinguished by having the whole sea poured over it, nor its violence prevented from bursting out by the weight of huge waves. Asclepiodotus, a pupil of Posidonius, has left it on record that the height to which the fire mounted, after overcoming the resistance of the waves, was a hundred fathoms. Now, if such a huge mass of water was unable to overcome the force of the flames that rose from its depths, how much less can the thin, dewy moisture in the clouds
6 extinguish fire in the atmosphere? In short, the moisture of the clouds is so far from presenting any obstacle to the formation of fire that lightning is never seen to flash except when the sky threatens rain. A clear sky has no bolts to hurl. No terror of that sort proceeds from a bright day, nor for the matter of that from a night that is not enveloped in cloud. But what! I hear some one say. Does it not sometimes lighten in a calm night when the
7 stars are visible? It does, but you must remember that there are clouds all the same in that quarter whence issues the flash; only, the earth's hump does not allow them to be seen by us. Add, too, what is quite possible, that low clouds near the earth may produce fire through friction. This fire when forced up to the upper regions becomes visible in the clear bright part of the sky, but none the less its place of origin was in the dark vicinity of earth.

XXVII

SOME writers have distinguished different kinds 1
of thunder, saying there was one kind with a deep growl like that which precedes an earthquake, when the wind moans and tries to burst its prison walls. Let me tell you how they suppose this kind of thunder to arise. When the clouds have enclosed air, it rolls through their cavernous depths and emits a hoarse, regular, continuous sound like bellowing. So also when that quarter of the heavens is charged with moisture, its exit is prevented until the thunder begins. Therefore, thunder 2
of this kind is a sure sign that rain is to follow. There is another kind, which is sharp, and it might be described more accurately as a crackling than as a regular sound; it resembles the report one hears when a bladder is burst over some one's head. Such thunder is the result of the breaking up of a densely massed cloud and the release of the air by which it was inflated. This is appropriately named a peal, sudden and violent. When it occurs, people collapse and are sometimes literally frightened to death by it; others retain life, but are dazed and completely lose their wits: we call them thunder-struck, for that sound in the heavens has quite unhinged their minds. This sound may also 3
be produced by the atmosphere shut up in a hollow cloud being rarefied, merely through motion, and expanded. By and by in seeking more room for itself it resounds against the walls that envelop it. In fact, is it not just similar to the applause given out by the clapping of the hands? only, when the

clouds collide, the sounds may be expected to correspond in volume to the greatness of the encountering bodies.

XXVIII

1 But clouds, says some one, are seen striking upon mountains without causing any sound. How is that consistent with your theory? Well, in the first place, a sound is not caused by any and every method of cloud collision, but only when there is an arrangement of their position suitable for producing a sound. Striking the backs of the hands does not produce clapping, but the contact of palm with palm does. It makes a great difference, too, whether the clouds that strike are hollow, or flat and extended. In the second place, the clouds must not merely drift, as against a mountain, but
2 be driven with great tempestuous violence. Besides, a mountain does not cut through a cloud, it merely disperses it by displacing the successive front layers of it. Even a bladder does not give a report irrespectively of the method in which it emits the air in it; it depends on the way in which the air escapes. If the bladder is cut with a knife, the air is emitted without the ear perceiving it. It must be burst, not cut, in order to give a report. The same, I assert, holds in regard to the clouds: they emit no peal unless broken up with great violence.
3 Besides, clouds driven against a mountain are not broken up, but merely pour round certain parts of the mountain, tree branches, shrubs, and rough projecting boulders. They are rent thereby, and emit by numerous exits whatever air they may contain; but there is no rattle unless the air all

burst out at once. In proof of this, bear in mind 4
that the wind blowing through a tree, which cuts it, hisses but does not roar. A broad blow, so to speak, that dissipates the whole mass at once, is required in order to the emission of a sound such as is heard when there is thunder.

XXIX

Moreover, the atmosphere is by constitution adapted to the transmission of sound.[1] Of necessity this is so, since sound is nothing but an impact of the atmosphere. The clouds that [as indicated] are completely rent must therefore be hollow and taut. One sees how much more resonant empty vessels are than full, and distended ones than slack. So this accounts for the sound of tambourines and cymbals; the former resound because the blow upon the air is resisted at the farther side; the latter are beaten against the air directly, but unless there were a cavity in the instrument it would not tinkle.

XXX

Some authors, including Asclepiodotus, are convinced 1
that thunder and lightning may also be produced by the collision of certain solid bodies. Once Etna was in violent eruption and cast up a huge quantity of burning sand. The daylight was veiled with the cloud of dust, and sudden night terrified the world. On that occasion, they allege, there was much thunder and lightning, produced, they maintain,

[1] The specific word *vox* = voice is used in the text.

by the concourse of dry bodies, not of clouds: with such a glow in the firmament there probably were
2 no clouds at all. Cambyses once sent an army to the temple of Jupiter Ammon in the desert. The sand raised by the south wind fell on it like snowflakes, first covering and finally overwhelming it. Probably on that occasion also there was thunder and lightning, caused by the mutual friction of the particles of sand. Such a view is not in-
3 consistent with my contention above. I have said that the earth's exhalations contain bodies of two kinds, dry and moist, portions of which roam through the whole expanse of the atmosphere. So if any heavy element be introduced, it makes a cloud thicker and more solid than if its texture were of pure air exclusively. Such a [solid] cloud
4 may burst with a loud report. The elements I have mentioned, whether they have charged the atmosphere with moist fires or with earth-sweeping winds, must produce a cloud before they produce a report. Dry elements no less than moist may make up a cloud. For cloud, as we have already said, is just a condensation of thick air.

XXXI

1 But further, if you will but open your eyes to them, there are marvellous effects in lightning that leave no doubt that a subtle divine power is inherent in it. For example, coins are fused while the purse containing them is uninjured and intact. A sword is melted while the sheath remains. The iron point is fused in a javelin, but the wooden shaft suffers no damage. The jar is smashed and

the wine frozen, but the stiffness does not last for more than three days. There are other no less 2
notable effects of lightning. The head of man or other animal struck by it always points in the direction whence the lightning issued: the twigs of all trees that are struck rise straight up in the direction of the lightning. Let me add, too, when venomous serpents or other animals whose bite is fatal are struck with lightning, all the poison disappears. How, you say, can I tell that? In the dead bodies of poisonous animals worms are not produced. But when struck with lightning they breed worms within a few days.

XXXII

LIGHTNING portends the future, too. Nor do the 1
signs it gives refer to only one or two events. Often a complete series of fate's succeeding decrees is intimated, with proof, too, plain to demonstration, far more distinct than if it were recorded in writing. There are differences of interpretation, however, between our countrymen and the Tuscans, the latter of whom possess consummate skill in the explanation of the meaning of lightning. We 2
think that because clouds collide, therefore lightning is emitted; they hold that clouds collide in order that lightning may be emitted. They refer everything to the will of God: therefore they are strong in their conviction that lightning does not give an indication of the future because it has occurred, but occurs because it is meant to give this indication. Whether the indication is its purpose or its consequence makes no difference in the method of its occurrence. How, then, do they

3 give indication unless they are sent by God? Just in the same way as birds give favourable or unfavourable omens, though they are not moved on their flight for the express purpose of meeting us. God moves them too, it is urged. You imagine He has so little to do that He can attend to trifles of this sort, if you will have Him arrange visions for one, entrails of victims for another.

4 Nevertheless, all those things are managed by Divine agency, not, however, in the sense that the wings of birds are immediately directed by God, or the bowels of cattle arranged by Him in certain forms under the priest's axe. It is in far other way that the roll of fate is unfolded; it sends ahead in all directions intimations of what is to follow, which are in part familiar, in part unknown to us. Everything that happens is a sign of something that is going to happen: mere chance occurrences uncontrolled by any rational principle do not 5 admit of the application of divination. An event that belongs to a series thereby becomes capable of being predicted. But why, then, is the honour conferred upon the eagle of giving omens concerning great events? or a similar function assigned to the raven and a very few other birds, while all the rest give no presage by their notes? The reason simply is that some departments have not yet been brought within the sphere of the art of augury, while some are incapable of ever being brought within it, because our acquaintance with them is too slight.

6 As a matter of fact, there is no living creature whose movement or meeting with us does not foretell something. Of course, only some, not all, can be observed. The omen lies in the observation. So it concerns the person who directs his attention

to it. But other things as well concern him, though they pass unheeded. For instance, the Chaldaeans confined their observation to the five great planets. But do you suppose that the influence of so many thousands of other bright stars is naught? The 7
essential error of those who pretend to skill in casting the horoscope lies in limiting our destinies to the influence of a few of the stars, while all that float above us in the heavens claim some share in us. Perchance the lower stars exert their force on us more directly; and[1] the same may be true of the stars that by reason of their more frequent movements turn their view upon man in a different way from that in which it is turned upon other living creatures. But even those stars that are either stationary or, from their velocity being the same as that of the world as a whole, seem to be so, are not without sway and dominion over us. Add 8
one other consideration and you have the subject set out with due arrangement of its parts:[2] it is not more easy to ascertain what the power of the stars is than justifiable to doubt that they possess such power.

XXXIII

To return now to lightning: the art relating to it falls into three divisions—its observation, its interpre-

[1] Or, Turn their view upon man no less than on the other living creatures now from one point, now from another, *i.e.* under more varied aspects. The passage is doubtful. The general sense is plain: nearness, frequency of appearance, and variety of aspect severally are or may be special factors in determining a star's influence on the fate of man.

[2] The text is corrupt and the sense more or less conjectural. Ruhkopf suggests that the words may have been transferred from some other passage to this. One would be inclined to suspect that *adjice* = add, instead of *aspice* = see, regard, is the correct word at the beginning of the sentence.

tation, its deprecation. The first has regard to the category in which it should be placed, the second to divination, the third to the propitiation of the gods, whose blessings we ought to ask and whose threats we must avert by prayer. We must ask them to fulfil their promises, pray them to remit their threats.

XXXIV

1 People are convinced that lightning possesses sovereign power, because its occurrence destroys the force of other portents. On the other hand, whatever it portends is regarded as unalterable, and the appearance of no other omen lessens its import. Anything threatened by unfavourable entrails or inauspicious birds will be cancelled by favourable lightning. But any warning given by lightning cannot be defeated by opposing entrail or
2 omen. Now this belief seems to me mistaken. My reason? Simply that nothing can be truer than the truth. If birds have truly foretold the future, the omen cannot be nullified by lightning: if it can, then it was not a true prophecy the birds uttered. It is not bird and lightning whose force I am here comparing, but two revelations of truth, which must be equal in authority if they are equally intimations of truth. Therefore, if the occurrence of lightning destroys the indications given by priests or augurs, there must have been a flaw in the inspection of the
3 entrails or the observation of the auguries. It is not a question of which of the two kinds of omen possesses the more exalted or powerful character: if both have furnished indications of truth, they are so far equal. You would be quite justified in asserting

that the power of flame was greater than that of smoke; but flame has just the same power as smoke, and no more, in giving indication of the existence of fire. So if the statement is confined to the assertion of the greater authority of lightning on occasions when the entrails give one indication and lightning a different one, I shall perhaps agree. But if the statement go on to affirm that although 4
other signs have foretold the truth, yet the lightning stroke has destroyed all that went before and claims credit only for itself, then the statement is untrue. And for this reason: the mere number of the auspices makes no difference. Fate is but one. If it was rightly understood through the first auspice, it is not destroyed through the second; it remains just the same. And so I say again it does not matter whether the means of our inquiry (= auspice) is the same or different, since the object of the inquiry remains the same.

XXXV

FATE cannot be changed by lightning. And why? 1
Lightning is itself a part of fate. Well, then, it may be asked, what is the good of expiation and atonement if the fates are immutable? Let me uphold the rigid sect that takes exception to such rites and regards vows as but comfort to a breast ill at ease. The fates perform their function in a far different way from that supposed; they are not moved by any prayer nor changed by pity nor by favour. The course they hold is irrevocable; once 2
they have entered upon it they flow on by unalterable decree. As the water of rushing cataracts

returns not upon itself, nor yet lingers, since each succeeding wave drives headlong that which went before ; so the order of events is rolled on by the eternal succession of fate, whose first law it is to abide by its decrees.

XXXVI

1 For what is one to understand as meant by fate ? I suppose it is the binding necessity of all events and actions, a necessity that no force can break. If you believe that such a power can be prevailed upon to change through sacrifice or the head of a snow-white lamb, you know little about the Divine dis-
2 pensation. You say that even a wise man does not change his mind : how much less is God a man that he should change ? Even the wise man knows what is best under present conditions ; to the Divine wisdom everything is present. Still, I wish, for the moment, to advocate the views of those who hold that atonement should be made for lightning, and who have no doubt that expiation is of avail, now to remove dangers, now to mitigate them, now to delay them.

XXXVII

1 In a little I will follow up what I have said and show the consequences involved. Meantime we have so much in common with the persons last mentioned in holding that vows are of service, but without prejudice to the power and sway of fate. Some things are, in fact, left by the immortal gods in such a state of suspense as to turn to the advantage

of worshippers if they employ prayer to heaven and take vows upon them. This, then, is so far from being opposed to fate that it is actually a part of fate. But my opponent argues thus: an event is either 2
going or is not going to take place. If it is going to, then it will take place, even though you take no vows upon you. If it is not going to, then it won't, even though you take the vows. The dilemma, I reply, is no valid one: you overlook an alternative that lies between those horns of yours. This, say I, will take place, but not unless vows have been taken upon those concerned. This, too, one may say, must be included in the order of fate, either that you undertake the vows or that you do not.

XXXVIII

SUPPOSE that I surrender at discretion and admit 1
that it is likewise included in fate that vows be assuredly performed. Then for that reason they will be performed. It is fated that a man be eloquent, but only if he use due means and apply himself to study. The same destiny enjoins that he should study; therefore he will study. Another will be rich, but he must first go to sea. But in the order of fate in which he is promised a great fortune, it is also decreed that he go to sea; therefore he will go to sea. In regard to expiation, I 2
apply just the same principle. A man is fated to escape danger if he expiate the threats foretold by heaven. But it is likewise contained in fate that he offer expiation; therefore he will offer it.

An objection is usually urged against this view which seeks to prove that no freedom of will is on

this assumption left to us, all sway is handed over to fate. When I come to treat of that subject, I will explain how, without infringing the power of fate,
3 something may still be left to human choice. For the nonce, I have explained the point at issue, viz. how, consistently with an order fixed by fate, perils from prodigies may be averted through expiation and sacrifice, inasmuch as they do not conflict with fate, but, on the contrary, are assumed by the very law of fate. What benefit, then, you say, can I derive from a soothsayer? In any case I must of necessity offer expiation, even though he be not by to advise it. He so far does good in that he is the instrument of fate. In like manner, when recovery from illness seems the work of fate, it is due at the same time to the doctor, because the boon of fate passes through his hands in order to reach us.

XXXIX

1 THERE are, Caecina says, three kinds of lightning —the counselling, the authoritative, and what is called the ordinary. The counselling occurs before an event, but after the design is formed. When something is simmering in one's mind, the lightning stroke either urges it or deters from it. The authoritative one succeeds an event, indicating its
2 outcome as good or ill fortune. In the ordinary case, people are busied neither with action nor design when the lightning suddenly occurs. The flash conveys either threat, promise, or warning. The last form is indeed called admonitory: I am disposed to think it is identical with the counselling mentioned above. One who warns at the same time counsels.

Yet there is a distinction between them. Therefore they are put in different classes. The one applies suasion or dissuasion, the other is restricted to warning how to avoid an impending danger; as, for 3
example, fire, or deception from neighbours, or a plot by slaves. Besides, I can perceive another difference between the two kinds: if one has a design, then the lightning that occurs counsels; but if one has no such design, it warns. Each situation has its own peculiar features. In deliberation advice is appropriate, but a warning comes unsought.

XL

On the face of it, one's comment on this view 1
would be that these are so many kinds of prognostications and not of lightning. Of the latter the kinds are the boring, the splitting, and the scorching. The first has a subtle flame, which from its unalloyed purity can win escape through the tiniest aperture. The second, which scatters to the winds what it strikes, is massed fire with an admixture of condensed tempestuous wind. So the first kind escapes again by the opening by which it entered. The second spreads wide the effects of its violence, it bursts what it strikes, and does not perforate it. The third kind mentioned, the scorching, has much 2
earthiness in its composition, and contains fire rather than flame. It therefore leaves deep scars of fire, which will be branded in what it has struck. No lightning, it is true, that comes to earth is fireless, but this kind is distinctively called fiery, because it imprints the marks of fire so manifestly, by either scorching or staining. It scorches in three

different ways, that is, it either breathes on its object, so to speak, inflicting slight injury, or burns it right up, or sets it on fire. All those are methods of what I have called scorching, differing, however, in character and degree. Whatever is, for example,
3 burnt up is necessarily scorched as well. But [the converse is not equally true], everything that is scorched is not necessarily burnt up. And so with what is set on fire ; it is not necessarily consumed, the fire may merely have scorched it in passing. Everybody knows that things may be scorched without breaking out into fire, but that nothing can break out into fire without being scorched. I have only one further remark on the point : an object may be consumed without being set on fire ; it may also be set on fire without being consumed.

XLI

1 I PASS on now to the kind of lightning that stains objects struck by it. The staining is either discolouring or colouring, between which I draw a distinction. When the colour is spoiled, without being changed, there is discolouring. On the contrary, there is colouring when the aspect of an object becomes different in kind from what it was, for example, when it turns dark blue or black or pale. So far the Etruscans and the philosophers are in agreement. But disagreement begins when the former go on to assert that lightning is sent by Jupiter, to
2 whom they assign three species of bolt. The first, according to their statement, gives a peaceful warning, being sent by Jove's own counsel. The second is, it is true, sent also by him, but by advice

of his council, to which he summons the twelve gods as assessors. This bolt is no doubt beneficial, but not without doing damage to some extent. The third kind of bolt is still of Jove's sending, but he summons into council the so-called supreme veiled gods. This bolt causes destruction of what it encounters, and in particular it changes the existing condition of private and public affairs that it finds For fire allows nothing to remain as it is.

XLII

TAKING a superficial view one would pronounce 1
these old beliefs all wrong. What could be more absurd than to believe that Jupiter hurls bolts from the clouds, aiming at pillars, trees, aye, and statues of himself sometimes, or that, passing by the sacrilegious unbelievers, he strikes sheep, sets fire to altars, and smites innocent flocks? or can one imagine that great Jove should call the gods into council, as if he were himself lacking in counsel? Or that those bolts bring promise of peace and joy that he hurls unaided, and those cause destruction in whose despatch a greater crowd of deities was concerned? If you ask my 2
opinion on the point, however, I may tell you that I do not for a moment suppose those people of old were so obtuse as to believe that Jupiter was evilly disposed or, to say the least of it, insufficiently prepared with his missiles. When he issued fiery bolts to pass over the heads of the wicked and strike the innocent, as is alleged, did he, do you suppose, refuse to send them with truer aim, or did he miss his shot? If that cannot be the explanation,

what was the idea of those ancients in speaking as
3 they did? Being men of profound wisdom they were, in my opinion, of the settled conviction that fear was essential to restrain the passions of the ignorant; we must reverence something higher than ourselves. In a time of such audacious crime it was expedient that there be a belief in something which no criminal could seem powerful enough to resist. And so it was to terrify those wretches, against whose passions innocence is no protection unless backed up by fear, that they placed over us in the heavens the image of an avenger, and him well armed.

XLIII

Why, therefore, on this assumption, is the bolt that Jupiter sends alone, peaceful, while the other is destructive on which he has sought counsel, and which he has sent down with the approval of other gods besides? The reason is that Jupiter, that is, an absolute monarch, when acting alone ought to be always a power for good; he should not inflict injury unless when a numerous council has ratified the decision. From this let all those who have inherited great earthly power learn that not even the bolt of heaven is sent without counsel taken. Let them call to them their advisers, let them ponder the opinions of a multitude of counsellors, let them temper the rigour of their decrees; and when some blow must fall, let them not forget that even Jupiter needs more than his own wisdom to guide him.

XLIV

Nor, again, were the ancient sages so stupid as to 1
suppose that Jupiter changed his missiles. It is only the licence of poetry that can with decency say :

> There is another and lighter bolt to which the Cyclopes' hands
> Have added less of harshness and of flame, less, too, of wrath.
> The dwellers above call them missiles of peace.

Those men of exalted wisdom were undoubtedly 2
not possessed with the delusion that Jupiter sometimes employs lighter bolts, weapons of the practising school, so to speak. Their object was to warn those who have to direct their bolts against the sins of men, that all offences are not to be visited after the same fashion : some offenders must be crushed, some censured and lightly punished, some [1] dismissed with an admonition.

XLV

Nor yet did these ancient sages believe that the 1
Jupiter we worship in the Capitol and the rest of the temples ever really hurled thunderbolts from his hand. They recognised the same Jupiter as we do, the guardian and ruler of the universe, its soul and breath, the maker and lord of this earthly frame of things, to whom every name of power is appropriate. If you prefer to call him fate, you will not be wrong. He it is on whom depend all things,

[1] *Admoneri* = to be admonished, seems necessary, instead of the authorised *admoveri*, to which it is impossible to attach any satisfactory meaning in this connection. The word means to be moved towards ; *amoveri* = to be removed, would make sense.

from whom proceed all causes of causes. If you prefer to call him providence, you will still be right;
2 for he it is by whose counsel provision is made for the world that it may pursue its orderly course and unfold the drama of its being. If you prefer to call him nature, you will make no mistake; for it is he from whom all things derive being, and by whose breath we live. If you prefer to call him the world, you will not be in error; for he is everything that you can see, he is wholly infused in all his parts, self-sustained through inherent power. The Etruscans thought so too. They said bolts were sent by Jove, just because nothing is performed except by his power.

XLVI

But, you ask, why does Jupiter pass over the guilty and strike the innocent? That is too big a question to enter on here; it shall have its own place and time. Meantime I insist on this, that bolts are not sent directly by Jupiter, but that all things are so arranged that even what is not done by him is yet not done without some plan, which plan is his. The force of the bolts is a consequence of his permission. For even though Jupiter does not make them, he caused them to be made. He does not superintend every detail; but to all he gives the signal, force, and cause.

XLVII

There is another division of them made to which I cannot agree. They are, according to the asser-

tion of some, either constant or limited or deferred. The constant are those whose prognostication extends all over life, not merely intimating a single occurrence, but embracing the series of coming events through the whole subsequent life. This is the kind of bolt that occurs first after entrance on an inheritance, or when an individual or a city has entered on a new phase of existence. Limited ones answer exactly to a definite date. Deferred are those whose threats may be delayed, though they cannot be averted and completely avoided.

XLVIII

I WILL now state my reasons for disagreeing with 1
this division. One is that even the bolt which is called constant lasts for a limited period. Such bolts correspond no less than others to a definite date. Nor do they cease to be limited because the period they signify is a long one. So, too, what is thought to be deferred is limited. For by the admission of the advocates of this division the period for which delay can be procured is a definite one. Bolts that relate to private matters cannot, according to them, be delayed longer than ten years, those relating to public affairs not more than thirty. So this class, as well as the first, is limited, as it includes the date beyond which the prognostication cannot be deferred. There is thus a fixed 2
period for bolts and results of every kind. For of what is uncertain there could be no distinct knowledge. Then, too, these people talk in too vague and general terms about the points to be noted in lightning. They ought rather to divide them

according to the scheme of the philosopher Attalus, who had specialised in this department. The inspection should determine where the lightning occurred, when, to whom, in what connection, of what kind, of what amount. If I were to attempt to arrange and classify all these, I should just be committing myself to an endless task.

XLIX

1 LET me now glance at the names of the lightning adopted by Caecina, and explain my own opinion of them. He calls one kind imperative, as it demands the re-establishment of sacrifices neglected or informally offered. Admonitory is the second kind, giving information of what must be guarded against. Pestilential is a kind that portends death or exile. Deceptive is that which, under guise of some
2 benefit, inflicts injury; for example, it gives the consulship to some one whose ruin the office will prove, or bestows an estate the profit of which must be compensated by some great loss. The avertible, again, bring an appearance of danger without real danger. The destructive remove the threats of previous lightning. The attested signify an agreement with former lightning. The earth-borne occur in a covered place. The overwhelming strike what was previously struck without due
3 atonement having been made. The royal smite either the election ground or the government quarter of a free city; their prognostication threatens a free state with an absolute monarchy. Infernal are when fire issues from the ground. Hospitable summon or, to use a more polite word, invite

Jupiter to share a sacrificial feast with us. If he happen to be angry with his host when he is invited, then his coming, Caecina says, is fraught with danger to his entertainers. Auxiliary come by summons too, but bring good to the summoner.

L

BUT how much simpler is the division employed 1
by our distinguished Stoic, Attalus, who combined skill in the Etruscan lore with all the subtlety of Greek thought! Of the different kinds of lightning, he says, one gives intimation of something that concerns us, another kind intimates either a thing of no importance or something whose meaning does not reach us. Of the significant lightning there are several varieties—one is favourable, one unfavourable, a third neither one nor other. Of 2
the unfavourable there are all these forms—the evils portended may be either unavoidable or avoidable, or such as may be mitigated, or such as may be delayed. Again, the benefits foretold by the favourable may be either abiding or transient. The mixture of favourable and unfavourable may either consist of half and half, good and ill; or ill may be turned by them into good, or good into ill. The lightning that is neither unfavourable nor favourable gives us intimation of some action by which we need neither be terrified nor elated, for example, a journey abroad from which there is nothing either to fear or hope.

LI

LET me revert for a moment to the lightning that portends something, but a something that does not

concern us; for instance, whether the same kind of lightning as has occurred will again occur in the same year. Sometimes lightning contains no indication at all, or one whose grasp eludes us; as, for example, those manifestations of it that are scattered through the spaces of the sea or in lonely deserts. Their indication, if any, is lost.

LII

1 I HAVE still a few remarks to add in order to show more fully the force of lightning in various ways, for its power is not always displayed in just the same way in every kind of material. For instance, the stronger bodies are shattered with greater violence on account of their resistance; it sometimes passes through the yielding ones without doing any damage. With stone and iron and all the hard substances it enters into conflict, because in its impetuous course it must find a way through them; so it makes a way by which to escape. The more flexible and thinner substances, though they seem very suitable material for flames, it spares, mitigating its fury when it encounters no obstacle to its passage. And so, as I said at a previous point, coin is found fused, while the purse that contained it is untouched; the extremely thin fire runs through the invisible interstices of the latter. But whatever solidity it meets in a beam it subdues
2 as being refractory. For, as I have just said, its fury does not always take the same form; the nature of the force in each case is revealed merely by the kind of the damage, and you can tell the species of the lightning by its effect. Again, the

force of the same flash produces many varieties of damage in the same material. For example, in a tree it scorches any portion that is very dry; what is firm and hard it bores through and smashes; the outer bark it scatters, the inner layers nearer the centre it bursts and cuts up, the leaves it lashes and strips off. Wine is frozen, iron and copper fused.

LIII

IT is a strange fact that when wine that has been 1
thus frozen is used after it returns to its liquid state, it either kills or drives mad those who have drunk of it. When one inquires why this effect should be produced, the suggestion presents itself that the lightning contains a pestilential force, some taint of which probably is left in the liquid it has condensed and frozen. Indeed, the substance could never have been solidified had not some bond of cohesion been introduced. Moreover, in oil and every kind of unguent there is a foul smell after lightning has touched them. Whence it is manifest 2
that this subtle fire, driven in a direction contrary to its nature, contains a pestilential power, for not only its blow but even its mere breath is overwhelming. Moreover, wherever lightning has struck there is sure always to be a smell of sulphur, a substance which, being naturally poisonous, causes delirium if breathed too freely. But we shall return to this point when we are more at leisure. For I should like some day to prove the extent to which the world is indebted to philosophy, the parent of the arts, for knowledge of all such matters. She it was that first both investigated the

causes of things and noted their effects. She performed a service far more valuable than the inspection of lightning in thus comparing results with the principles from which they are derived.

LIV

1 I WILL at this point revert to Posidonius' opinion of the cause of thunder. From the earth and its confines are exhaled certain elements, partly moist, partly dry and smoke-like. The latter element remains in the sky as material for lightning, while the former falls in rain. The dry smoky particles that reach the atmosphere will not allow themselves to be enclosed in clouds, but burst their envelope. Thence comes the report which we name thunder. Besides this, anything in the atmosphere itself that is rarefied is at the same time dried and heated up.
2 This also, if it is enclosed, seeks an exit with equal eagerness, and causes a report as it escapes. On one occasion it makes a complete burst, and the thunder is consequently the more violent; on another it escapes by degrees in small portions. Air of this kind, then, by either bursting or flying through the clouds, produces peals of thunder. The rolling of the air enclosed in a cloud is the most potent cause of setting fire to what is struck.

LV

1 THUNDER is, in short, simply the report of explosions of dry air, which cannot occur unless there is either friction or a rent in a cloud. Posidonius

adds that if the clouds merely collide with each other, the kind of blow needed to produce an explosion is given, but not completely; clouds do not meet through their whole extent, but only part with part. And again, soft substances do not resound unless knocked against hard ones; a wave is not heard unless when it beats on the hard shore. But fire, which is soft, says an opponent, when let into water, also a soft substance, produces sound in being extinguished. Well, suppose it is so, it makes 2
for the opposite view which I urge. For it is not really the fire that makes the sound, but the air escaping through the water that is quenching it. Granted that fire is both produced and extinguished in the cloud, it arises from air and friction. Well then, it is urged, may not some of the shooting stars plunge into a cloud and be extinguished? Even supposing that such a thing can and sometimes does occur, it does not remove the difficulty. It is not the occasional chance cause but the natural normal one that we are in search of. Suppose I admit the truth of your contention that occasionally after thunder fires gleam in the heavens much like shooting and falling stars. Yet this does not prove 3
that the thunder was caused by them; it merely shows that the thunder occurred simultaneously with this other phenomenon. Clidemus asserts that a lightning flash is an empty reflection, and not real fire; for in the same way after nightfall a gleam appears from the motion of oars in water. His illustration is not on all fours with the phenomenon. In the latter case the gleam is seen actually within the water; in the former, in the atmosphere, it bursts and leaps out of its element.

LVI

1 HERACLITUS is of opinion that the flash of lightning is the first attempt of a fire to kindle ; just as on earth when the flame is at first unsteady, now dying down and now darting up again. The ancients used to call this summer lightning. We now say in the plural thunder peals (*tonitrua*) ; the ancients said either thunder (*tonitruum*, 2 sing.) or merely peal (noise, *tonus*). The foregoing remark I find in Caecina, an eloquent man, who would have had a considerable reputation as such had he not been overshadowed by Cicero's towering form. Besides, the ancients had other variants of a similar kind. They employed with the penult short the word that we use with it long ; we say *fulgēre* (to lighten) just as we do *splendēre* (to gleam). But in order to denote this sudden burst of light from the clouds their usage was to shorten the middle syllable so as to make it *fulgĕre*.

LVII

1 WHAT do I think myself about the matter, you ask. For up to this point I have been reproducing the opinions of others. Well, I will tell you. There is lightning when light bursts out suddenly and widely. This occurs when the atmosphere has been changed, by the rarefaction of the clouds, into fire, which has not gathered strength to issue to any considerable distance. There is, I presume, no cause for surprise either that movement rarefies air or that rarefaction kindles fire. In the same

way a leaden bullet is liquefied when discharged from a sling, and falls in drops by reason of atmospheric friction just as it would do through fire. Bolts of lightning are more numerous in 2
summer, for the reason that there is most heat at that season. Fire naturally starts more readily when the friction is in warmer air. A flash of lightning which merely gleams and a bolt which is discharged are produced in exactly the same way. But there is less force in the former case and less fuel. To put my opinion on the point shortly : a bolt is just lightning in its most intense form. So 3
then, when a body of the nature of heat or smoke is exhaled from the earth and, meeting with clouds, is for a long time rolled about in their hollows, at last it bursts out. Since it possesses no strength, it is merely a flash. But when lightnings have more material and burn with fiercer glow, they not merely become visible, but also fall to the earth.

LVIII

Some writers are firmly convinced that the lightning 1
bolt always returns to the clouds. Others hold that the bolt settles in the ground, at least when its fuel is heavy, and when it has comparatively little force in its stroke as it glides down. But why, it may be asked, does the bolt make its appearance suddenly, and is there not a continuous trail of fire ? It is on account of the extreme rapidity of its motion ; it fires the air at the same moment as it bursts through the cloud. By and by when the motion ceases, the flame subsides. For the course of the 2
air that forms the bolt is intermittent, which pre-

vents continuity in the fire. As often as the air by its more violent agitation sets itself on fire it conceives an impulse toward flight. When the internal conflict has been ended by its escape, it is afterwards for the same reason sometimes carried down as far as the earth, and sometimes, if urged down with less force, it is dissipated in air. Why, again, is the course of the lightning oblique? The reason is that the air current of which it is composed
3 is oblique and tortuous. Nature summons fire upward, violence presses it downward, and so it begins to be zigzag. Sometimes, when neither force gives way to the other, the fire is at the same moment urged toward the upper and depressed toward the nether regions. Why are the peaks of mountains frequently struck by it? Because they are exposed to the clouds, and objects falling from heaven to earth must pass by way of them.

LIX

1 I KNOW quite well what you have long been anxious to say and what you demand. I had rather, you say, get rid of fear of thunderbolts than learn all about them. So you may reserve for others your instruction regarding their origin. Let me be delivered from fear of them rather than be informed of their nature. Well, I will follow your invitation, for I quite allow that some moral should be attached
2 to all studies and all discourse. As we dive into the secrets of nature and treat of things in the heavens, the soul must be delivered from its errors and from time to time reassured. Even the learned who devote themselves exclusively to this pursuit require such reassurance; not in order to escape

the arrows of fortune, for her missiles are hurled on us from every side, but in order to bear them with resolution and constancy. Unvanquished we may be, unassailed we cannot be, though meantime the hope sometimes insinuates itself that even this is possible. How? you exclaim. Despise death and 3
then everything that leads to death is despised, be it war or shipwreck, or the jaws of wild beasts, or the weight of roofs rushing down with sudden fall. What more can they do than part the body from the soul? And this parting no care can shun, no good fortune can remove, no power can prevent. Other features in human lot are variously 4
assigned; to death's call all are alike subject. Whether heaven is propitious or wrathful, die we must.

Let courage be derived from our very despair. The most cowardly of animals which nature has created for flight, if they find no way of escape open to them, show fight with their unwarlike body. In fact, no foe is more deadly than one into whom a tight corner has put courage. Far more violent resistance is offered to death through necessity than through valour. A desperate soul 5
shows as much daring as a courageous, probably more. Let us assume that, so far as concerns death, we are given over to it; and so we are. The fact is so, Lucilius; we are all destined to death. All this nation that you see, all the people you can anywhere suppose to exist, will some day soon be recalled by nature to the grave. There is no question of the fact, only of the day. Sooner or later we must all go to the one place. Well, then, 6
does not he seem to you the most fearful and silliest of men who by great entreaty seeks to delay death?

Would you not despise a man who was set in a company of those appointed to death if he asked by way of favour to be allowed to be the last to lay his head upon the block? We do the same in setting such store upon a little delay in the time of death. Capital punishment is the sentence on
7 all mankind, and the sentence is most just. We possess what is wont to be regarded as the greatest consolation that those sentenced to the extreme penalty could enjoy; the circumstances of all being the same, our fate is the same. If handed over by a judge or magistrate to execution, we should follow and render obedience to our executioner; what difference does it make whether it is by order of another or of our own accord that we go to death?

How foolish you must be, how forgetful of your feebleness if you are afraid of death every time it thunders! Does your abiding safety really depend
8 on this? Will life be secure if you escape the lightning? You will be a victim of the sword, of a stone, of a fever. The lightning is not the most serious of dangers, it is only the most conspicuous. Your fate, I should think, would not be a bad one if the inconceivable rapidity of your death prevented any sense of it, if your death was the occasion of sacrificial ceremonies, if even when you breathe your last, you are not quite a superfluity,
9 but remain as a sign of some great event. Your fate is surely not bad if you are buried along with the bolt of lightning. And yet you are in panic at a crash in the sky, you tremble at the sound of a hollow cloud; as often as there is a flash you are ready to give up the ghost. Well then, is it in your judgment more creditable to die of sheer chicken-heartedness than to be killed by

lightning? Rather, say I, confront all the more resolutely the threats of the heavens, and when the universal world is in flames around you, consider that in such a mighty mass you have nothing to lose. But if you can bring yourself to believe that that wreck of heaven, that conflict of the stormy winds, is aimed at you, if it is on your account that the clouds are piled up and collide and roar, if it is for your destruction that such a mass of fire is scattered abroad, then you may surely regard it as some consolation that your death has cost so dear! But there will then be no room for such a reflection. The fate of one struck by lightning removes all fear. Among other advantages it includes this, that it anticipates your expectation; no man ever was afraid of lightning except one who had escaped it.

BOOK III

WHICH TREATS OF THE DIFFERENT FORMS OF WATER

PREFACE

I AM not unaware, my dear friend Lucilius, of the 1
greatness of the edifice whose foundations I am laying in my old age, when I resolve to survey the universe, to unearth its motives and secrets, and to reveal them to the knowledge of others. When shall I ever manage to cover such a field, gather together such widely-spread material, behold with clear vision such profound secrets? Old age presses hard on the rear, upbraiding me with the years bestowed on vain pursuits. We must ply our task all the more vigorously, and toil must now make good the loss of a lifetime withdrawn from its true purpose. Night must be added to day, engagements cut 2
short, care abandoned of property that lies far away from its owner. The mind must be wholly set free from other thoughts, and at least at the moment of its flight from earth must bestow itself in self-contemplation. It shall do so, and shall urge itself on, and each day it shall measure the brief span of time left. What has been lost shall be repaired by diligent use of the remainder of life. The surest pledge of virtue is repentance and amendment. I may ex- 3
claim in the words of an illustrious poet:

> High is the courage that inspires me, great the work, but short
> The time in which to plan.

I should say the same were I planning it in boyhood or in youth. No period could be anything but narrow in face of such an undertaking. As it is, when the midday of life is past, I have entered upon
4 a task that is serious, difficult, limitless. Let me act as people generally do in a journey—those that are late in starting make up for the delay by their speed. I must hurry on, and without further excuse on the score of age proceed to tackle my problem —undoubtedly a vast, possibly an insuperable, one. My mind swells with pride when I survey the magnitude of my undertaking and reflect how much is unaccomplished of my plan, though not of my life.

5 Some writers have wasted their efforts in narrating the doings of foreign kings, and in telling, as the case may be, the sufferings or the cruelties of nations. Surely it is wiser to try to end one's own ills than to record for a coming generation the ills of others. How much better to make one's theme the works of the gods than the robberies of Philip, or Alexander, or the other conquerors who earned their fame by the destruction of mankind! Such men were as truly scourges of humanity as a flood by which a whole plain has been inundated, or a conflagration by which the greater part of its
6 living creatures has been burnt up. The historians tell us how Hannibal crossed the Alps, how he suddenly transferred into Italy a war rendered more formidable by Roman disasters in Spain; how, when his fortunes were shattered, more determined still, even though the fate of Carthage was sealed, he wandered through all kingdoms, offering to be leader against Rome, and begging for an army; how he never ceased even in his old age to seek

to rouse up war in every corner of the world. He could, it was plain, endure to be without a country, but not without a foe.

How much better is it to inquire what ought to 7
be done than what has been done, and to teach those who have entrusted their state to fortune that nothing she gives is stable, but that all her gifts are more fickle than the very air! For she cannot rest, her delight is to match sadness with joy, and to mingle smiles with tears. Therefore in the day of prosperity let no man exult, in the day of adversity let no man faint: the successions of fortune alternate. Why should you boast yourself? The wave 8
meantime bears you aloft on its crest; but where it may strand you, you cannot tell. Its end will be of its own choice, not of yours. Or why, again, do you despond? You have been carried down to the nadir; now is the chance of rising again. Adversity alters for the better, success for the worse. Changes of the kind must be anticipated, not merely in private families, which are affected by a slight cause, but also in sovereign houses. Dynasties rising from the gutter have ere now established themselves above the ruling powers, while ancient 9
empires have fallen when in the very heyday of their power. The number cannot be reckoned of the kingdoms that have been overthrown by other kingdoms. God now makes it His special aim to exalt some and to overthrow others; nor does He let them gently down, but dashes them from their pinnacle, so that no remnant of them is left. A great sight it is; we think it so only because we are ourselves small. There are many departments 10
in which the standard is not derived from the actual size of the objects, but from our own littleness.

What, I ask, then, is the principal thing in human life? Not to have filled the seas with fleets, nor to have planted the standard of the nation on the shores of the Red Sea, nor, when land has been exhausted, to have wandered for the injury of others over the Ocean in quest of the unknown. Rather it is to have grasped in mind the whole universe, and to have gained what is the greatest of all victories, the mastery over besetting sins. There are hosts of conquerors who have had cities and nations under their power, but a very few who have subdued self. What is the principal thing? I say again. To raise the soul above the threats and promises of fortune; to
11 consider nothing as worth hoping for. For what does fortune possess worth setting your heart upon? Why, as often as you lapse from converse with what is divine back to what is human, your eyes will be blinded just like the eyes of those who have returned from bright sunlight into gross darkness. What is the principal thing? To be able to endure adversity with joyful heart; to bear whatever betide just as if it were the very thing you desired to happen. For you would have felt it your duty to desire it, had you known that all things happen by God's decree.
12 Tears, complaints, lamentation, are rebellion. What is the principal thing? A heart in face of calamity resolute and invincible; an adversary, yea, a sworn foe, to luxury; neither anxious to meet nor anxious to shun peril; a heart that knows how to fashion fortune to its will without waiting for her; which can go forth to face ill or good dauntless and unembarrassed, paralysed neither by the tumult of the
13 one nor the glamour of the other. What is the principal thing? Not to admit evil counsel into the heart, and to lift up clean hands to heaven; to seek

for no advantage which some one must give and some one lose in order that it may reach you; to pray—a prayer that no one will envy—for purity of heart; as for other blessings which are highly esteemed by the world, even should some chance bring them to your home, to regard them as sure to depart by the same door by which they entered. What is the principal thing? To lift one's courage 14
high above all that depends upon chance; to remember what man is, so that whether you be fortunate, you may know that this will not be for long; or whether you be unfortunate, you may be sure you are not so if you do not think yourself so.

The principal thing is to have life on the very lips, ready to issue when summoned. This makes a man free, not by right of Roman citizenship, but by right of nature. He is the true freeman who has escaped from bondage to self. That slavery is constant, from it there is no deliverance; it presses us day and night alike, without pause, without respite. To be a slave to self is the most grievous 15
kind of slavery; yet its fetters may easily be struck off, if you will but cease to make large demands upon yourself, if you will cease to seek a personal reward for your services, and if you will set clearly before you your nature and your time of life, even though it be the bloom of youth; if you will say to yourself, Why do I rave, and pant, and sweat? Why do I ply the earth? why do I haunt the forum? Man needs but little, nor needs that little long.

To this end it will be profitable for us to examine the nature of the universe. In the first place we shall rise above what is base; in the second, we shall set the spirit free from the body, imparting to it that courage and elevation of which it stands in need.

16 Besides, subtlety of thought practised on the hidden mysteries of nature will prove no less efficacious in problems that lie more on the surface. And nothing is more on the surface than these salutary lessons we are taught as safeguards against the prevailing vice and madness—faults we all condemn, but do not abandon.

I

1 LET us enter then on an investigation of forms of water, and let us trace the causes that produce them; whether, as Ovid says:

> There was a fountain silvery clear with gleaming wavelets;

or, as Virgil says:

> Whence through nine mouths with mighty roar of the mountain
> The sea issues in broken waves, overspreading the fields with its resounding flood;

or, as I find it in your own poem, my dear Lucilius:

> The stream of Elis wells up from Sicilian fountains.

Let us inquire by what method the waters are
2 supplied; how it is that day and night unceasingly so many huge rivers roll down their course; why some are swollen by the rain of winter, some increase in summer when all the other streams fail. Meantime let us separate the Nile from the common crowd; it is a river of peculiar and unique character. We shall give it its turn by and by. At present we will confine our treatment to the common waters, cold as well as hot. In regard to the latter we must inquire whether the heat is due to natural or artificial causes. We shall discuss other waters too which are rendered remarkable by taste or some

special virtue. Some, for example, I may explain, 3
alleviate affections of the eyes, some, those of the sinews, some effect complete cure of chronic maladies given up by doctors as hopeless. Some again heal sores, some by being drunk ease internal pain and relieve complaints of the lungs and bowels. Some staunch the flow of blood; in fact their individual uses are as varied as their taste.

II

All waters are classed as either standing or running; they are either gathered in one or occupy different channels underground. Some of them are sweet, others have pungent flavours of different kinds, among them salt, bitter, medicinal. Belonging to the last class one may name sulphur, iron, alum waters. The taste shows the quality. Waters of different kinds have many other differences. First there is touch, hot and cold; then weight, light and heavy; then colour, pure, muddy, dark blue, yellowish; then wholesomeness, wholesome and useful, or deadly or capable of petrifaction. Some waters are thin, some thick; some give nourishment, others pass through the system without benefiting it at all; the use of some removes barrenness.

III

The lie of the ground makes water either stand or run; on a slope it flows down, a plain keeps it in, causing it to stagnate. Sometimes under pressure of air it is forced uphill; it is then driven, it

does not flow. Surface water comes from rain; spring water from a natural fountain. There is, however, nothing to prevent surface and spring water in the same spot. This we see in Lake Fucinus, into which the streams drain all the rainfall of the surrounding mountains, while there are also large springs concealed under the surface of the lake itself. So, even when the torrents discharge into it in winter, it preserves its appearance unaltered.

IV

LET us inquire therefore, in the first place, how the earth can contain sufficient water to maintain the unbroken flow of the rivers, and where such a vast quantity of water comes from. We are surprised that the ocean is not sensible of the additional water derived from rivers. It is no less surprising that the earth is not sensible of the loss of all the water that issues from it. What is it that has so filled it up that it can from its hidden recesses furnish such quantities and continually make good the loss as it does? Whatever explanation we give regarding a river must apply also to streams and springs.

V

SOME are of opinion that the earth receives back all the water it has lost. The sea, therefore, does not get larger, because it does not assimilate the water that runs into it, but forthwith restores it to the earth. For the sea water returns by a secret path,

and is filtered in its passage back.[1] Being dashed about as it passes through the endless, winding channels in the ground, it loses its salinity, and, purged of its bitterness in such a variety of ground as it passes through, it eventually changes into pure, fresh water.

VI

SOME suppose that all the water that the earth drinks in from rain is sent out again into the rivers. They set down by way of proof the fact that there are fewest rivers in the localities where there is least frequent rain. On that account, they say, the deserts of Ethiopia are destitute of streams, and few springs are found in the interior of Africa, because there is always a blazing sky and almost perpetual summer. Therefore there are ugly stretches of sandy waste, without tree and without inhabitant, sprinkled at rare intervals by showers that they immediately swallow up. On the other hand, it is well known that there are abundant streams and rivers in Germany and Gaul and next to them in Italy, because they enjoy a moist climate, and even the summer is not without rainfall.

VII

A GREAT deal can obviously be urged in reply to 1
this. First of all, as a diligent digger among my vines, I can affirm from observation that no

[1] The ordinary text, as Koeller saw, is evidently wrong. It runs: "For by a secret path the sea water enters the ground and becomes visible, and returns stealthily, and is filtered, etc." No author can be supposed to have written such a sentence. The restoration must be conjectural. I have adopted what seems simplest and most in keeping with the context.

rain is ever so heavy as to wet the ground to a depth of more than 10 feet. All the moisture is absorbed in the upper layer of earth without getting down to the lower ones. How, then, can rain, which merely damps the surface, store up a supply sufficient for rivers? The greater part of it is carried off at once into the sea by river-channels. But a small portion is absorbed by the ground, and even that is
2 not retained. For the ground is either dry and so uses up at once the water poured into it; or else it is saturated and throws off what of the rainfall it does not require. This is the reason why rivers do not rise with the first rainfall; the thirsty ground absorbs it all.

And then, again, how are we to explain the fact that some rivers burst out from rocks and mountains? What contribution can be made to them by rains that are carried down over the bare crags
3 and have no earth into which to sink? Besides, wells sunk in the very driest localities to a depth of 200 or 300 feet reveal rich springs of water at a depth to which rain water does not penetrate. One may be sure there is no rain water there nor any gathering of moisture, but living (= spring) water as it is usually called. The opinion in question is disproved by this other argument, too; some springs well up in the very summit of a mountain. It is plain, therefore, that the water in them is forced up or forms on the spot, since all the rain water runs off.

VIII

SOME writers think there is an exact parallelism between the external and the internal distribution

of water in the earth. On the outer surface are huge marshes, great navigable lakes, and seas covering immense tracts of earth and pouring over its hollows. So in the interior of the earth there is abundant store of fresh water, which overflows great spaces no less than the Ocean and its gulfs above ground; in fact, still more extensively, as the depth of the earth extends farther down than that of the sea. From that supply in the deeps, therefore, those rivers of which we have spoken issue. And why should one be surprised that the earth is not sensible of their withdrawal since the sea is not sensible of their addition?

IX

SOME approve the following explanation: The 1
earth contains, they assert, many hollow recesses and a great quantity of air. This air, under pressure of the gross darkness, of necessity freezes. Then remaining sluggish and unmoved it ceases to circulate and turns into water. Just as on earth a change in the density of the atmosphere produces rain, so beneath the earth the change of density starts a river or a stream. In the former case the air above our heads cannot long remain sluggish and heavy; for sometimes it is rarefied by the sun's heat, sometimes expanded by the wind's force. There are, therefore, long intervals between falls 2
of rain. But underground the forces, whatever they are, that turn air into water, are constant—perpetual darkness, everlasting cold, inert density; they can, therefore, supply without a break the sources of fountain or flood. We Stoics are satisfied that the

earth is interchangeable in its elements. So all this air that she has exhaled in her interior, since it is not taken up by the free atmosphere, condenses and is forthwith converted into moisture.

X

1 THERE you have the first cause of the origin of underground water. You may add the more general principle that all elements arise from all: air comes from water, water from air; fire from air, air from fire. So why should not earth be formed from water, and conversely water from earth? If the earth is capable of transmutation into other elements, water must be one of them, in fact, the most suitable of them. The two things are cognate; both are heavy, condensed, both driven by nature down to the very confines of the universe. Earth is formed from water; why not water from earth in like manner?

But, you say, the rivers are too large to be accounted for in this way. Well, after you have considered the size of the rivers, just look at the
2 size of the reservoir whence they issue. Are you surprised that a fresh supply of water is always forthcoming for them, since they flow on for ever, some even rushing down their channel with impetuous haste? Surely you might as well be surprised, when the winds drive hither and thither the whole atmosphere, that the supply of air does not fail, but flows on day and night unceasingly. And the wind, remember, is not confined to a definite channel, as rivers are, but goes with wide sweep over the broad expanse of heaven. You might

well, too, be surprised that after so many breakers have spent their force, any succeeding wave is left. The truth is, nothing is ever exhausted that returns 3
upon itself (*i.e.* is self-supported). All the four elements return alternately upon one another; what is lost in one is conserved by passing into another. Nature, too, weighs her parts as if with nice adjustment in the balance, lest their just proportion should be disturbed and the world topple over into ruin (= lose its equilibrium). All elements are in all. Air not only passes into fire, but it is never without fire. Deprive it of its heat and it will grow stiff, stagnant, hard. Air passes into moisture, but nevertheless contains moisture. Earth yields both 4
air and water, and is never at any time devoid of water any more than it is of air. The mutual transition is the easier, because there is already an admixture of the element to which the transition is to be made. So (1),[1] then, the earth contains moisture, which it forces out. (2)[1] It contains air, which the darkness of its wintry cold condenses so as to form moisture. (3)[1] By nature, too, it has itself the power of changing into moisture: this power it habitually exerts.

XI

You have still a difficulty, you say. If the causes 1
giving rise to rivers and fountains are constant, why are their waters sometimes dried up? and why do they sometimes appear in places where they did not exist before? Their routes, I should reply, are often disturbed by earthquakes; the channel is cut off by a

[1] The numerals here have no counterpart in the original.

fall of rock or earth, and the water being held back seeks a fresh exit, which it forces with a certain measure of violence; or merely by the earth's vibration the course is shifted from one place to another. On the surface of the earth one may observe that rivers that have lost their channels are first of all dammed back, but afterwards, in lieu of the course
2 they have lost, force a new one. Theophrastus affirms that an incident of the kind took place in the Corycian Mount,[1] where, after a slight shock of earthquake, a fountain burst out from a fresh source.

But some writers are of opinion that other causes too are at work to call up water in other ways, or to drive or turn it from its course. Mount Haemus was once destitute of water; but after a tribe of the Gauls, being hard pressed by Cassander, took refuge there, and felled the woods, an immense supply of water appeared. No doubt the woods had attracted it for their nourishment previously. When they were uprooted, the moisture, ceasing to
3 be used up by their roots, overflowed. Theophrastus affirms that the same thing happened near Magnesia.

But with all respect to Theophrastus, this is not a very likely story. Everything that is most shady tends most to gather water. But that would not be the case if trees drained off water. Roots draw their nourishment from their immediate vicinity; but the volume of river water flows from recesses far down, and is derived from a source deeper than roots can penetrate. Besides, when trees are cut down, more moisture than before is required; the stumps suck up a supply, not merely for life, but for new growth.
4 Theophrastus tells us, too, that round Arcadia,

[1] In Cilicia.

which was a city in the island of Crete, the wells and lakes disappeared, because the land ceased to be tilled after the destruction of the city; but after it had got back its tillers, it recovered its waters also. He sets down as the cause of the dryness, that the earth had got hidebound and quite hard, and not being stirred could not transmit to the underground reservoirs the rain that fell. But if this is true, how comes it that we see springs in great plenty in the most desert ground? In fact, one finds a great deal more ground that began to be tilled on account of the abundance of water than that began to have an abundant supply of water because it was tilled. You may be quite sure that it is not mere rain water that is carried down in our greatest rivers, navigable by large vessels from their very source,[1] as is proved by the fact that the flow from the fountain-head is uniform winter and summer. Rainfall may cause a torrent, but it cannot maintain the steady, constant flow of a full river. Rains cannot produce, they can only enlarge and quicken, a river.

XII

Let us, if you please, go into the matter a little more deeply, and you will soon see that you have no cause to put further questions, once you reach the true origin of rivers. A river is, of course, formed by a supply of water that is always constant. If you ask me, therefore, how water is produced, I will ask in my turn how air or earth is produced. If there are four elements in nature, you are not entitled to ask where water, one of them, comes

[1] The text seems to be at fault, but the argument is quite clear.

2 from; it *is* the fourth part of nature. Why, therefore, are you surprised that so great a portion of nature can furnish a perpetual supply of liquid from itself? Just as the atmosphere, which is likewise a fourth part of the universe, is the source of winds and breezes, so is water, of streams and rivers. If wind is atmosphere in motion, so is a river water in motion. I have given it strength enough in saying that it is one of the four elements. You must be aware that what has an element as its source can never run short.

XIII

1 WATER is, according to Thales, the most powerful of the elements. He thinks it was the first of them, and that all the others sprang from it. We Stoics, too, are also of the same opinion; or perhaps I should rather say that we think it is the last.[1] For we say that it is fire that lays hold upon the world and changes all things into its own nature. We suppose that fire eventually fades and sinks, and that, when the fire is quenched, nothing is left in nature save moisture, in which lies the hope of the world that is to come. So fire is the end, moisture the beginning, of the world. Can you wonder that rivers may always issue from this, which was before all things, and from which all things have been
2 formed? In the separation of the elements [at the beginning] the moisture was reduced to a fourth part, and was placed in such a situation that it could furnish a sufficient supply for rivers, streams, and fountains. The next opinion expressed

[1] *I.e.* that to which all others may be reduced: the text seems corrupt, and the meaning is more or less conjectural. Gercke's text reads, "are also of the same or an analogous opinion."

by Thales is a silly one. The whole earth, he says, is upborne by water, and floats just like a boat; when it is spoken of as trembling, it is rolling by the movement of the water. It is no wonder, then, that there should be abundance of water to pour forth in rivers, since the world is itself wholly set in water. You should put out of court such an antiquated, unscientific idea. There is no ground for believing that the water comes in through the chinks in the earth's sides, and forms bilge-water in her centre.

XIV

THE Egyptians have recognised four elements also; and they then form each into two, male and female. The atmosphere they consider male where it is windy, female where it is cloudy and sluggish. They call the sea manly water, every other kind of water they call womanly. Fire they call masculine where a flame is burning, and feminine where there is a glow that is harmless to touch. The firmer kinds of earth, such as boulders and crags, they call male, reserving the term female for the parts that are amenable to cultivation.

XV

THERE is but one sea, which has so existed no doubt 1
from the beginning of things. It has sources of its own, from which its impulses and tides are derived. As with the raging sea, so with this gentler kind of water, there is a vast supply[1] in secret, which no

[1] All the texts give *via* = way. The obvious correction is *vis* = amount, supply. Gercke confirms this correction.

river course can drain dry. The exact explanation of its reserve strength has not yet been discovered. It is only the superfluous portion of it that is
2 released. Now, there are some of these beliefs to which we may safely subscribe; but I hold this further opinion. My firm conviction is that the earth is organised by nature much after the plan of our bodies, in which there are both veins and arteries,
3 the former blood-vessels, the latter air-vessels. In the earth likewise there are some routes by which water passes, and some by which air. So exactly alike is the resemblance to our bodies in nature's formation of the earth, that our ancestors have spoken of veins (= springs) of water. Again, in our bodies there is not merely blood, but many other kinds of moisture, some essential to life, others tainted and somewhat thick—brain in the head, marrow in the bones, mucus, saliva, tears, and a kind of lubricating substance that suffuses the joints, and enables them to turn more quickly (= synovial fluid).

So, too, in the earth there are several different
4 kinds of moisture. There are some kinds that grow hard when fully formed. Hence arises all the metalliferous soil, from which our avarice seeks gold and silver. Then there is the kind which turns from liquid into stone. In some localities the earth and its moisture combine to form a liquid like bitumen and other substances of the same kind. There, then, we find the cause of waters produced according to the law and will
5 of nature. But as in our bodies, so in the earth, humours often contract taints of various kinds. A blow, or some shock, or exhaustion of the ground, or cold or heat injures the natural vigour. A vein

of sulphur, too, may solidify the moisture, lasting for a longer or shorter time. Therefore, as in our bodies, when a vein is cut, the flow of blood lasts till the blood is exhausted or the incision in the vein has closed up and stopped it, or until some other cause has staunched the blood; in like manner in the ground, when the seams have been loosened and laid bare, a stream or river rushes forth. The 6
way in which the water is used up depends on the extent of the opening in the seam. At one point its flow is checked by some obstacle; at another it heals up, so to speak, into a scar and chokes the path it had made; at another the power of transmutation, which we have said the earth possesses, reaches its limit and cannot longer supply material that may be liquefied: sometimes the exhausted source is replenished, now by energy self-recruited, now by a supply drawn from external sources. For I ought to say that often dry objects placed opposite to wet attract the moisture to them. Earth itself, 7
which easily assumes another form, often wastes away, and is dissolved in moisture. The same phenomenon occurs under the earth as above it in the clouds; becoming too dense and heavy to retain longer its own character, solid begets liquid. There is often a gathering of thin, scattered moisture like dew, which from many points flows into one spot. The dowsers call it sweat, because a kind of drop is either squeezed out by the pressure of the ground or raised by the heat. This slender trickle scarce suffices to form a spring. But if the sources are great and the gatherings great, rivers issue. Sometimes they flow gently if the water merely descends by its own weight, sometimes with violence and loud roar if air be intermingled and eject the water.

XVI

1 ANOTHER peculiarity requires explanation: some wells are full for six hours and dry for six alternately: why is this so? It is hardly necessary to name the rivers individually which are at certain months broad, at certain narrow, and to give separate causes of this, seeing I can give a common explanation that applies to all. An ague returns at the same hour, gout always keeps its appointment, the custom of women, unless interrupted, observes its stated period, birth is ready at the proper month. In like manner waters have their intervals of recurrence, at which to withdraw and at which to return.
2 Now, some intervals are shorter, and the more striking on that account; some are longer, but no less certain. And what is strange in that, when you see that the succession of events, and all nature, by decree preserve their appointed order? Winter has never mistaken its time. Summer has always blazed forth in its season. The changes of spring and autumn have occurred according to their wont. Solstice and equinox alike have kept their appointed days.

Beneath the earth likewise there are laws of nature, less familiar to us, but no less fixed. Be assured that there exists below everything that you see above. There, too, there are antres vast, immense recesses, and vacant spaces, with mountains
3 overhanging on either hand. There are yawning gulfs stretching down into the abyss, which have often swallowed up cities that have fallen into them, and have buried in their depths their mighty ruins. These retreats are filled with air, for nowhere is there a vacuum in nature; through their ample

spaces stretch marshes over which darkness ever broods. Animals also are produced in them, but they are slow-paced and shapeless; the air that conceived them is dark and clammy, the waters are torpid through inaction. Most of these creatures are blind, such as moles and underground rats, which have no sense of sight, since it is unnecessary for them. From these depths fish are, according to Theophrastus, dug up in certain localities.

XVII

At this point many pleasantries will occur to you 1
to apply to my incredible narrative, which you will politely call a good story. A man will no longer go to fish with net and hook, but with his mattock! The next thing will be for some one to go out hunting at sea. Now what reason is there, I ask, why fish should not cross the land if we can cross the sea and change our abodes? You are surprised at this happening. How much more incredible are the achievements of luxury as often as it either counterfeits or vanquishes nature? Fish are to be found swimming in the dining couch; one is caught right under the table, to be transferred immediately to the table. A mullet is not thought 2
fresh enough unless it expires in the hand of the banqueter. These fish are handed round enclosed in glass jars, and their colours are observed while they expire; death paints many hues on them as they draw their last struggling breath. Others are pickled alive and killed in the sauce. These are the people who think one is romancing who asserts that a fish can live underground and instead of

being caught can be dug up! How inconceivable it would sound to them to hear that a fish swam in sauce and was killed during dinner, but not to be served at dinner; that first it was long admired, and that the eyes were feasted on it before the gullet was!

XVIII

1 SUFFER me here to lay aside my subject, and to apply the scourge to luxury! Commend me for a beautiful sight, says one, to an expiring mullet. In the death-struggle, as its life ebbs away, first a ruddy glow, then a pallor suffuses it. How symmetrical are the variations as it changes from tint to tint between life and death! Our somnolent, jaded luxury gets a long respite by means of this.[1] It was late in waking up to find how cruelly it had been circumscribed in being cheated of such a pleasure!
2 Hitherto only fishermen have been able to enjoy this grand and beauteous sight. But why should we at the banquet be satisfied with a cooked, a lifeless fish? Let him expire on the very tray. We used to be surprised at the fastidiousness of our epicures in refusing to touch fish unless it had been caught on the same day, when, as the saying goes, it smacked of the briny. It used for that reason to be delivered post haste—way had to be made for the breathless
3 porters as they hurried along shouting. To what lengths have refinements now been pushed? A fish killed to-day has come to be considered as already

[1] The passage is almost hopelessly corrupt. The meaning of this sentence seems to be that luxury gets some respite from the fatigues of the table by watching the mullet's death-struggle. Ruhkopf suggests an emendation which would give the sense: Our somnolent, jaded luxury has taken a long time to discover this new enjoyment. That would certainly be well in keeping with the following sentence.

stinking. "He was taken out of the water this day, I assure you." "I cannot trust you in a matter of such moment. I must have the evidence of my own senses; let the creature be brought here and breathe out his life before my eyes." Such a pitch of fastidiousness has the gourmands' palate reached that they will not taste a fish unless they have seen it swimming and throbbing in the very banqueting room.

The more skill our jaded luxury has had placed 4
at its disposal, the more refined and elegant the devices that in its frenzy it day by day invents; it spurns everything that is common. We used to hear the remark, "Nothing can surpass a mullet caught on the rocks"; but now it runs, "Nothing equals the beauty of an expiring mullet. Let me hold in my own hands the glass vase, to see him jump and quiver." After long and fulsome praise 5
has been lavished on him, he is taken out of his transparent pond. Then each guest shows off his experience of such scenes by pointing out the hues to his fellows. "Look how the red bursts forth, deeper than any carmine; look at the veins he has along his sides: see, you would think his belly was covered with blood; what a gleam of dark blue shot forth just under the brow! Now he is stretching himself out, and sinking to a uniform pallid hue!" Not one of these selfish fellows would sit by a dying friend's bedside, none of them can endure the sight of a father's death—a sight they have dearly longed for. How few will attend the funeral of a relative! 6
The last hour of brothers and friends is shunned by them; they are all in a hurry to be in at the death of a mullet! For he has a delicate beauty, don't you know, that nothing can surpass. My impatience

makes me sometimes exceed the bounds of decency and use words at random. These drivellers are not satisfied to bring teeth, and palate, and stomach to the revel; they make their very eyes partners in the gluttony.

XIX

1 But to return to my subject. Here is a proof I have to give you that in the underground recesses are concealed great quantities of water which abound in filthy fish. Any time that the water bursts out, it brings in its train a huge crowd of creatures foul to sight, disgusting and noxious to taste. At any rate, once, near the city of Hydissus in Caria, a flood of underground water threw up to the light of day a number of strange fishes, and all
2 who ate them died. And no wonder. Their bodies were full of oil from their long inactivity; they had been fattened in the darkness without exercise, and deprived of that light whence health is derived. A further proof that fish may be produced in those depths of earth is afforded by the breeding of eels in shady places; they also are a heavy diet through their want of exercise, especially if a considerable depth of mud has hidden them quite out of sight.
3 So then the earth contains not only veins of water by the union of which rivers may be formed, but also streams of very great size. In some cases their channel is concealed throughout, until they are swallowed up in some cavern; others of them well up in the bottom of some lake. Everybody knows that some marshes have no bottom. What is the point of my argument? It shows plainly that mighty rivers have here unending supplies whose

limits are incalculable, just as is the duration of rivers and fountains themselves.

XX

FOR the variety of taste in water there are four causes. The first is the kind of soil through which it flows. The second also depends on the soil when the water arises from transmutation of it. The third is from air which has been transformed into water. The fourth comes from some taint which water often contracts when injuriously affected by foreign bodies. These causes impart to water, first, variety of taste, then medicinal power, its heavy pestilential smell, its lightness and heaviness, its heat and its excessive astringency. It is affected by its passage through ground full of sulphur, or nitre (= saltpetre), or bitumen. If the water is tainted in this way, the drinking of it endangers life. This is the explanation of a passage in Ovid : 1 2

The Ciconians have a river a draught of whose waters turns into stone
The bowels ; which mantles in marble all that it touches.

The river in question has medicinal properties, its mud being of the kind that glues together and hardens the bodies it encounters. Just as the dust at Puteoli becomes stone if it touches water, so, contrariwise, if the water of this river touches a solid body, it adheres and gets firmly affixed to it. This is the reason why objects thrown into the same lake[1] are constantly found to be turned to stone when they are taken out. This occurs at several places in Italy ; you may put into the water 3

[1] The allusion is not quite evident.

a twig or bough and a few days after you can
4 take out a stone. The mud surrounds the object and gradually coats it over. This will seem the less surprising if you have remarked that the Albula, and, generally speaking, all water charged with sulphur, deposit a coating of it on the banks of their channels and streams. Some one or other of the foregoing causes accounts for the peculiarities of those lakes, whereof who tastes with the lips, in the words of the same poet,

> Goes raving mad or endures a sleep of wondrous depth.

5 The effect is like that of strong drink, only more violent. Drunkenness is madness until its effects pass off; with a weight like lead it bears down its victim into sleep. In the like manner the strong infusion of sulphur in this water contains a sort of poison that is more potent owing to the noxious atmosphere, and either goads the mind to madness or weighs it down in deep sleep. The river in Lyncestis likewise possesses this baleful power:

> For whoso with intemperate lips has drained a draught,
> Staggers as if having drunk deep of wine undiluted.

XXI

THERE are certain caves a glance down into which has cost people their life. So swift is their destructive power that it kills in flight the birds that cross them. That is the kind of air and the kind of place from which waters of death escape. If the infection of the air and place is less severe, the damage is less fatal too, merely affecting the sinews like men overpowered by intoxication. I am not

at all surprised that place and air infect water and render it similar in character to the tract through which and from which it proceeds. Similarly, milk shows the taste of the cow's fodder, the quality of the wine comes out even in the vinegar it yields. There is, in fact, nothing that does not bear marks of its origin in the same way.

XXII

THERE is another species of water which we Stoics are satisfied must be coeval with the world. If the latter has existed from all eternity, so must it too. If the world has had some beginning, then the water was assigned its place at the creation. You want to know what kind of water I mean? I mean the Ocean and all its seas that wash the continents of the earth. Some philosophers are convinced that the rivers likewise whose nature is inexplicable, date from the creation of the world; such are the mighty rivers Danube and Nile, too remarkable to be supposed by any possibility to have the same origin as other rivers.

XXIII

SUCH is the division of various kinds of water, as it presents itself to some minds. After that come waters of the sky, which the clouds pour down from the upper regions. Of terrestrial waters, they say, there are some that overflow, so to speak, and creep along the surface; others are concealed underground. I have already explained all these.

XXIV

1 SEVERAL explanations are given of the temperature of water. Sometimes it is hot, sometimes it boils so fiercely that it cannot be used until it has given off its steam in the open, or is tempered by mixing cold water with it. Empedocles is of opinion that as there are fires concealed in many places beneath the earth, water is heated when they happen to lie beneath the ground through which it has to flow. Let me use an illustration. We are in the habit of constructing serpentines,[1] and cylinders, and vessels of several other designs in which thin copper pipes are laid in descending spiral coils. The object is to make the water meet the same fire over and over again, and flow through a space sufficient for heating it up; so, entering as cold it comes out hot.
2 Empedocles supposes something of the same kind to take place underground. People who have their baths heated without fire may well believe that he is right. In this case air from the heated furnace is introduced. The air glides along the passages, warming up the walls and vessels of the bathroom just as if fire had been directly applied. In short, all the cold water in these instances is changed into hot by merely passing through a heated medium; and inasmuch as it is conveyed in an enclosure there is no evaporation to impart a flavour to it.[2] Others, again, suppose that the water contracts heat by issuing from or passing through ground charged with sulphur; the heat is imparted by the properties

[1] The technical name is "worm."
[2] There is considerable doubt regarding the correct text and meaning.

of the material, to which also smell and taste bear witness. All substances, I may say in general terms, tend to reproduce the qualities of the medium by which they have been warmed. If you are surprised at sulphur warming water, you have only to pour water over quicklime; it will at once evolve heat.

XXV

SOME waters are fatal, although they give no in- 1
dication of this either by smell or taste. In Arcadia, near Nonacris, the river called by the people there the Styx lures strangers to ruin, as its appearance and smell rouse no suspicion. This is like the drugs of accomplished poisoners, which cannot be detected save by their fatal effects. The water I mentioned a little above brings destruction with amazing swiftness, and allows no opportunity of applying a remedy. It hardens immediately it is 2
drunk, and, much like chalk under the influence of water, it sets and binds fast the bowels. There is a poisonous water in Thessaly, near Tempe, shunned by all cattle and wild beasts. It comes out through seams of iron and copper, and contains the power of softening the very hardest material. It does not nourish any trees either, and it kills grass. Certain rivers possess a peculiar and strange power. Some there are whose draught dyes whole flocks of sheep. Within a short time those that were black have white fleeces; in other cases those that came white go away black. This is what two rivers in Boeotia do, one of which from its effect is called Melas (Blackwater). Both the rivers issue from the same lake, to go on their opposite

3 missions. So, too, in Macedonia, Theophrastus asserts there is a river to which shepherds who desire to turn their sheep white bring them. If the sheep drink it for any length of time, their colour changes as if they had been dyed. But if those people want a dark wool, they have a dyer ready at hand who charges nothing; they have merely to drive the same flock to the river Peneus. I have recent authorities for the statement that there is a river in Galatia that has the same power of changing the colour in all animals, while in Cappadocia there is one which if drunk changes the colour of horses but not of any other animal; their skin is dappled with white spots.

4 It is well known that there are lakes whose waters bear up those who cannot swim. There used to be a pool in Sicily, there still is one in Syria, in which brickbats float, and no objects thrown in, however heavy, will sink. The cause of it is obvious. Weigh any object and compare it with water while they are equal bulk for bulk. If the water is the heavier, it will bear the object that is lighter than itself, and will raise it above its surface to a height proportionate to its lightness; objects heavier than the water will sink
5 in it. But if the weight of water and of the object compared with it in respect of weight be equal, the object will neither go to the bottom nor yet will it stick up; it will just be in equipoise with the water. It will float, it is true, but almost submerged and without any part projecting. The differences in weight give the reason why some logs float almost entirely above water, while some sink to their centre, and some go down until they are in

equipoise with the water. For it always holds good that, when the weights of the two are equal, neither yields to the other; but objects heavier than water sink, those lighter are upborne.

Now heavy and light do not refer to our judg- 6
ment of weight, but are relative to the medium by which an object is to be supported. So when water is heavier than the human body or than a stone, it does not allow the inferior weight to sink. So it comes to pass that in some lakes even stones will not go to the bottom; I mean hard solid stones. There are many light pumice stones, of which in Lydia whole islands that float are composed. Theophrastus is my authority for the statement. I have myself seen a floating island in the lake near Cutiliae. Another is carried about in the Vadimonian Lake, another in the lake by Statonia. The island at Cutiliae 7
contains trees and grows grass, and yet it is borne up by the water, and is wafted now in this direction, now in that, not merely by wind, but even by a mere air. So light the breath that moves it that night and day it never remains stationary in one spot. There are two reasons for it: first, there is the weight of the water, which is medicated and therefore heavy; and then there is the portable material of the island itself, which contains no solid body, although it supports trees. Perhaps in the first 8
instance the thick liquid laid hold upon and made fast light trunks and boughs scattered over the surface of the lake. So also whatever rocks are in the island, you will find porous and hollow. They resemble those formed of moisture that has hardened especially near the banks of medicinal springs; in such cases the scourings of the spring coalesce and

the foam is solidified. It is necessarily light, being formed by concretions of windy, empty material.

9 There are other peculiarities attaching to waters of different kinds, of which no explanation can be offered. For example, why should Nile water make women more fruitful? So effective is it in this respect that in some instances wombs shut up in prolonged barrenness have relaxed so as to render conception possible. Or why should certain waters in Lycia prevent miscarriage, being sought after by ladies who are subject to this frailty? For my own part I set these down among vulgar errors. It is firmly believed by people that certain waters, whether applied outwardly or taken inwardly, affect the body with scab, certain with leprosy and foul blotches over the skin. Water gathered from dew, they say,
10 has this fault. Wouldn't any one suppose that water that turns into ice is the heaviest of all? The truth is just the opposite of this. The change takes place in the thinnest water, which for that very reason is most easily congealed by the cold. The origin of the stone that resembles ice is plain from the very name used for it by the Greeks. They apply the term crystal (*κρύσταλλος*) equally to the transparent stone and to the ice from which the stone is supposed to be formed. Rain water, which contains very little solid matter, once it is frozen becomes more and more condensed through the persistence of the longer cold until all the air is expelled, and it is compressed to the last degree; then what was once moisture is changed into stone.

XXVI

Some rivers rise in summer like the Nile, of which I will give an account later on. Theophrastus makes himself responsible for the statement that in Pontus likewise certain rivers rise in the summer season. Four different causes are assigned for this. First, the earth is at that period most readily changed into moisture. Second, there are in the remote districts heavier rains, the water from which, finding its way by secret channels, comes unnoticed to swell the volume of the rivers. A third explanation is that the estuary is exposed to more frequent winds, and is lashed by the sea waves; the river is checked and seems to increase because it cannot discharge freely. The fourth reason connects itself with the heavenly bodies. These bodies by their more severe pressure during certain months drain the rivers; when they retire to a greater distance, the waste and drain are less. What was previously lost now accrues by way of increase. Certain rivers fall visibly into some grotto or other, and thus are withdrawn from sight; some are gradually wasted and disappear. They return, however, at some distance off and recover their name and course. The reason is plain enough. There is vacant space underground. All liquid naturally is carried to the lower level and to the unoccupied space. The rivers received into these recesses have run their course there in secret. But as soon as any solid obstacle blocks the way, they burst through the part that offers the slightest obstruction to their escape and regain their channel above ground.

So when Lycus has been swallowed up by the yawning earth,
He comes forth far thence, and is born from another source.
So is now drunk up, now gliding with silent stream,
Is restored to its Argolic waves the mighty Erasinus.

4 In the East as well as the West this happens. The Tigris is absorbed by the earth and after long absence reappears at a point far removed, but undoubtedly the same river. Some fountains cast out their scourings at a fixed period; the fountain Arethuse does so every fifth summer during the Olympic festival. Thence comes the belief that the Alpheus makes its way right from Achaia to Sicily, stealing under sea by secret sluice, and reappearing only when it reaches the coast at Syracuse. On that account, during the days on which the Olympic festival is taking place, the dung of the victims offered in sacrifice being thrown into the stream of the river (Alpheus) turns up in
5 quantity away in Sicily. You have yourself told the story, my dear Lucilius, in your own poem, and so has Virgil, who says in his address to Arethuse:

So when thou glid'st beneath Sicilian seas,
Never may sea nymph mingle bitter salt waves with thine.

In the Carian Chersonese there is a fountain of the Rhodians which at long intervals sends up from its depths certain foul excretions of mud, until
6 it is set free of them by being cleaned out. At certain places wells throw up not merely mud but also leaves, and bits of crockery and any other filthy things that have accumulated in them. The sea does the same everywhere, its nature being to drive ashore all filthy impurities. In the neighbourhood of Messana and Mylae as it boils and tosses in storms it throws up on the beach something

actually like ordure, which has a vile smell too. Whence comes the fable that the oxen of the sun are stalled in that neighbourhood. In certain cases of this kind it is difficult to reach the true explanation, especially when the time of the occurrence in question has not actually been observed and is therefore doubtful. But though the immediate and 7
special cause cannot be discovered, there is a general one worth mentioning; all waters when standing and enclosed tend to throw off impurities. In water that has a current the impurities cannot settle, as they are carried down and expelled by the mere force of the stream. The waters which do not throw off foreign bodies that settle in them always boil more or less. As for the sea, it drags from its lowest depths dead bodies, refuse of vegetation, and all kinds of wreckage, and purges itself of them, not merely when its billows rage in a storm but likewise in its calm and peaceful moments.

XXVII

THE occasion reminds me of a wider question. 1
When the fated day of deluge comes, after what fashion will the earth for the most part be overwhelmed by the waves? Will it be by the strength of Ocean and the rise of the outer sea against us? Or will the rain descend uninterruptedly, and will summer be cut out of the year while persistent winter bursts its clouds and pours down endless masses of water? Or will earth herself open new 2
reservoirs and shed forth rivers more abundantly? Or will a single cause be insufficient to produce such a catastrophe, and all the methods conspire

together, the rains descending and the river floods rising, and the seas hurrying in hot haste from their place—all agencies in concert bent upon the one aim, the destruction of the human race? The last is the truth. Nature finds no difficulties in compassing her ends, especially when she hastens to make an end of herself. At the creation of things she economises her efforts, putting forth her energy in small imperceptible increase: for destruction she
3 comes with sudden and irresistible might. How long a time is needed to bring the embryo child to the birth! How great the toil called for in rearing the tender infant! How careful the nurture through which the frail body is at length brought to manhood! But how insignificant the effort needed to undo it all! Cities take centuries to establish: an hour brings their ruin. Ages rear the forest: a moment turns it to ashes. To its stability and vigour this universe of things calls for great and constant protection; quickly and
4 suddenly dissolution comes. Deviation by nature from her established order in the world suffices for the destruction of the race.

So when that day of fate comes, many causes will be at work in fulfilling its decrees; and as some, including Fabianus, think, such a change will not come without a shock to the whole universe. In the first instance there will be excessive rainfall, a dull leaden sky with never a glimpse of the sun. The clouds will be unbroken, the gathering moisture will cause thick darkness, and there will be no winds to lick
5 it up. Hence the crops will be diseased, the grain ere it be grown will wither without fruit. All tillage of man's hand will be ruined; marsh grass will spring up over all the plains. Presently the stronger

plants feel the strain ; their roots are loosened, and the pollard elms fall forward, carrying their vines with them. All shrubs lose their hold on the soil, which has become soft and flabby. Soon the ground is so saturated that it can support neither grain nor fruitful pasture. The stress of famine is felt, and recourse is had to the ancient sustenance of berries. The fruit is shaken from ilex and oak, and any other tree that has been able to keep its ground by the support of the clefts of the rocks in the mountains. Roofs are sodden and rickety ; the rain has 6
penetrated to the depths, and the foundations sink. The ground is all a marsh. It is vain to seek supports to the tottering houses ; every foundation is set on slippery ground, and in the muddy soil nothing is firm. After the storm-clouds have more and more densely massed, and the accumulated snows of centuries have melted, a cataract sweeps down from the lofty mountains carrying before it the woods now insecure in their place, tearing off boulders from their fastenings, and whirling them down in fierce career. It washes off the country 7
houses, and takes down with it flocks of sheep among the *débris*. The smaller hamlets it carries off as it passes, but at length it leaves its course and rushes in fury upon the larger homesteads. It draws in its career whole cities, inhabitants, and buildings all mixed together : people know not whether to complain of a catastrophe or a shipwreck. So utterly crushed are they and at the same time submerged by its coming.

By and by, as it advances, the cataract is swollen by the absorption of other torrents, and in devastating course roams through the whole plain. Finally, it holds universal sway ; it has earned a

title by the widespread destruction of the world
8 which it carries as its burthen. The rivers, too, originally large, have been so hurried down by the storms that they have left their channels. The Rhone, the Rhine, the Danube, even when confined within their banks, have an impetuous torrent. What, suppose you, are they now that they have overflowed and made themselves new banks, and, cutting through the soil have all wandered from their wonted course? With what headlong rush they roll down! The Rhine overspreads the plains, but the wideness of the space causes no slackening of its energy; it pours its waters in full force over the whole extent as if it were rushing through a
9 gorge. The Danube no longer washes the base, or even the middle, of the mountains; it lashes the very summits, bearing down with it the mountain sides it has flooded, the crags it has overturned, the beetling promontories through whole provinces; it undermines their foundations, and carries them far off from the mainland. And, after all, the river finds no exit—for it had closed up every passage against itself—but returns in a circuit, and envelops in one vast whirlpool the huge expanse of lands and cities.

Meantime the rains continue, the sky becomes still more threatening, and thus, for long, disaster is heaped upon disaster. What was once cloud
10 is now profound night, and that, too, dread and terrible, with gleams of lurid light between. For frequent flashes show, and squalls disturb the sea. Then for the first time, feeling the increase from the rivers, and too narrow to contain itself, the main advances its shores. Its own bounds cannot contain it, and yet the torrents from land prevent its escape, and drive back its waves. Still, the

greater part of the torrents detained by their narrow mouth recoil in pools, reducing the fields to the aspect of a continuous lake. Now everything, far as the eye can reach, is a waste of waters. Every hill is hidden in the abyss, everywhere is 11
fathomless depth of water. Only in the highest mountain tops are there shallows. To these heights men have fled with wives and children, and have driven up their cattle. All intercourse and communication have been cut off among the wretched survivors; for all the lower ground has been filled by the waves. The remnants of the human race cling to every lofty peak. Brought to the last shift, they have this one solace, that apprehension has passed into stupor. Astonishment so fills them that there is no room for fear. Even 12
grief finds no place; for it loses its force in one whose wretchedness has passed beyond perception of suffering. So there are only mountain tops that appear like islands above the water, and increase the number of the scattered Cyclades, as that accomplished poet finely says; with an exaltation of language too in keeping with his theme, he exclaims:

> All was sea; to the sea there was no shore.

It is a pity he reduced that burst of genius and his splendid subject to childish twaddle by adding:

> The wolf has to swim among the sheep, the wave carries tawny lions.

There is too little seriousness in making sport in 13
this way when the earth has been swallowed up. He expressed a fine thought and caught a vivid picture of the utter confusion when he said:

> Through the open plains the rivers wander at their will,
> . . . The towers totter and sink beneath the flood.

That was splendid, if he had not minded what the wolf and the sheep were doing. Could anything, in fact, swim amid such deluge and destruction? Was not every hoof drowned in the same torrent as carried it off? You conceived a worthy image, Ovid, when all the world was overwhelmed, and the sky itself descended upon earth. Keep it up. You will know what it ought to be if you reflect that the whole world was afloat. Now we must return to our discussion.

XXVIII

1 THERE is a section of philosophers who hold that while the earth may be greatly harassed by excessive rains, it cannot be overwhelmed by them. By a mighty blow this mighty earth must be smitten. Rain will spoil the crops, hail will knock off the fruit; but the rivers will only be swollen above their banks, and will subside again. Some, again, are satisfied that the cause of the widespread destruction will be derived from the movements of the sea. The great shipwreck of the world cannot, they think, arise from injury by cataract, river, or rain.
2 I am willing to grant that when that day of destruction is at hand, and Heaven is resolved to create a new race of men, the rain will pour down incessantly, and there will be no limit to the floods, the north and other dry winds will cease to blow; the south will bring up in plenty clouds and rain and stream.

> But hitherto only damage has been inflicted.
> The crops are laid low, and to the grief of the farmer,
> All hope of increase is abandoned; the toil of the long year is wasted and vain.

But for our purpose the earth must be more than damaged, it must be submerged. In fact, the disasters described are merely the prelude to destruction. After that, the seas swell far beyond their wonted bounds, sending out their waves far above the farthest high-water mark of the most violent tempest. The winds will urge them on from the 3
rear, rolling up huge billows that will break far inland out of sight of the highest shore. In course of time the shore will thus be shifted forward, the deep will be established in a realm that is not its own ; the mischief will come nearer, and from its new base the tide will issue still from the deepest recesses of the main. For just like atmosphere and ether, this element, sea, has a large reserve, and in its depth is far more copious than appears to the eye. This reserve, moved by fate, not merely by tides—for tides are but the agency of fate—raises and drives before it a gulf of vast extent. Then in 4
wondrous wise it rears its crest, and overtops all man's refuges of safety. Nor do the waters find this a hard task, since, if the heights were calculated, it would be found that the sea mounts from an elevation equal to that of earth. The surface of the sea is of uniform level ; for the earth itself as a whole is uniformly level. Hollows and plains are everywhere below the general level.

But the whole globe is as a matter of fact formed into a regular sphere, while in part of it is the sea, which unites to form the unity of a single ball. But just as when one looks out across a plain, the 5
ground that sinks gradually deceives the eye, so we are not aware of the sea's curvatures, and all that is visible is a plain. But being on a level with the earth, the sea does not require to raise itself to

any great height in order to overflow. In order to overtop what is on a level with it, it need make only a slight rise. Besides, the flow of it does not proceed from the shore where it is lower, but from mid ocean where the heap in question stands. Therefore,
6 as the tide at the equinox soon after the conjunction of moon and sun rises to a height greater than at any other time of year; in like manner this one that is sent out to seize upon the earth must exceed in violence the highest of ordinary tides, and bear a far greater volume of water; nor does it begin to ebb until it has swollen above the peaks of the mountains that are its objective. Some localities have at present a tide that runs up inland for a hundred miles in ordinary course harmlessly. It flows up to its normal limit and then ebbs again.
7 But when the time of deluge comes, the tide, freed from all restraint, will set no limit to its advance. In what way? you say. Just in the same way as the great conflagration is destined to take place. Both will take place when God has seen fit to end the old order, and bring in a better. Fire and water are lords of the earth. From these it took its rise, and in these it will find its grave. So when a new creation of the world has been resolved upon by Heaven, the sea will be let loose on us from above; or it may be the raging fire, if another variety of destruction is Heaven's will.

XXIX

1 SOME suppose that in the final catastrophe the earth, too, will be shaken, and through clefts in the ground will uncover sources of fresh rivers which will flow

forth from their full source in larger volume. Berosus, the translator of [the records of] Belus, affirms that the whole issue is brought about by the course of the planets. So positive is he on the point that he assigns a definite date both for the conflagration and the deluge. All that the earth inherits will, he assures us, be consigned to flame when the planets, which now move in different orbits, all assemble in Cancer, so arranged in one row that a straight line may pass through their spheres. When the same gathering takes place in Capricorn, then we are in danger of the deluge. Midsummer is at present brought round by the former, midwinter by the latter. They are zodiacal signs of great power 2
seeing that they are the determining influences in the two great changes of the year. I should myself quite admit causes of the kind. The destruction of the world will not be determined by a single reason.

But I should like to apply in this connection as well, a principle which we Stoics adopt in regard to a conflagration of the universe. Whether the world is a soul, or a body under the government of nature, like trees and crops, it embraces in its constitution all that it is destined to experience actively or passively from its beginning right on to its end; it resembles a human being, all whose capacities are wrapped up in the embryo before birth. Ere the 3
child has seen the light the principle of beard and grey hairs is innate. Albeit small and hidden, all the features of the whole body and of every succeeding period of life are there. In like manner the creation of the world embraces sun and moon, stars with their successive phases, and the birth of all sentient life; and no less the methods of change in all earthly things. Among the latter is flood,

which comes by a law of nature just as winter and
4 summer do. So, that catastrophe will not be produced simply by rain, but rain will contribute: nor by inroads of the sea, but these inroads will contribute: nor by earthquake, but earthquake will contribute. All elements will aid nature, that nature's decrees may be executed. The chief cause of its inundation will be furnished by the earth herself, which, as has been already said, is subject to transmutation, and may dissolve in moisture.

5 Therefore, there will one day come an end to all human life and interests. The elements of the earth must all be dissolved or utterly destroyed in order that they all may be created anew in innocence, and that no remnant may be left to tutor men in vice. There will be more moisture then than there ever was before. At present the elements are all carefully adjusted to the parts they have to fulfil. To destroy the equipoise in which the balance stands, there must be some addition to one or other of them. The addition will be to moisture. It has, at present, power to surround, but not to overwhelm the earth. Any addition to it must of necessity overflow into ground that does not now belong to it.[1] So the earth as the weaker is bound to yield to sea which has gathered unnatural strength. So it will begin to rot, then to be loosened and con-
6 verted into moisture, and to waste away by the continuous drain. Rivers will then issue forth beneath mountains, shaking them to the foundations by their fury; then they will flow on in silence without a breath of air. The soil will everywhere give forth water; the tops of mountains will pour it out, just as disease corrupts what is sound, and an

[1] The text is uncertain, but the meaning fairly obvious.

ulcer taints its whole vicinity. The nearer the part is to the soil that is being liquefied, the more quickly will it be washed off, dissolved, and finally carried away. The rock will everywhere gape in fissures, and the fresh supplies of water will leap down into the gulfs, and unite in forming one great sea. There will be no Adriatic any longer, no strait in the Sicilian Sea, no Charybdis, no Scylla. All 7
the fabulous dangers will be swallowed up in the new sea; the existing Ocean which surrounds the fringes of the earth will come into the centre.

Nor will this be all. As if this were not enough, winter will seize upon months that are not his, summer will be stopped, the heat of every heavenly body that dries up earth's moisture will be quenched and cease. All these names will be obliterated—Caspian and Red Sea, Ambracian and Cretan Gulfs, the Pontus and the Propontis. All distinctions will disappear. All will be mixed up which nature 8
has now arranged in its several parts. Nor will walls and battlements afford protection to any. Temples will not save their worshippers, nor citadels their refugees. The wave will anticipate the fugitives, and sweep them down from their very strong-hold. Some enemies will hasten from the west, others from the east. A single day will see the burial of all mankind. All that the long forbearance of fortune has produced, all that has been reared to eminence, all that is famous and all that is beautiful, great thrones, great nations—all will descend into the one abyss, will be overthrown in one hour.

XXX

1 NATURE, as I have said, finds no task hard, and especially one resolved upon from the beginning, to which she does not come of a sudden, but of which long warning has been given. From the world's first morning, when out of shapeless uniformity it assumed this form it wears, nature's decree had fixed the day when all earthly things should be overflowed. Nay, from of old the seas have practised their strength for this purpose, lest at any time destruction as a strange work might be found difficult to compass. Do you not see how the breaker dashes against the beach as if it wished to leave its element? Do you not see how the tide sometimes crosses its bounds and instals the sea in possession
2 of the land? Do you not see how unceasing is the war it wages against its barriers? But what special apprehension need there be of the sea, the place where you see such turmoil, and of the rivers that burst forth in such fury? Where has nature not placed water? She can attack us on all sides the moment she chooses. I can give my own word of honour for it that water meets us as we turn up the soil; every time our avarice sends us down a mine, or any other motive induces us to sink a shaft deep in the earth, the end of the excavation is always a rush of water.

3 Remember, too, that there are huge lakes hidden deep in the earth, great quantities of sea stored up, and many rivers that glide through the unseen depths. On all sides, therefore, will be

causes of deluge ; for some waters flow in beneath the earth and others flow round it. Though long restrained they will at last prevail, and will join stream to stream and pool to marsh. The sea will fill up the mouth of every fountain, and will open it out to wider extent. Just as the bowels drain 4
the body in the draught, or as the strength goes off into perspiration, so the earth will dissolve, and though other causes are inactive, it will find within itself a flood in which to sink. All the great forces will thus, I should suppose, combine. Nor will destruction tarry. The harmony is assailed and broken when once the world has relaxed aught of its needed care. At once, from all sides, open and hidden, above and beneath, will rush the influx of waters. There is nothing like the letting loose of the sea's 5
full force, for violence and ungovernable fury ; it rises in rebellion and spurns every restraint. It will make full use of its permitted liberty ; as its nature prompts, what it rends and surrounds it will soon fill up. Just as fire that breaks out at different points will speedily unite the flames and make one grand blaze, so the overflowing seas will join forces in an instant. But the waves will not enjoy their unrestrained 6
liberty for ever. When the destruction of the human race is consummated, and when wild beasts, whose nature men had come to share, have been consigned together to a like fate, the earth will once more drink up the waters. Nature will force the sea to stay its course, and to expend its rage within its wonted bounds. Ocean will be banished from our abodes into his own secret dwelling-place. The ancient order of things will be recalled. Every 7
living creature will be created afresh. The earth will receive a new man ignorant of sin, born under

happier stars. But they, too, will retain their innocence only while they are new. Vice quickly creeps in; virtue is difficult to find; she requires ruler and guide. But vice can be acquired even without a tutor.

BOOK IV

CONTAINING A DISCUSSION OF SNOW, HAIL, AND RAIN [THE NILE]

PREFACE

You tell me you are delighted, Lucilius, my most 1
esteemed of friends, with your peaceful government
of Sicily. You will continue to be delighted if you
are willing to observe the bounds of moderation, and
do not try to turn into an empire what is merely a
province. Nor do I doubt that this will be your
choice, knowing as I do that you are a stranger to
ambition, and a friend to a peaceful life of letters.
Let those who cannot bear their own company, long
for a crowd of affairs and of people! You are on
the best of terms with yourself. It is little wonder 2
that few attain such a happy lot. We are always
laying commands upon ourselves to our own dis-
peace. We suffer at one moment from love of, at
another from weariness of, ourselves. Our unhappy
soul is now inflamed with pride, now inflated with
passion. Sometimes we relax it through indulgence,
sometimes we consume it with anxiety. The most
pitiable thing of all is that we are never alone
with ourselves. So, where such a crowd of vices 3
have to mess together, there must be continual
wrangling among them. Behave, therefore, my
dear Lucilius, as you are wont to behave. Separate
yourself as far as possible from the common
herd, and expose no side to the attack of flattery.
Flatterers are adepts in spreading a net for their

betters. However much you are on your guard, you will be no match for them. If you allow yourself to be caught, you will be delivering yourself up to
4 betrayal, take my word for it. Flattery has in it the inherent charm, that even when spurned, it is not unpleasing: often shut out, it is at the last taken to the bosom. Flattery accepts its rejection as a mark of attention ; even insults cannot subdue it.

What I am going to tell you may sound incredible,
5 yet it is the simple truth. Every man is most open to danger on the side on which he is attacked. Perhaps, indeed, that is the very reason why he is attacked on that side. You must, therefore, lay your account to recognise that, do what you will, you cannot manage to be impervious to adulation. When you have closed every loophole, it will still wound you through your harness. One assailant will employ his flattery secretly and sparingly; another, above board, openly, with an affectation of honest sincerity, as if it were straightforward bluntness, not device. Plancus, the greatest adept in the art before Vitellius' time, used to say that secret, dissembled flattery was not to be employed. Ad-
6 vances, quoth he, are lost if they are not recognised. The flatterer makes most headway when he is detected; still more, in fact, if an open rebuke brings the blush to his cheek. You must assume that a public character like you will encounter many Plancuses. It is no remedy against the inveterate plague to refuse to be praised. I never knew a man more shrewd in every practical matter than Crispus Passienus, and especially in diagnosing and treating faults of character. He often used to say that we only put-to the door against flattery, and do not shut it, much in the same way as in the face of a mis-

tress. If she gives it a shove, we are pleased, still more so if she forces it open. I remember hearing 7
that distinguished man, Demetrius, remark to a certain powerful freedman that he, too, had an easy road to riches on the day that he made up his mind to renounce all virtuous resolutions. Nor will I grudge any of you, said he, the knowledge of the art, but I will teach those who regard gain as the one thing needful how they may attain their object. They need not follow the doubtful fortune of the sea, nor the competition of buying and selling: they need not place their faith in the fickle proceeds of the ground, nor the still more fickle fortunes of the exchange. I will teach them a means of making money not merely easy, but positively so merry that the victims whom they fleece will share the fun. Flattery shall be the means. If you have the 8
stature of the pigmy Thracian matched against Thracian in the arena, I will swear that you are taller than Fidus Annaeus or Apollonius Pycta. I will say that no fellow could be more liberal than you, nor shall I lie, since you may be considered to have bestowed upon all whatever you have not robbed them of.

The fact is, my dear Junior, the more open and shameless flattery is, and the more completely it has brazened its own features and raised the conscious blush in those of others, the more quickly it storms the citadel. We have now reached such a pitch of madness that he who uses flattery sparingly is considered niggardly. I used to tell 9
you that my brother Gallio—a man whom even his most ardent admirer cannot love according to the measure of his deserts—was a stranger to other vices, but this he positively loathed. You might assail

him on every side. One began by paying homage to his intellect, the greatest and worthiest of all, which one had rather see consecrated to the service of heaven than wasted in weak human effort; he ran away from one who talked thus. Or one began to praise his thrift—he was so indifferent to money that he seemed neither to possess it nor to condemn it—he cut short the very first words of the panegyric.

10 Or, again, one would admire his *bonhomie* and unaffected grace of character, which charms even those it passes unnoticed—a service to every one he meets, which costs the author nothing. No one in the world, I may tell you, is such a favourite with his one chosen friend as he is with all. At the same time so great is his natural amiability that it is free from all savour of artifice or pretence. No one, you would think, can refuse credit for a goodness in which all share. At this point, too, he successfully resisted your blandishments, leading you to exclaim that you had found a man absolutely impregnable to assaults of the flattery which no one ever refuses
11 to take to his bosom. You were forced to admit that you respected his wisdom and determination in escaping from that unavoidable plague, all the more that you had hoped that your insinuating words would be received with open ears because they were true. Yet all the more he saw that he must resist your wiles. For when truth is attacked by falsehood, the attack always seeks the aid of some measure of truth. Still, I would not have the flatterer who tried his art upon my brother displeased with his success, as if he had acted his part ill while the other suspected some joke or
12 trick. You had not been detected, your advances had simply been rejected. Now do you, Lucilius,

adapt yourself to this model. When any flatterer approaches you, say to him: Do you wish to convey a complimentary message such as passes between magistrates duly installed in office? Do you think that I am prepared to return the compliment, and willing, therefore, to listen to your long story? Neither do I wish to dupe, nor can I be duped. I should like well enough to have the praise of people like yourself if you did not praise the bad as well as the good.

And yet, Lucilius, why is it necessary for you to come down to their level, and allow them to attack you at close quarters? Keep a long distance between you and them. When you desire to have genuine praise, why should you be indebted to another for it? Yourself commend your own efforts. Say thus: Though my poverty prompted another kind of career, and tempted me to devote my talents to 13
a field which promised to application a quick return, yet I gave myself up to liberal pursuits. I turned aside to the unremunerative domains of poetry, and bestowed myself upon the wholesome study of philosophy. I have showed that seeds of virtue are planted in every breast. I have surmounted the difficulties of birth; measuring my powers, not by my lot, but by my capacity, I have reached a position on a level with the highest. My friendship with Gaetulicus did not sap my allegiance to the Emperor Caius Caligula. Messalina and Narcissus, long enemies of the State before they became enemies of one another, were unable to overturn 14
my resolve to be true to others whom it was a crime to love.[1] I risked my head for my loyalty.

[1] The passage is evidently corrupt; the facts with which it deals are in part unknown.

No word was wrung from me that I could not utter with a clear conscience. All my fears were for my friends, none for myself, except the fear of not proving a true friend. No womanish tears escaped me, nor did I cling as suppliant to the hands of any ruler. I have done nothing unbecoming a man or a good man. Rising superior
15 to dangers, ready to face all they threatened, I thanked fortune for affording opportunity of showing what a price I put upon honour. Such an issue could not be lightly esteemed in my eyes. The suspense was not of long continuance. The weights in the scale were by no means equal —was it better for me to perish for honour's sake or for honour to perish for my sake? I did not rush headlong to self-destruction, the refuge of despair, to rescue myself from the mad rage of the rulers. In Caius' time I saw tortures and fires of persecution. Under his reign I recognised at one period that the lot of humanity
16 had sunk to such a depth of misery that the loss of one's life might be ranked among the deeds of mercy. Yet, I did not fall upon my sword, nor leap open-mouthed into the sea: I would not have it seem that death was the only service I could render for honour's sake. Add, now, that my soul has never stooped to bribes, amid the eager race for wealth my hand has never reached forth to receive unjust gain. Add, too, the thriftiness of my mode of life, the restraint of my speech, my courtesy toward inferiors, my respect for superiors.

After these reflections, ask yourself, my friend, whether what you have related of yourself be true or false. If it is true, you have a most important

witness to your character; if false, there will be no witness to the derision you have earned. I may 17
myself appear at present to be either seeking to throw my net over you or trying to make you rise to my fly. Take either supposition for true, and begin, from the example I offer, to fear all flatterers. Meditate on Virgil's words:

> Nowhere is honour safe;

or on Ovid's:

> As far as earth extends, the savage Fury rules;
> For crime, methinks, all have conspired;

or on this sentiment of Menander's—for who has not put forth the full strength of his indignation 18
on this topic, in abhorrence of mankind's agreement in rushing toward vice? All are bad livers, says the poet, presenting himself on the stage in the rude character of a raw countryman. He excepts neither greybeard nor youth, neither man nor woman. He adds to the charge that it is not individuals or small numbers that sin, but that wickedness is now ingrained in society all through. One must flee from the world and return to oneself, nay, rather one must escape from oneself. Though you and I are separated by the sea, I will endeavour to render you some 19
service: placing my hand in yours I will guide your doubtful steps along the more excellent way. At this distance I will mingle my talk with yours, that you may not feel the loneliness. We shall be united in our noblest part—the spirit. We shall impart mutual counsel, and, as you hang upon the lips of your monitor, I will lead you far away from that province of yours. For I would not have you put too implicit trust in records of the past, or become self-satisfied as often as you reflect: I

20 have under my jurisdiction a province here which both maintained and crushed the armies of the mightiest states, when it was offered as a prize in that colossal war between Carthage and Rome. It saw the strength of four Roman generals, in other words, of the whole empire, massed in one spot; it raised high the fortunes of Pompey, brought Caesar's to their culmination; transferred the power of Lepidus to his rivals, and contained the fate of all. Sicily was an eye-witness of that great spectacle
21 which showed plainly to the world how rapid the descent from highest to lowest could be, and in how many different ways great power might be overthrown by fortune. For at one and the same time it witnessed the downfall of Pompey and Lepidus from the pinnacle of power in opposite ways; Pompey had to run from his enemy's army, Lepidus from his own.

I

ALTHOUGH Sicily, then, has many wonderful sights in and around it, I will meantime withdraw your mind wholly from your own province, and, passing by all questions relating to it, will direct your thoughts to a far different scene. In your society I will resume the inquiry postponed in my last book, why the Nile overflows in the summer months. Now, let me remark that the philosophers have asserted the similarity of the Danube to the Nile, because its source is unknown and it is larger in summer than in winter. Both statements are clearly false. We know for a fact that the Danube rises in Germany. Again, though the

rise of the Danube begins in summer, it is at a period when the Nile still remains within its ordinary limits: the heat is then only beginning, and the stronger sun toward the latter part of spring is softening the snows, but it has to melt them before the Nile begins to rise. During the remainder of the summer the Danube actually falls until it reaches its winter size, from which in due course it begins its rise again.[1]

II

BUT the increase of the Nile begins in the middle of 1
the hot season, before the rise of the dog-star, and continues till after the equinox. Nature has raised up this noble river before the eyes of the world, and has so ordered its inundation of the land of Egypt that it should occur at the very time at which the ground is most parched with heat. The earth thus drinks the more deeply, and imbibes sufficient to counteract the drought of the whole year. In the part of Egypt that stretches round Ethiopia, you must bear in mind, there is either no rain at all or it occurs only at long intervals, and is insufficient to give much relief to a land which ordinarily knows nothing of water from the clouds. It is in the 2
Nile, as you are aware, that Egypt reposes all its hopes. According to the abundance or scantiness of its overflow is the leanness or the fatness of its season. *None of its farmers regards the sky*, are the words of your own poem. And why should I not crack a joke with my dear poet friend, and

[1] The meaning of the last clause is taken by some to be: and even falls below it—a somewhat pointless remark.

retort with a verse from his favourite Ovid ?[1] who says :

Nor do the herbs make supplication to the rain-god Jupiter.

3 If one could only ascertain at what point in the course of the river the rise begins, the causes of the rise would also be discovered. As it is, the river wanders through great deserts, spreads out into marshes, among many scattered tribes, before it is for the first time after its wandering, mazy course gathered into one near Philae. Philae is a rugged island, precipitous on all sides ; it is surrounded by the two branches of the river before they unite to form the one river which henceforth bears the designation Nile. The whole city of Philae is surrounded by the Nile, which after leaving Ethiopia is a large rather than rapid river.[2] Next in its course are the sandy deserts through which
4 passes the trade route to the Red Sea.[2] After that the Nile enters the Cataracts, a spot famous for a wonderful sight. The river rises over high crags that are at several points jagged. The opposing rocks break up its course and rouse its utmost force ; as it struggles through the narrows, swirls show the points where it conquers or is conquered. A smooth channel had hitherto conducted its waters without uproar. Here for the first time they are roused, and the turbulent cataract leaps down through the narrow passage quite unlike its
5 former self. Up to that point the stream was thick and muddy. But once it enters the craggy gorge it breaks into foam. Its colour is no longer the natural one, but derived from the ground through

[1] The quotation is really from Tibullus.
[2] The text is very uncertain.

which it has to force its way. When at length it has struggled through the obstructions, suddenly deprived of support, it falls from a vast height with a roar that resounds through all the surrounding regions. The race planted in that savage place was indeed unable to endure the din ; their ears were deafened by the constant crash, and they were therefore removed from the settlement.

Among the wonderful sights of the river I have been told of a feat of incredible daring performed by the inhabitants. Two of them embark in a small boat, one steering, the other baling out the water. Forthwith they are violently buffeted from side to side 6
by the furious waves of the rapid river, and at length reach the narrowest channels, through which they thread their way till they escape from the craggy gorge. Then they are carried down along with the whole volume of the stream, guiding all the time by hand the rushing craft. At one moment they seem to stand right on their head ; the spectators are in great alarm ; one gives them up for lost, and believes they must be sunk and overwhelmed by such a mass of water. But finally they are shot out like an arrow, and are discovered afloat at a point far below where they had entered the current. The waves in their fall do not swamp them, but pass them on to smooth water.

The first rise of the Nile is observed near the 7
island Philae which I have just mentioned. A short distance from it the river is divided by a rock in the centre, which the Greeks call the Inaccessible (Ἄβατος). No foot approaches it save that of the priestly ministers. Those cliffs first feel the increase of the river. Then a long distance below that two crags project, called by the natives

the veins of the Nile. A great quantity of water is shed out by them, but yet insufficient to flood the land of Egypt. When the date of the sacred festival comes round, the priests throw into these fountains a public offering, while the magistrates
8 offer gifts of gold. From this point the Nile, obviously displaying the fresh energy it has gained, flows onward in a channel of profound depth, but is restrained by mountain barriers from spreading widely beyond its banks. Only when it reaches Memphis is it released; and separating into numerous channels, it roams over the champaign.

In order to regulate the supply, canals are constructed by hand, and thus the water is distributed over all Egypt. At first near its bank the stream is simply divided; by and by the waters extend till they assume the aspect of a wide, swollen sea at rest. The extent of the country flooded, which embraces the whole land of Egypt to right and left, deprives the
9 current of all its force. The height of the Nile's rise determines the expectation of growth for the year. The farmer is never out in his reckoning; the fertility of the land answers unfailingly to the measure of the river's increase. It spreads a coating of soil as well as water over the thirsty, sandy ground. As it comes down swollen, it deposits all its sediment in the dry, gaping cracks, and spreads over the parched soil all the rich mud it has brought down. It thus renders a double service to the land—first, by overflowing it, and then by coating it with slime. And so any
10 portion that it does not reach lies waste and unsightly. If the inundation is unduly high, it does damage.

The river possesses this wonderful characteristic: while all other rivers wash away and exhaust land, the Nile, though so much larger than the

rest, far from eating away or rubbing off soil, actually adds to its vigour; it contains very little that injuriously affects the soil,[1] for by the mud it brings down, it soaks and binds the sands. Egypt, in fact, owes to the river not merely the fertility of the soil, but also the soil itself. It is 11
a beautiful sight when the Nile has spread itself over all the fields. The plains are hidden, the valleys have disappeared; only the towns stand out like islands. In the interior of the country there is no communication except by boat. The people are overjoyed the more, the less they can see of their country. Even when the river has resumed its normal course, it discharges into the sea by seven mouths, any one of them itself a sea. Moreover, it sends out many less famous arms toward either bank.

And then when we look at the monsters it rears, they are equal to those of ocean in size, and no less formidable. One may judge indeed of the 12
greatness of the river from the hugeness of the animals for whose sustenance it provides food in abundance, and for whose free movements it affords room. Balbillus, a most excellent man who has distinguished himself in every walk of letters, has recorded that during his own government of Egypt he himself saw in the largest mouth of the Nile, the Heracleotic, the strange sight of what may be called a pitched battle between dolphins, coming up from the sea, and crocodiles meeting them in front from the river. The crocodiles 13
were in the event vanquished by the inoffensive animals with harmless bite. It happened on this wise: The upper part of the crocodile's body is hard, and cannot be pierced by the teeth even of

[1] Or, its least service is that it tempers the soil.

larger animals; but the lower part is soft and tender. The dolphins dived in the fight and wounded the belly of the crocodiles with the projecting spikes they carry on their back; then driving home the stroke, they fairly cut up the enemy.
14 When a number of the crocodiles had been opened out in this fashion, the remainder, to adopt military language, wheeled their line and retreated. The battle was not to the strong, the fleeing creature successfully resisted the daring, the most daring fled before the timid! Nor is it by any peculiar virtue of stock or blood that the islanders from Tentyra beat the crocodiles, but merely through pluck and contempt of them. They take the offensive against them, and as the crocodiles try to escape they lasso them and drag them ashore. At the same time many of the hunters lose their lives through lack of nerve in the chase.

Theophrastus assures us that the Nile has at
15 times brought down sea water. It is a well-established fact that for two successive years, the tenth and eleventh of the reign of Cleopatra, there was no rise in the river. People say that this was an intimation of the impending fall of its two rulers. For as a matter of fact, the rule of Antony and Cleopatra did fall. At an earlier period the Nile did not rise for nine whole years, according to the statement of Callimachus.

16 But I must now go on to inquire into the explanations of the occurrence of the rise of the Nile in summer; and I will begin with the most ancient of them. Anaxagoras asserts that the snow melting on the peaks of Ethiopia is constantly running down to the Nile. All antiquity shared the same view, which is recorded by Aeschylus, Sophocles,

and Euripides. But many proofs make it plain that 17
it is a mistaken one. First of all, the blackened complexion of the people shows that Ethiopia is exceedingly hot. So do the habits of the Troglodytes (cave-dwellers), who for coolness have underground houses. The rocks glow with heat as if a fire had been applied, and that, not only at mid-day, but even toward nightfall. The dusty ground is so hot that no foot of man can endure it. Silver is unsoldered.[1] The joints of statues are melted. No coating of plated metal will stick on. The south 18
wind, too, coming from that tract of country, is the hottest of all winds. None of the animals that go to earth in winter ever hibernates there. Even in midwinter the serpent is seen above ground in the open. At Alexandria, too, which lies far north of this excessive heat, snow does not fall; but the upper regions have not even rain.

How then, I ask, could a district exposed to such broiling heat receive a snowfall sufficient to last through a whole summer? No doubt some of 19
the mountains in Ethiopia, as well as elsewhere, intercept snow; but there can never be a greater fall than in the Alps, or the peaks of Thrace, or the Caucasus. It is in spring, however, or early summer, that the rivers that flow from the European mountains are swollen; subsequently during winter time they decrease. The reason, of course, is that the rains in spring wash off so much of the snow, and the first heat of summer soon scatters the remnants. Neither the Rhine, nor the Rhone, nor the Danube, nor yet the Caÿstrus is liable to the catastrophe of an overflow in winter; their increase is in summer, though in those northern

[1] Some render—is dissolved and gives off its lead.

peaks where they rise the snow lies very deep.
20 The Phasis, too, and the Dnieper would swell during summer if snows had the power of raising the rivers high in spite of the heat of that season. Besides, if this were the cause of the flooding of the Nile, its stream would be fullest in early summer; for that is the period when the snow is deepest and least impaired, and when from its softness the thaw is quickest. The Nile, however, has a regular increase to its stream during four months.
21 If one may believe Thales, the Etesian winds hinder the descent of the Nile and check its course by driving the sea against its mouths. It is thus beaten back, and returns upon itself. Its rise is not the result of increase: it simply stops through being prevented from discharging, and presently, wherever it can, it bursts out into forbidden ground. Euthymenes of Marseilles bears corroborative testimony: I have, he says, gone a voyage in the Atlantic Sea. It causes an increase in the Nile as long as the Etesian winds observe their season. For at that period the sea is cast up by pressure of the
22 winds. When the winds have fallen, the sea is at rest, and supplies less energy to the Nile in its descent. Further, the taste of that sea is fresh, and its denizens resemble those of the Nile. Now, if the Etesian winds, as alleged, stir up the Nile, why, I should like to know, does its rise begin before them and last after them? Moreover, it does not rise higher in proportion to the violence of their blast. Nor does it swell and fall according as they blow furiously or gently. All which would happen if it derived from them the strength of its increase.
23 Then, again, the Etesian winds beat on the shore of Egypt, and the Nile comes down in their teeth:

whereas, if its rise is to be traced to them, the river ought to come from the same quarter as they do. Furthermore, if it flowed out of the sea, its waters would be clear and dark blue, not muddy, as they are. Add to this that Euthymenes' evidence is refuted by a whole crowd of witnesses. At such a time when foreign parts were all unknown, there was opportunity for falsehood: people like Euthymenes had scope for giving currency to travellers' myths. But nowadays the whole coast of the sea beyond Gibraltar is visited by trading vessels: none of the traders tell us that the Nile rises there, or that the sea in the Atlantic tastes differently from what it does elsewhere. The very nature of the sea forbids 24
belief in the story that it is fresh: the freshest water is always lightest, and as such attracted by the sun in evaporation: the residuum, sea, must be salt. Besides, why, on this theory, does the Nile not rise in winter? The sea may be raised at that season by storms too, which are considerably greater than the Etesians; the latter are comparatively moderate in their force. Besides if the source were derived from the Atlantic Ocean, Egypt would be flooded all at once; but, as a matter of fact, the increase is very gradual.

Oenopides of Chios has another explanation: he 25
says that in winter heat is stored up under the ground; that is why caves are then warm, and the water in wells is less cold. The veins of water are dried up by this internal heat, he thinks. In other countries rivers swell through rain: but the Nile, being aided by no rainfall, dwindles during the rainy season of winter, and by and by increases in summer, a season at which the interior of the earth is cold, and the frost returns to the springs. Now, 26

if that were true, rivers in general would increase in summer, and all wells would then have greater abundance of water. Besides, it is not true that there is an increase in the heat underground in winter. Water and caves and wells are warm at that season because they do not admit the frosty air from without. Thus, they do not possess heat, they merely exclude cold. For the same reason they are chilly in summer, because the air heated by the sun is drawn off to a distance, and does not penetrate to them.

27 The next account is that of Diogenes of Apollonia. It runs thus: The sun attracts moisture; the earth drained of it replenishes its supply in part from the sea, in part from other water. Now, it is impossible that one land should be dry and another overflowing with moisture. The whole earth is full of perforations, and there are paths of intercommunication from part to part. From time to time the dry parts draw upon the moist. Had not the earth some source of supply, it would ere this have been completely drained of its moisture. Well, then, the sun attracts the waves. The localities most affected
28 are the southern.[1] When the earth is parched, it draws to it more moisture. Just as in a lamp the oil flows to the point where it is consumed, so the water inclines toward the place to which the overpowering heat of the burning earth draws it. But where, it may be asked, is it drawn from? Of course, it must be from those northern regions of eternal winter, where there is a superabundance of
29 it. This is why a swift current sets from the Black Sea toward the Lower Sea, without interruption, and not, as in the case of other seas, with alternate

[1] The text is uncertain; the general meaning is, however, plain.

flow and ebb of tide; there is always a descending flood in the one direction. Unless this took place, and these routes supplied the means whereby what is lacking may be bestowed on each land, and what is superfluous may be given off, the whole earth would ere now have been either drained or flooded. Now, one would like to ask Diogenes, seeing the 30
deep and all streams are in intercommunication, why the rivers are not everywhere larger in summer. Egypt, he will perhaps tell me, is more baked by the sun, and therefore the Nile rises higher from the extra supply it draws; but in the other countries, too, the rivers receive some addition. Another question—seeing that every land attracts moisture from other regions, and a greater supply in proportion to its heat, why is any part of the world without moisture? Another—why is the Nile fresh if its water comes from the sea? No river has a fresher and sweeter taste.

III

I SHOULD be somewhat too bold if I were to assure 1
you as on oath that hail is formed in the sky much in the way ice is with us, only that in the former case a whole cloud is frozen. So I may regard myself as a witness only in the second degree—one of those who say not that they have actually seen but have been informed. Or, I may, for once, do as the chroniclers do. After lying at large to their heart's content, they fix on some one point for which they refuse to vouch, adding: Evidence of this will be found in the authorities. So, if you do 2
not believe me, Posidonius will vouchsafe to you his authority both for the statement I have made,

and for one that I am going to make. He will assure you, as confidently as if he had witnessed the process of formation, that hail is formed from a cloud that is charged with rain, and has already turned into moisture. You can discover without a tutor why the hail is round if you observe that drops of
3 all kinds tend to become globular. This is seen, for example, in looking-glasses, which gather moisture from the breath, as well as in cups, and any other smooth surface bedewed with it. So, too, in the leaves of grass or trees, any drops that adhere take a circular form.

> What is harder than rock, what softer than water?
> Yet the hard rock is hollowed by drops of the soft water;

or, as another poet tells us:

> The drip by its fall hollows the stone:

4 and this hollow is itself round. Whence it is evident that its shape resembles this drip which hollows it out, sculpturing the spot to its own form and character. Besides, the hail, even were it not of this shape, might be rounded in its fall, and worn equally on all sides into globular form as it is again and again whirled round in its descent through the space of thick air it traverses. Snow, on the contrary, cannot be affected thus, because it is not so solid, being indeed very much scattered, and falling from no great height. It has its source in the neighbourhood of the earth, and its descent is of no great distance through the air, but starts from a point quite close
5 by. Why should I not allow myself the same licence as Anaxagoras in differing from my authorities? Nowhere can equality of rights be claimed with more propriety than among the philosophers. Hail

is simply ice held suspended in mid-air; snow is a floating congealed mass of the nature of hoar-frost. I have already said that the difference between water and dew is reproduced in the difference of hoar-frost and ice, and, in like manner, in that between snow and hail.

IV

I MIGHT take leave of the question here, holding 1
that I had finished it. But I will give you good measure, and, having begun to trouble you with my speculations, I will discuss everything connected with the topic. One of the cognate questions is, why in winter there is snow but no hail, while in spring, after the worst of the cold is over, there are falls of hail. For let me be deceived for your benefit, though I may say I am fully persuaded of the truth of what I am about to affirm. I lend always a credulous ear to these trivial falsehoods; perhaps they deserve to be punished by having one's mouth stopped, but they 2
hardly call for the putting out of one's eyes! In winter the atmosphere is stiff, and is therefore not as yet capable of being converted into water, but only into snow, to which the atmosphere is more akin. But when spring begins, a greater variation of the atmosphere ensues, and, the sky being warmer, the drops are larger. Therefore, as our poet Virgil says:

> When rain-charged spring descends,

there is a more violent change in the atmosphere, which everywhere opens up and relaxes through the action of the mere warmth. For this reason the clouds that are carried to earth are heavy and large 3

rather than lasting. Winter rain is thin and persistent. The fall often occurs in the form of small, fine rain, with an admixture of snow. We call it a snowy day when the cold is intense and the sky leaden. Besides, when the north wind doth blow, producing its characteristic sky, there may be fine rain. With south wind the rain is more persistent, and the drops heavier.

V

1 One position held by the philosophers of my sect I neither venture to adopt on account of its seeming weakness, nor yet can I pass it by without mention. Where can be the harm of suggesting even an improbable explanation when one has such an indulgent judge? If we are to apply a test like the pyx to every argument, we shall soon cease to advance any hypothesis at all and be reduced to dumbness. There are very few statements that pass unchallenged. All the rest have to assert their rights before they can win their case. Well, the assertion of the Stoics is, that all the ice-bound region about Scythia and Pontus and the northern quarter is released from its chain in spring; then the frozen rivers resume their course, then the mountains melt the snows in which they have been buried. It is quite conceivable, therefore, that cool airs arise from this and mingle with the atmosphere of spring.
2 They add a proof which I have never tested nor have any intention of testing. You, too, I fancy, however anxious you may be to ascertain the truth, will be cautious about making such a trial of snow. The feet are said to suffer less pain when one treads on hard, solid snow than if the snow were slushy

and half melted. Well, then, if the Stoics do not lie, all the currents of air wafted from those northern parts, when the snow has now been dislodged and the ice is breaking up, condense and bind the atmosphere of the southern region which is already becoming warm and moist. So what was going to be rain becomes, through the violence done by the cold, hail instead.

VI

I CANNOT refrain from trotting out all the silly 1
fancies of our Stoic friends. The assertion in question is that there are some people skilled in observing the clouds who foretell when a hail shower is coming on. They gather this just from experience by marking the colour of the clouds and noting which was on previous occasions followed by hail. It seems incredible that at Cleonae there were hail-guards (χαλαζοφύλακες) appointed by the state to look out for the approach of hail. When they had given the signal that the hail was close at hand, what do you think? that people ran off to get their overcoats or cloaks? Nay, they each offered 2
sacrifice as fast as they could, one a lamb, another a chicken. Forthwith, those clouds after getting a little taste of blood drew off in another direction. You smile! There is something to make you smile more broadly. If one had not a lamb or kid by, one laid hands upon oneself to an extent that could be done without serious damage. You must not think the clouds greedy or cruel; one merely pricked one's finger with a well-sharpened style and made atonement with this blood. The hail as invariably turned away from his little plot as from the estate of the

man who had prevailed upon it through the offering of greater victims.

VII

1 CERTAIN writers seek for a rational explanation of this practice. One school, adopting the only line that comports with philosophy, deny the possibility of making any bargain with hail and buying off storms by paltry presents, true, though it be, that gifts overcome even gods. Others affirm their suspicion that blood itself contains a virtue potent enough to avert and repel a cloud. But how, I ask, should a drop or two of blood possess a virtue to reach on high and influence the clouds? Is it not much easier to say, the whole thing is a parcel of
2 lies? But Cleonae was strict in dealing with its warders who had received charge of looking out beforehand for the storm, if it happened that through their neglect the vineyards had been beaten down or the crops laid. And among ourselves, too, at Rome the laws of the Twelve Tables introduce safeguards against the blighting of a neighbour's crops by charms. Antiquity as yet untutored entertained the belief that rain could be attracted or repelled by incantations. The impossibility of such fancies is so evident that one need not enter a school of philosophy in order to be taught how to disprove them.

VIII

I SHALL add one more remark which you will be very glad, I am sure, to approve and applaud. It is asserted that snow is formed in the part of the

atmosphere near the earth. This layer has more heat than any other, and that for three reasons. One is that all evaporation from the earth, containing as it does much dry, glowing matter, is always the hotter, the more recently it has left the ground. The second is that the sun's rays are reflected from the ground and return upon themselves. Their reflection heats up the parts next the ground, which thus have more warmth from getting the sun's heat twice. The third reason is that the upper regions are more subject to wind; but all places that are sunk are less wind-swept.

IX

To the foregoing Democritus' explanation falls to be added. Every body receives heat more quickly and retains it longer in proportion to its solidity. For example, if three vessels, of copper, glass, and silver respectively, are set in the sun, the heat will penetrate the copper one soonest and will remain in it longest. The reason why Democritus is of this opinion may also be added. In the bodies, he says, that are harder, more compact, and dense, the openings must of necessity be smaller than in others, and in each of the openings the film of air must be thinner. It follows that just as smaller baths and smaller cylinders are heated more rapidly than others, so these concealed apertures, so small as to elude the eye, both feel the heat more quickly, and by reason of this same smallness of calibre give back more slowly the heat they have received.

X

This long preamble leads up to the point we are now examining. All air is the denser the nearer it is to the earth. In water and other liquids the dregs are always at the bottom; in like manner in the atmosphere the thickest portions settle down to the lowest part nearest the earth. But it has already been proved that all things, in proportion as they are denser and more compact in their consistency, guard more faithfully the heat they have received. On the other hand, the more exalted the air is, and the farther it is withdrawn from the pollutions of earth, the less contaminated and the more pure it is; and so it does not retain the sun's rays, but transmits them as if through a vacuum; hence it is less warmed by them.

XI

1 But contrariwise, certain persons assert that mountain peaks ought to be warmer in the degree in which they are nearer the sun. Such people seem to me, however, to be astray in supposing that the Apennines and the Alps and other mountains famed for their exceeding height are so greatly elevated that their size should enable them to feel in any special way the sun's proximity. No doubt those are lofty heights so long as the standard of comparison is ourselves. But when one regards the size of the universe, the lowness of them all becomes evident. Compared with one another,
2 mountains are surpassed or surpass in height. But

nothing on earth is elevated so high that even the greatest of objects should be any[1] appreciable portion in comparison with the whole universe. Were this not so, we should not be in the habit of saying that the whole earth is a ball. The distinctive mark of a ball is a certain uniform rotundity, much the same as the uniformity seen in a football or cricket ball.[2] The seams and chinks constitute no great objection to the ball being described as symmetrical on all sides. As in a 3
playing ball, those spaces do not in any way prevent the appearance of roundness, no more, in the earth at large regarded as a sphere, do lofty mountains, whose height is lost in a comparison with the whole world. A person who says that a higher mountain ought to be warmer from receiving the sun's rays at a shorter distance, may just as well say that a taller man should be heated sooner than a dwarf, and his head sooner than his feet! But any one who 4
will take the trouble to judge the universe by its proper standard, and who will reflect that this earth occupies but a single point in space, will not fail to perceive that nothing on earth can be of such eminence as to be more sensible than others of the influence of the heavenly bodies, as if it had approached their neighbourhood. Those mountains at which we gaze up, their summits weighed down with eternal snows, are none the less but low and humble. While it is true that a mountain *is* nearer the sun than is plain or valley, yet it is in the same sense as javelin is spoken of as thicker than javelin, tree as larger than tree, mountain than mountain.

[1] The argument seems to require *ulla* = any, instead of *nulla* = no.

[2] The specific references are not contained in the Latin words; the modern counterpart of the Roman games of ball serves, however, to bring out the meaning of the illustration.

5 Accordingly to that mode of speech of yours, one tree must be said to be nearer the sky than another; which is false, because among puny objects there cannot exist great differences except while they are compared with one another. When one comes to compare such objects with the mighty frame of things, it is immaterial how much the one is bigger than the other, because the very small things, however great the differences among them, are quite dwarfed by comparison with the universe.

XII

But to return to my main theme; for the reasons which I have detailed, most authorities are satisfied that snow is formed in the part of the atmosphere which is in the vicinity of the earth. It is less compacted than hail because congealed through less intense cold. For the air near us has at once too much cold to allow its passage into water and rain, and at the same time too little to get hardened into hail. Through this moderate but not too intense cold the water is massed and turns into snow.

XIII

1 Why, I fancy I hear you say, do you pursue so laboriously those frivolous explanations of yours, by which no one is made either more accomplished or more virtuous? You tell us all about the formation of snow; it would be far more to the point that we should be told why it is a

wrong thing for snow to be bought.[1] I see you wish to drag me into a dispute with luxury, a quarrel of daily occurrence that never leads to any tangible result. Let us withal brace ourselves for the struggle; even if luxury win the day, it must find us fighting and resisting to the death.

Well then! do you suppose that the examination of nature, irrelevant as it may appear, makes no contribution to the object you have at heart? When 2
we inquire how snow is formed, telling that its character resembles hoar-frost, containing more air than water, do you not think that it is a reproach upon the epicures? If it is a scandalous thing to buy water, they are still worse, for they do not get even water [but chiefly air] for their money. Let us, I say, inquire rather how snow is formed than how it is preserved. The means of preservation have already been discovered; not content with racking wines of vintage, arranging them by flavour and age, we have devised means of compressing snow to overcome the power of summer, and of protecting it by the coolness of the icehouses from the hotness of the season. And what have we accomplished by all our anxious 3
efforts? The privilege of buying water that we might have got for nothing! We are vexed that we cannot buy air and sunlight, and that the atmosphere all around streams in easily and unbought upon the fastidious and the rich. How badly nature treats us in leaving anything that is common property! Upon this other element, water, which nature has allowed to flow for the free use of mankind, and which she has given the

[1] *I.e.* the moral turpitude of sinking into such debased luxury as to require snow should be set forth rather than mere theories of the formation of snow; the ethical should take precedence of the physical.

whole world to drink, this that she has shed forth with lavish prodigality for the service alike of man and of beasts and birds and the very laziest of the animal creation—upon this, luxury, with ill-conceived
4 ingenuity, has managed to put a price. In fact, nothing can please luxury unless it is expensive. Water was the one thing that used to bring down the rich to the level of the common herd, in which the wealthy could not surpass the very poorest. Those who found their riches a burden have devised a plan whereby water should become a luxury.

How it has come about that no running water should be thought cool enough, I will now explain. As long as the stomach is healthy and is able to relish wholesome food, with which it is satisfied and not overloaded, it is quite content with the natural
5 stimulants. But when through daily indigestion it suffers from the heat not of the season but of its own indulgence, when habitual drunkenness has taken firm hold on the organs of life, and turns into bile which parches the intestines, then it becomes necessary to seek out some means of quenching the internal heat. Water merely inflames it, the disease is aggravated by the remedies. Therefore, for this purpose they use snow for drink, not only in summer, but even in the depths of winter. The cause can be no other than the internal complaint. Digestion is spoiled through indulgence ; respite is never given it in which to rest. Breakfast is heaped upon a supper prolonged till daylight. While the revellers are literally bursting with the lavishness and variety of the courses, heavy drinking plunges them still deeper in the mire.

6 Then the continuous excess causes heartburn from the food previously consumed, and inflames

the constant craving for some new stimulant. So, though they protect the banqueting hall with draperies and windows, and seek by roaring fires to banish winter's colds, none the less the languishing appetite, exhausted by its own heat, yearns for something new to revive it. Just as we sprinkle cold water on people who have lost consciousness through a fainting fit, in order to bring them back to their senses ; so the internal organs, numbed through excess, are past feeling, unless they are smitten by the parching, as it were, of more violent cold. Hence it is, I say, that not 7
content even with snow, they call for ice, as if the stimulant were the more certain from its solidity, and melt it with repeated douches of water. The ice, too, is not taken from the surface, but, that it may have greater virtue and more lasting cold, it is dug out of the depths of the pile. Thus it is not even of uniform price ; but water actually has its hawkers and—alas the day!—a varying price. The Lacedaemonians once banished the perfumers from their city, ordering them to quit the country with all speed, because they were wasting the oil supply. What would they have 8
done, I wonder, if they had seen cold stores for preserving snow and such an army of beasts employed in carting water, whose colour and flavour are often all spoiled by the straw in which it is kept ?

Good heavens! how easy a thing it is to quench the thirst of health! But what feeling can jaws retain that are deadened and numbed by scalding food ? These epicures can have nothing cold enough, neither can they have anything hot enough. Mushrooms taken from the fire and hastily 9

dipped in their special sauce are crammed down the throat almost boiling, and the heat has to be allayed by draughts chilled in snow. One may see, I tell you, slender youths, rigged out in cloaks and mufflers, pale and sickly, not merely sipping the snow, but actually eating it, throwing little pieces of it into their glasses to prevent them from getting warm during the intervals of drinking. Do you call that honest thirst? It is fever, the more acute too as it cannot be detected by the pulse or the wonted heat that overspreads the skin. The very heart is dried up by that incurable malady, luxury, whose habitual weakness and unsteadiness are turned into endurance and obstinacy. Don't you know that habit dulls the force of everything? The snow in which you are now, so to speak, swimming[1] has through custom and the daily slavery of the stomach come to occupy the place of water. You must now search for something colder still; for a stimulant that is habitual is no stimulant at all.

[1] Which you now use in your baths.

BOOK V

WHICH TREATS OF WINDS AND ATMOSPHERIC MOVEMENT IN GENERAL

I

WIND is the atmosphere in motion. Some have 1
put the definition thus: Wind is the atmosphere in motion in one direction. The latter seems the more accurate, because the atmosphere is never so still as not to be in agitation of some kind. In a similar way the sea is called calm when it is only slightly moved and does not set in a particular direction. Thus, if you read the verse:

When the winds slumbered and the sea was still,

you must bear in mind that the sea was not actu- 2
ally still, but heaved gently; and that it is called calm in a comparative sort of way because it receives no distinct impulse to this side or to that. The same opinion is likewise to be adopted in regard to the atmosphere: it is never absolutely motionless, even though it be still. This you may gather from the following observation: When the sun pours into any circumscribed space, one sees minute particles carried through the air in different directions, some up, some down, meeting each other in a great variety of ways. Therefore, if one say: 3
a wave is an agitation of the sea, one will very imperfectly express what is meant, because even when at rest the sea is agitated. But one will more than sufficiently safeguard oneself if the definition

be: a wave is an agitation of the sea in one direction. So in the subject which at the moment forms our special topic, the definition will not be unduly restricted if one is careful to say: wind is the atmosphere flowing in one direction; or, wind is atmosphere flowing through some impulse, or, is the force of the atmosphere going in one direction, or, is a rush of the atmosphere more forcible than usual in some one direction. I am aware of a criticism that may be made in regard to the first
4 definition. What need is there to add that it is in one direction that the atmosphere flows? For surely whatever flows, flows in one direction. No one says that water flows if there is simply an internal movement of it, but only if it is borne in a particular direction. So a substance may be in motion and yet not flow; but, on the other hand, it cannot flow except in one direction. Well, if, on the one hand, the shorter definition is free from cavil, let us employ it; but if, on the other, any one is a stickler, let him not omit the phrase whose addition will serve to preclude all ambiguity. Now that we have sufficiently discussed our terms, let us come to grapple with our problem at closer quarters.

II

DEMOCRITUS avers that when there are many particles, which he calls atoms, in a small empty space (*i.e.* vacuum), wind is the outcome. But, on the contrary, when the space is large and the particles few, there is a still peaceful condition of the atmosphere. To illustrate: in the market square or in a side street as long as there is a sprinkling of

people there is no disturbance as one walks along it; but when a crowd meets in a narrow space, then they jostle against each other, and quarrelling arises. Similarly in this space which surrounds our earth; when many bodies have crowded a very small portion, it is unavoidable that they should jostle one another and be driven back and forward, and be intertwined and squeezed. Hence results wind; the particles that were struggling have had to give way, and after being tossed about and remaining in suspense for a long time they at length lean their weight toward one side. But when a few bodies occupy a large roomy place, they can neither ram each other nor be jostled by one another.

III

THE falsity of this view may be inferred merely 1
from the fact that wind by no means invariably accompanies a cloud-laden atmosphere, and yet more particles have gathered at that than at any other time in a narrow space, where they produce condensation and heaviness in the clouds. Besides, in the neighbourhood of rivers and lakes cloud is frequent from the confinement and accumulation of particles, and yet there is no attendant wind. Indeed, sometimes such a darkness overspreads the place that the view of objects in the immediate vicinity is cut off; which would never happen unless numerous particles were massed in a small space. Yet no period is more free from 2
wind than a period of cloud. Add now a consideration of an opposite character: When the sun rarefies at his rising the thick dank morning air,

then a breeze springs up; the particles have got more room now, and the thickly packed crowd of them is broken up.

IV

1 But how, you will say, are winds then formed, for you won't deny that they are formed? Not in any single way, I reply. Sometimes the earth herself emits a great quantity of air, which she breathes out of her hidden recesses. At other times a great and long-continued evaporation drives the emissions from the depths up on high, where the change which the mixed breath undergoes issues in wind. A suggestion has been made which I cannot make up my mind to believe, and yet I cannot pass over without mention. In our bodies food produces flatulence, the emission of which causes great offence to one's nasal susceptibilities; sometimes a report accompanies the relief of the stomach, some-
2 times there is a more polite smothering of it. In like manner it is supposed the great frame of things when assimilating its nourishment emits air. It is a lucky thing for us that nature's digestion is good, else we might apprehend some less agreeable consequences. Is it not, then, nearer the truth to say that numerous particles are constantly borne up from every part of the world; and when they are accumulated and subsequently begin to be rarefied by the sun, wind starts up? It is a general principle that anything contained in a narrow space when it expands tries to get more room.

V

WELL, then, do I ask you to believe that evapora- 1
tion from land and water is the sole cause of wind? Do I affirm that it produces a weight in the atmosphere, the breaking up of which causes a rush of air? that at that moment what was previously dense and stationary gets rarefied and strives, as its nature requires, to obtain a wider space? I do approve of this as sometimes the explanation. But there is a far truer and more potent one, to wit, that the atmosphere by its constitution possesses a native capacity of movement, this power not being derived from an external source, but being like others of its powers inherent. For can you suppose 2
that we men have been endued with strength to move about, while the atmosphere has been left sluggish and immovable? Water, too, has its own motion, even though the winds are at rest; otherwise it could not produce animal life. We see also forms of vegetable life like moss produced by water, and certain kinds of herbage floating on its surface.

VI

WELL, then, I take it, in water there resides some vital principle. In water, did I say? Why, fire, the universal destroyer, has a creative function; it may not seem a likely thing, but all the same it is but the truth that some animals are generated by fire. The atmosphere, then, possesses some power of this kind; and that is why it sometimes grows thick, sometimes expands and throws off impurities,

sometimes contracts, at others opens up and disperses. There is thus the same difference between air and wind as between lake and river.[1] There are occasions when the sun is the sole cause of wind, as he rarefies the stiff atmosphere and opens it out from its thick contracted state.

VII

HAVING spoken of the winds in general, let us now proceed to the discussion of individual winds. Perchance the discovery of the time and place of their origin will conduce to the discovery of their manner of formation. First, then, let us look at breezes before dawn, which are borne either from rivers or hollow valleys or from some bay. None of these winds lasts long, but falls when the sun has got stronger; nor is it carried up out of sight of the earth. This class of wind sets in in spring, and does not last beyond summer. It comes chiefly from a quarter where there are spaces of water and mountains. Plains, for instance, may have abundance of water, and yet they have no breeze; I mean a breeze strong enough to be called wind.

VIII

1 How, then, is a blast of this kind, which is called by the Greeks a gulf breeze (ἐγκολπίας), formed? This is the theory of them: All the exhalations of marshes and rivers—and they are abundant and constant—form by day the sun's nourishment. By night, however, there is no drain on them, and they

[1] This remark would have been more apposite in Chap. I., above; possibly that is its correct place.

are enclosed by the mountains and accumulate in one quarter. When they have filled up this quarter and can no longer find accommodation in it, but are squeezed out on one side and move in a particular direction, then you have the wind. It inclines, of course, toward the side to which it is invited by the freer exit, and by the openness of the place toward which the accumu- 2
lated elements can rush. A proof of this is that a wind of this kind does not blow in the early part of the night. At that time the gathering only begins, but by daybreak it has reached the full, and seeks relief by flowing off. It chooses its exit by preference where there is the largest empty space and a great expanse of open. It is stimulated by the rays of the rising sun striking on the chilly air. Even before he makes his appearance his light of itself has an influence. The sun does not at that stage, it is true, drive away the atmosphere with his beams ; still, he already attacks and harasses it by 3
the shafts of light he sends before him. When he comes out himself in his power, part of the gathering is carried off to a greater altitude, part is dissipated by his heat. Wherefore power is not granted to these winds to continue longer than the morning. All their strength collapses at sight of the sun. Even if their blast is somewhat violent, yet they begin to subside as mid-day approaches ; in fact, the breeze [1] never lasts as long as noon. Any other variety of the breeze is weaker and shorter in duration ; they vary according as the causes to which they owe their origin are more or less powerful.

[1] The precise meaning of this and the following sentence is doubtful ; one would suspect that the latter originally ran—varieties of the breeze are longer or shorter in duration according as, etc.

IX

1 But why, again, are winds of this nature stronger in spring and summer? For during the remainder of the year they are very light, never rising sufficiently to fill the sails of a boat. The reason is that spring is a wetter season. There is at that time more evaporation going on, both from the abundance of water lying about, and from the saturation of the ground to overflowing through the moist character of the sky. And the reason why this wind is equally prevalent in summer is that the heat of the day remaining after sundown and lasting during a great part of the night draws out exhalations, and attracts more forcibly any of them that are wont to be given off spontaneously by the ground. But subsequently the heat has not
2 sufficient strength to use up what it drew out. This is the reason, I say, why the soil and its moisture give off for a longer period [at certain seasons] the particles derived from the earth's wonted emanations and exhalations. The sunrise produces wind by its stroke as well as by its warmth. For, as I have already said, the light which precedes the sun does not as yet heat up the atmosphere, but merely smites upon it; being smitten the air retires to one side. And yet I cannot go so far as to admit that the light is quite devoid of heat, inasmuch as it is derived from heat. Probably it does not contain as great an amount as would appear from its effect. Still, it accomplishes its own task by separating and rarefying the dense
3 exhalations. Moreover, places which through some disservice of nature are so shut in that they cannot receive the direct rays of the sun, even they, I say,

are heated somewhat by the dull cloudy light that can pierce to them and are less rigid during the day than by night. Furthermore, all heat naturally dispels cloud and drives it off from itself. Therefore the sun likewise has the same effect. For that reason some people suppose that the blast must come from the direction in which the sun lies. But this opinion is manifestly false, seeing that the breeze sets in any direction, and one can sometimes sail right toward the sunrise with all canvas set. That could not happen if the wind were always coming from the direction of the sun.

X

THE Etesian winds, too, which some drag into the 1
discussion, do not give much support to their contention. First, I will tell you what their opinion is, and, secondly, why it is not mine. The Etesians, say they, do not blow in winter, because at the season of the shortest days the effect of the sun ceases before the cold is overcome. So, snow accumulates then and freezes hard. In summer the Etesian winds begin to blow at the time when the day is lengthened out and the sun's rays come down straight upon us. Probably, therefore, the snows smitten by the greater heat exhale more moisture. The earth likewise breathes more freely when uncovered and relieved of the snow. So more particles issue from the northern portion of 2
the heavens, and are wafted toward our quarter, which lies lower and is warmer. From this the Etesians derive their impulse ; wherefore they begin at the summer solstice, and do not blow strongly

after the rise of the Dog-star, because by that time a great part of the cold northern exhalations has been carried down to our regions. But when the sun has changed his course he still directs his beams straight down on our hemisphere; and one part of the air he attracts, but another he thrusts before him.[1] Thus the blast of the Etesians breaks the force of the summer heat, protecting us from the full severity of the most broiling months.

XI

I MUST now, as I promised, tell you why the Etesian winds do not give any assistance to their advocates nor contribute aught to their argument. We have said that the breeze is stirred by the morning light, but it no less surely subsides when the full sun has touched it. And yet the Etesians are called by sailors sleepy-headed and dainty, for the very reason that, as my brother Gallio puts it, they cannot get up in the morning. They begin to show face at the time when even the most persistent morning breeze has fallen. This would not occur if the sun reduced the force of the Etesians as he does that of the morning breezes. Add also that, if the cause of their rise was the lengthened space of the day, they would blow even prior to the solstice when the days are at their longest, and when the thaw of the snow is at its height. By the month of July everything is clear of snow, or, at any rate, very few places are still covered with it.

[1] The meaning is very obscure. The text has been suspected, not without cause: the words "he still . . . hemisphere" are out of place, to say the least of it.

XII

THERE are some species of winds which issue 1
from clouds that are rent and pour down their contents. They are called by the Greeks cloud winds (ἐκνεφίας). Their method of formation, as I suppose, is this: among the particles given off by the earth's vapour and carried aloft there is great inequality and dissimilarity, some being dry and others moist. When the particles have massed in one body there is great discord and internal strife, which probably leads to the forming of certain hollow clouds with narrow pipe-shaped spaces left between, much like a flute in shape. In these gaps there 2
is shut up rarefied air, which, being buffeted about in the confined space and becoming heated, strives to get more room. It expands and rends its envelope, breaking forth in wind, which, as a rule, is squally, since it descends from above and falls on us with fierce vehemence. It is not diffused, nor does it come through a wide open space, but it struggles and opens up its way by main force. As a rule, it 3
is a brief gust. As it bursts through the cloudy receptacle by which it was confined and overleaps the battlements, it comes in tumultuous energy, sometimes not unattended with fire and the sound of thunder in the heavens. Such winds are much more violent and of longer duration if they have taken up in their course other gusts proceeding from a like cause, and thus several have conspired to form one. It is just like the flow of torrents of moderate size, not serious as long as each has its separate course. But when a number of them have 4

combined their streams, they surpass in size regular, constant rivers. The same thing may probably happen in squalls; they are short-lived whenever they are alone. But when they have joined forces, and the air expelled from several parts of the sky at once has all combined in one, both force and duration are added to them.

XIII

1 So, then, wind results from the breaking up of a cloud, which breach is effected in several different ways. The accumulation of air is burst sometimes by the internal struggle, as it seeks to gain an exit; sometimes by the heat produced either simply by the sun or else by the mutual ramming and friction of the roaming bodies.

At this point, if you have no objection, one may raise the question why a whirlwind occurs. In rivers, when their course has been without any obstacle for a long distance, the channel is a straight,
2 uniform one. But when they meet some boulder that juts from the bank, the stream is driven back and whirls the waters in a circle without a way of escape, so that in their revolution they are constantly sucked in toward the centre to form a whirlpool. In like manner the wind pours out in full force as long as no obstacle stands in the way. But when it is reflected from some jutting projection, or is massed in a quarter which combines to form a thin downward channel, then it revolves upon its own axis, and produces an eddy similar to that in which, as we have just
3 said, the water revolves. This revolving wind,

which always traverses the same spot and is roused to fury by the mere giddy whirling, is a whirlwind. If it is a very fierce one, and revolves longer than ordinary, it ignites and causes what the Greeks call a fire-wind (*πρηστήρ*), which is just a fiery whirlwind. The bursting of such winds from the clouds produces almost all the disasters by which herds are carried off and ships lifted, bodily, right out of the water. Further, some winds produce different ones by dispersing the air and driving it before them in other directions than that toward which they themselves have bent their course.

It occurs to me at the moment to mention 4
a parallel to wind that may be drawn from drops of moisture. The single drops may begin to incline downwards and be on the verge of giving way, but yet do not manage to fall. When, however, several have united and the mass has imparted strength, then they are said to flow and to move. So, as long as there are slight movements of the atmosphere disturbed at several points, they do not produce wind. The latter begins only when all those movements are united and concentrated in a single effort. Air differs from wind in degree alone. A more violent air is a wind; air in turn is gently flowing atmosphere.

XIV

Let me now recall a remark that I had made early 1
in this book, namely, that wind issues from cave or inner recess of earth. The whole earth is not of solid compact constitution down to its lowest foundations, but at many points is hollow,

. . . hung over dark retreats.

In some places it contains voids that have no moisture. Though there is no light there to show the distinctions in the air, yet I venture to
2 assert that cloud and mist settle in that gloom. Above ground cloud and mist surely do not exist because they are seen; but, rather, they are seen because they exist. Well, there too rivers none the less exist that they are not seen. You must understand that down there rivers flow equal in size to our own. Some glide gently, others resound as they tumble down headlong over the broken ground. So must not you equally allow that there are some lakes underground and some
3 water in pools without an exit? This being so, it is of necessity that the air be charged with moisture, and that, being charged, it lean in one direction, raising the wind by its propulsion. We must recognise, therefore, that from those subterranean clouds blasts of wind are raised in the dark, what time they have gathered strength sufficient to remove the obstacles presented by the earth, or can seize upon some open path for their exit, and from this cavernous retreat
4 can escape toward the abodes of men. Now it is obvious that underground there are large quantities of sulphur and other substances no less inflammable. When the air in search of a path of escape works its tortuous way through ground of this nature, it necessarily kindles fire by the mere friction. By and by, as the flames spread more widely, any sluggish air there may be is also rarefied and set in motion; a way of escape is sought with great roaring and violence. This point I will elaborate in more detail when I go on to treat of earthquakes.

XV

You must now allow me to tell you a little story! 1
Asclepiodotus vouches for the tale. Once on a time a large party of miners was sent down by Philip into an old mine, long since abandoned, to ascertain its prospects and condition, and to see whether ancient avarice had left anything for posterity to glean. Down they went with plenty of light to last for days. In due time, when they were quite tired by the length of the road, they saw a sight to make their hair stand on end—huge rivers and vast reservoirs of sluggish waters, equal in size to any above ground, not pressed down either with a weight of earth above, but overarched with an open vault. I confess I felt lively satisfaction in reading the story. It showed me that the vices from which 2
our age suffers are not new; they have been handed down from ancient days. Nor is it in our age that avarice has for the first time ransacked the reefs of soil and stone, searching in the dark for treasure badly hidden. Those ancestors of ours, whom we are always vaunting, our declension from whose standard we constantly bemoan, were also lured by hope to cut down the mountains and stand beneath the ruins to gloat over their filthy lucre.

Before the time of Philip of Macedon there were 3
kings who pursued treasure down to its deepest lurking-places; leaving the free air and light of day behind, they lowered themselves into those caverns, which no distinction of night from day could reach. What expectation could lead them on? What necessity caused man, whose head points to the

stars, to stoop below, burying him in mines and plunging him in the very bowels of innermost earth to root up gold? The quest for the precious bane
4 is no less perilous than its possession. For this he drove shafts and crawled round his dirty, uncertain booty, forgetful of day, forgetful of his better nature, which he abjured. On no dead man does earth lie so heavily as it lies on those on whom insistent avarice has cast earth's weight, from whom it has withdrawn the light of day, whom it has buried in the depths where that noxious poison lurks. They had the hardihood to descend to a region where they found a new order of nature, forms of overhanging earth and winds raving through the blind void, where are dread fountains of waters whose streams none drink, and night reigns deep and unbroken. And then, after all that has come and gone, they dread the gods of the nether world!

XVI

1 But to return to the matter in hand; there are four winds, divided, according to the cardinal points, into east, west, south, and north. The rest of the winds, which are called by different names, are attached to these:

> Eurus has gone toward the dawn and the realms of Nebaioth
> And Persia and the peaks that lie beneath the rays of morn.
> Evening and the coasts that are warmed by the setting sun
> Are close to Zephyrus. Scythia and the Great Bear
> Are under the sway of dread Boreas. The land that faces these
> Is bathed in unbroken cloud and rainy Auster.

2 Or, if you prefer a briefer enumeration, you may gather them in one great storm—a physical impossibility, by the way:

Eurus and Notus (south) rush together, and with squall upon squall
Africus (south-west).

And we may add Aquilo (north), which has no place in the famous battle of the winds to which Virgil refers. Some make the number of the winds twelve. They divide the four quarters of heaven into three parts each, adding two subsidiary winds to each of the principal ones. On this principle that diligent 3 author, Varro, classifies them. And there is good ground for it; the other method, which refers them to seasonal changes, is very unsatisfactory. For instance, the sun does not always rise or set at the same point. He has one place of rising at the equinox — indeed, the equinox occurs twice a year —another at the summer, and still another at the winter, solstice. The wind which sets in from the direction of sunrise at the equinoxes is with us called Subsolane (near the sun); the Greeks call it ἀφηλιώτης (from the sun). From sunrise in winter Eurus comes, named by our countrymen Vulturnus (*i.e.* from Mt. Vultur in the S.E.). Livy also calls it 4 by this name, in connection with that famous battle of Cannae, which proved so disastrous to Rome. Hannibal on that occasion managed to get our army with its face to the rising sun and to the wind; by the aid of the wind and the glare that dazzled the eyes of the enemy he snatched the victory. Varro likewise uses the same name. But Eurus is a name now naturalised, and has a place in our vocabulary that does not suggest any foreign origin. The wind that is raised by sunrise at the 5 summer solstice was called by the Greeks καικίας;[1] we have no name for it. Sunset at the equinox sends

[1] No explanation of this name of the nor'-easter is forthcoming.

us Favonius, which even people who cannot speak Greek will tell you is called the Zephyr. Corus, which is by some called Argestes [from its clearness], comes from the sunset at the summer solstice. I do not approve of the identification; Corus is a vehement wind, rushing in one uniform direction, while Argestes is, as a rule, a gentle wind, and blows impartially on travellers coming and going along the same road (*i.e.* is constantly
6 shifting). From sunset in midwinter comes the rushing furious Africus (African wind), named by the Greeks the Libyan (λίψ). In the northern quarter the highest (*i.e.* most easterly) is Aquilo, the central one is Septemtrio, the lowest Thracias,[1] for which there is no corresponding word in Latin. In the southern region there is Euronotus, then Notus, or in Latin Auster, then Libonotus, which has no Latin name.

XVII

1 We Stoics hold that there are twelve winds; not that there are everywhere so many (the slope of the earth [*i.e.* of the earth's axis] excludes some), but because there are nowhere more than twelve. We speak of six cases in the same way, not because every noun possesses six, but because none has more than six. Those who assert the number of the winds to be twelve adopt the principle that the number must be the same as the divisions of the heavens. Now the heavens are divided into five zones passing through the cardinal points
2 of the world. These are the northern, the solstitial,

[1] *I.e.* the Thracian; Thrace must have been N.W. of the region in which the name had its origin.

the equinoctial, the wintry, the one that faces the northern. A sixth is added in the zone which separates the upper part of the world from the lower. As you know, there is always one-half the world above our head, and one-half beneath our feet. This line which lies between the visible and the concealed parts of the sky is called by the Greeks the Horizon (ὁρίζων = bounding line): our school call it the Bounder; others, the Bounding [line]. To this must be added the 3
meridian circle, which cuts the horizon at right angles. Some of these zones run transversely, intersecting others. Now there must necessarily be as many divisions of the heavens as there are parts. So, then, the horizon or bounding circle cuts those five zones, of whose position I have just spoken, making ten parts, five to east and five to west. The meridian circle which meets the horizon gives two additional divisions. Thus the 4
air receives its twelve divisions, and yields a like number of winds.

There are some of the winds that are peculiar to certain localities; they do not carry far, but reach only the immediate vicinity. They do not derive their impulse from a particular quarter of the world at large. For example, the wind Atabulus haunts Apulia; the Iapygian, Calabria; the Scironian, Athens; Cataegis, Pamphylia; Circius, Gaul. To the last mentioned, though it shakes their houses, the people are very grateful, believing they are indebted to it for the healthiness of their climate. At any rate, the late Emperor Augustus, when he was staying in Gaul, erected to it a temple he had vowed. My task would never be done if I were to attempt to enumerate the individual winds. There is hardly

any district that has not some particular wind that arises in it and falls not far from it.

XVIII

1 WHEREFORE among the other works of Providence this one must be regarded as worthy of all admiration. Heaven had many purposes in view in devising the winds and distributing them through all the varied quarters of the earth. The first object was to prevent the atmosphere from becoming gross; by their constant tossing the winds were meant to render it beneficial, a source of life to those who were to breathe it. In the second place, they were to supply the earth with rain, and at the
2 same time to restrain excess of rain. This they accomplish by now gathering, now scattering the clouds, so that the rainfall should be fairly distributed over the whole world. The south wind drives it toward Italy, the north sends it back to Africa. The Etesian winds will not suffer the clouds to settle in our quarter; but yet the whole of India and Ethiopia are watered with constant rain during the period of their prevalence. Moreover, crops could not be gathered in unless the worthless elements were winnowed by the blast from the good grain with which it is mixed. The breeze is needed, too, to rouse the seed and bring to light the latent fruit, by causing it to burst through its covering, those wrappings which the farmers call follicles.
3 Furthermore, the wind has established intercommunication among all the different nations, and has united tribes far removed from each other in place.

A great service is this that nature here renders, did

not man's madness turn it to his own injury! As it is, the remark may be applied to the winds which was commonly made regarding Caesar the Elder (Julius), as recorded by Titus Livius (Livy); it was doubtful whether his birth was a blessing or a curse to the state. In like manner all the useful and necessary services performed by the winds cannot outweigh the devices which man's madness has through them framed for his own destruction. But 4
they do not cease to be inherently good, even though, through fault of those who degrade their use, they are turned to instruments of harm. Surely Providence and God, the great Disposer of the world, had a beneficent aim in establishing the winds, and diffusing them on every side, to wit, that the atmosphere might be kept in motion by them, that no part of the world should become unsightly through inactivity. His object was not that we might man our fleet with armed soldiers to seize every quarter of the main, and that we might go in search of foes either in or beyond the sea. What frenzy goads us on, and matches us in strife for our mutual destruction? We spread the sails 5
to the winds to go in quest of war, and we run risks of sea for the sake of meeting risks of battle! We tempt the uncertainty of fortune, the force of tempests that no human effort can overcome, death without hope of burial. The prize would not be worth the toil if the voyage conducted us to peace. As it is, when we have passed so many hidden rocks and hidden shoals of a treacherous sea; when we have escaped the billows that rise like mountains above us, into which the raging wind forces all voyagers; when we have passed through 6
days enveloped in mist, and nights rendered still

more awful by cloud and thunder, and by whirlwinds that rend the frail bark in pieces; what reward shall we have for all the toil and anxiety? What harbour will give us hospitable shelter, worn out as we are with so many sufferings? War, I trow, will meet us, and an enemy ready prepared on shore and tribes destined to cruel slaughter, but not without much damage to the conqueror, and ancient cities in flames. Why do we press whole nations into arms? Why do we enrol armies to marshal
7 their lines amid the billows? Why do we disquiet the seas? The land, I suppose, is not wide enough to compass our death. Fortune deals too tenderly with us: she has given us too hardy bodies, too sound health. No ravage of plague cuts us off: each one may comfortably fill up the measure of his years and reach the haven of old age. So let us launch upon the deep and call toward us the loitering fates. Poor wretches, what is it ye seek? Death, which is always too much with us? It will attack you, even in your couch; well, see that the victims it attacks are innocent of crime. It will seize you in your house; be sure it find you planning no mischief.

8 But what can one call it but plain insanity actually to carry destruction in your train, to rush in anger against men you never saw, to lay waste without provocation all that comes in your path, and, after the fashion of wild beasts, to kill a man you do not hate? We are worse than beasts, for they bite only in retaliation or from hunger; but we, utterly lavish of our own and others' blood, harass the seas by the vessels we launch, entrust our safety to the waves, and pray for favouring winds, counting it our good fortune to be

borne in safety to the wars! To what lengths have our crimes hurried us criminals? It is not enough 9
to vent one's madness within one's own sphere. Your stupid King of Persia must cross into Greece, filling it with an army with which he has failed to conquer it. Your Alexander, leaving behind Bactra and India, must needs seek to learn what lies beyond the great sea, and will chafe that there is any point beyond which he cannot go. Crassus in like manner will fall a prey to the Parthians through his lust of gold. He will not dread the imprecations of the tribune who calls him back, nor the storms of the tedious sea, nor the lightning by Euphrates that foretold destruction, nor the resistance of heaven itself. Through the wrath of man and God alike 10
gold shall be sought.

Not without good cause, therefore, it may be said that nature would have done better by us had she forbidden the winds to blow at all, had she checked their roaming abroad in their fury, and ordered each one to abide in his own land. If this had served no other end, at any rate the mischief of each human life would have been restricted to itself and its own nation. As it is, the ills of home are too little for us; we must toil to share those abroad as well. No land is so far removed from neighbours that it cannot send forth in some direction its evil propensities. How do I know 11
but that some ruler of a great nation meantime concealed from view, swollen by fortune's kindness, may choose not to confine his arms within the boundaries of his own realm, but with secret design may even now be fitting out his fleet against us? How can I tell whether this wind or that shall convey war to me? It would go far to ensure

the peace of the world if the seas could be shut up.

Still, as I said a little ago, we cannot put the blame on God, our Author, if we corrupt His
12 blessings and turn them into curses. He gave us the winds to maintain the equable temperature of earth and sky, to call forth or to repress the waters, to nourish the produce of field and tree; the crops are brought to maturity, among other causes, by their mere tossing in the wind, which attracts the nourishment to the top, and by movement prevents the stagnation of decay. He gave the winds that we might gain acquaintance with foreign lands. Man would have been an untutored creature without much experience of the world if
13 circumscribed by the bounds of his native soil. He gave the winds that the blessings of each region might become common to all; not to convey across the sea regiments of horse and foot, nor arms for the destruction of mankind. If we simply estimate nature's boons by the degraded uses to which they have been put, there is nothing that we have not received for our own hurt. Who is aught the better of the gift of sight? or of speech? To whom is life itself not a torment? I defy you to find anything of such undoubted utility that it cannot by misuse be converted into a curse. So it is with the winds: nature had designed them for a boon; we
14 have ourselves made them the opposite. They all lead us to some disaster: one man has not the same motive as his neighbour for putting to sea, but none has a good one. Diverse temptations lead us to essay the way. Above all, we love to go to sea in order to damage some one. Plato, with whose testimony I may close, has observed, with great

aptness, it is mere trifles that men purchase with their lives. Yes, my dear Lucilius, if you estimate aright man's madness, in other words, our own—for we all wallow in the same herd — you will be still more amused by the reflection that we amass for life what in the end wears life out.

BOOK VI

WHICH TREATS OF EARTHQUAKES

I

WE have just had news, my esteemed Lucilius, 1
that Pompeii, the celebrated city in Campania, has been overwhelmed in an earthquake, which shook all the surrounding districts as well. The city, you know, lies on a beautiful bay, running far back from the open sea, and is surrounded by two converging shores, on the one side that of Surrentum and Stabiae, on the other that of Herculaneum. The disaster happened in winter, a period for which our forefathers used to claim immunity from such dangers. On the 5th of February, in the consulship 2
of Regulus and Virginius, this shock occurred, involving widespread destruction over the whole province of Campania; the district had never been without risk of such a calamity, but had been hitherto exempt from it, having escaped time after time from groundless alarm.

The extent of the disaster may be gathered from a few details. Part of the town of Herculaneum fell; the buildings left standing are very insecure. The colony of Nuceria had painful experience of the shock, but sustained no damage. Naples was just touched by what might have proved a great disaster to it; many private houses suffered, but no public building was destroyed. The villas 3
built on the cliffs everywhere shook, but without

damage being done. In addition, they say, a flock of six hundred sheep was destroyed, and statues were split open ; some people were driven out of their minds, and wandered about in helpless idiotcy. The plan of my present work demands a discussion of the causes of this, and the disaster itself fits in with our present inquiries (*i.e.* our discussion is opportune in view of the recent disaster). We must seek solace for the anxious and dispel overmastering fear. For what can any one believe quite safe if the world itself is shaken, and its most solid parts totter to
4 their fall? Where, indeed, can our fears have limit if the one thing immovably fixed, which upholds all other things in dependence on it, begins to rock, and the earth lose its chief characteristic, stability ? What refuge can our weak bodies find ? whither shall anxious ones flee when fear springs from the ground and is drawn up from earth's foundations ? If roofs at any time begin to crack and premonitions of fall are given, there is general panic : all hurry pell-mell out of doors, they abandon their household treasures, and trust for safety to the public street.

5 But if the earth itself stir up destruction, what refuge or help can we look for ? If this solid globe, which upholds and defends us, upon which our cities are built, which has been called by some the world's foundation, stagger and remove, whither are we to turn ? What comfort, not to say help, can you gain when fear has destroyed all way of escape ? Where, I say, is there any protection you can trust? what is there that will stand as sure defence either of oneself or of others ? An enemy I can drive off from my city wall. The mere difficulties of approach to turrets set on the dizzy heights will stop the march even of great armies.

From storm the harbour shelters us ; our roofs are 6
able to withstand the whole force of clouds let loose, and the endless deluges of rain. Fire cannot pursue us if we run away from it. Against heaven's threats in thunder refuges underground and caverns dug out in the depths of the earth are of avail—the fire of heaven does not pierce the ground, but is beaten back by the tiniest portion of the soil. In time of plague we may change our place of abode. No species of disaster is without some means of escape. Lightning has never consumed whole nations. A plague-laden sky has drained cities, but has never blotted them out.

But this calamity of earthquake extends beyond 7
all bounds, inevitable, insatiable, the destruction of a whole State. Nor is it only families or households or single cities that it swallows ; it overthrows whole nations and regions. At one time it hides them in their ruins, at another consigns them to the deep abyss ; it leaves not a wrack behind to witness that what no longer is, once was. The bare soil stretches over the site of the most famous cities, and no trace is left of their former existence. Nor are there wanting those who dread most of all this kind of death, in which they go down alive into the pit, houses and all, and are carried off from the number of the living : as if every form of death did not lead to the one goal. Among 8
nature's righteous decrees this is the chief, that when we reach the end of life we are all on a level. It makes no difference, therefore, to me whether one stone wound me to death or I am crushed beneath a whole mountain ; whether the weight of one house come down on me, and I expire beneath the dust of its humble mound, or whether the whole

world descend upon my head; whether I yield up this breath in the open light of day or in the vast abyss of the yawning earth; whether I am borne down to those depths all alone or along with a great
9 throng of perishing nations. To me it can make no difference how great is the turmoil that accompanies my death; the thing is everywhere just the same.

Wherefore, let us raise high our courage against that disaster, which can neither be shunned nor yet foreseen. Let us cease to listen to the people that have bid adieu to Campania since the time of this disaster, and have removed to other districts, vowing they will never set foot in that quarter again! Who can guarantee them more
10 solid foundations in whatever soil they choose? All the world is subject to the same fate. If it has not yet suffered from earthquake, it may; perchance this spot on which you stand in full security will be rent this night, or even this day before night. How can one tell whether is better the state of the places on which fortune has already spent her force or of those which are upheld meantime, but only for some disaster to come? We do greatly err if we suppose any quarter of the world wholly exempt from this danger. All quarters are subject to the same law. Nature framed nothing to be immovable.
11 Different things will fall at different times. Just as in large cities, now this house and now that leans over and has to be shored up, so in the world as a whole, now this part contains a flaw, now that. Tyre was once notorious for a disaster of the kind. The province of Asia lost at a single stroke twelve of its cities. Last year calamity overtook Achaia and Macedonia, now the injury has fallen upon Campania, whatever be the nature of that force

which thus assails us. Fate makes a circuit, paying a second visit to places she has long passed over. On some places her attacks are more rare, more 12
frequent on some. Nothing is suffered to be quite exempt from injury. Not merely we men, whose life is frail and fleeting, but cities too, and the earth's coasts and shores, yea, the very sea falls under bondage to fate. And in face of this we promise ourselves permanence in the boons fortune bestows! we suppose there will be stability and endurance in happiness, whose fickleness is greatest of all things on earth! While men promise themselves all things 13
in perpetuity, it never enters their thoughts that the very earth on which we stand is not permanent. The flaws of the ground are to be found everywhere; they are not peculiar to Campania or Tyre or Achaia. The earth coheres imperfectly, it suffers breach from many causes; permanent as a whole, it is subject to collapse in its parts.

II

WHAT am I doing? I had promised to offer 1
comfort in face of danger, and lo! I threaten its terrors on all sides. I tell you that there can be no assured peace in what can suffer or cause destruction. But that very fact I regard as a solace, and, indeed, the most powerful of all. Fear is but folly when there is no escape from it. Philosophy delivers the wise from fear; even the unlearned may derive great confidence from despair. You must, therefore, regard the words addressed to those amazed by sudden captivity amid fire and foe as addressed to the whole human race:

> The one safety of the conquered is to hope for none.

2 If you wish to fear nothing, think that everything is to be feared; consider by how slight causes our life is dissipated. Neither food nor drink, nor waking nor sleeping, is healthful, except in due measure. One may soon realise that we are but puny, insignificant bodies, weak and unstable, that small effort is needed to compass our destruction. The only sufficiency of danger, doubtless, would be the earth's trembling, its sudden dissipation, the rending of its surface into chasms!
3 Surely he sets a high value on his life who dreads only lightning, and earthquakes with their yawning abysses; won't he allow himself to open his eyes to his frailty and be afraid of choking on his phlegm? Such, forsooth, is our constitution by birth, such the powerful frames we have obtained, such the size we have grown to, that we cannot perish unless the four quarters of the world are moved, the
4 heavens thunder, and the earth subside! Why, a pain in a tiny nail, not even the whole nail, but a little ragnail at the side, may finish us! And I must fear only the trembling of the world, when too thick a spittle will choke me! I am to await with dread the removal of the sea from its place, or the overflowing of an abnormal tide with its excess of water; why, some ere now have been strangled by a drink that took a wrong course down the throat! What folly to be afraid of the sea when you know
5 that a single drop may kill you! There is no solace of death greater than the very liability to death, no solace of all the terrors from without equal to the thought that there are countless dangers within our own bosom. What greater madness than to collapse at the sound of thunder, and through fear of lightning to creep under the ground? What

greater folly than to stand in fear of the earth's 6
tottering and the sudden fall of mountains, or inroads of the sea cast up beyond the shore, when death is everywhere present and meets us on every side? Nothing is so small as not to be strong enough to compass the destruction of the human race. Great or unusual dangers ought not to unnerve us, as if they implied more mischief than a common death; nay, rather when one must quit the world and at last resign life, it should be a positive joy to perish by some grand cause. Die we must some- 7
where, sometime. The ground you tread may stand firm, it may confine itself within its own bounds and not be tossed about by any violence; yet some day I shall be beneath it. Does it really matter, then, whether I place it on myself or itself do? It is rent by the irresistible force of some disaster; it bursts and draws me into its immense depths. What then? Is death easier on the earth's level surface? What reason for complaint have I if nature will not have me lie in a place unknown to fame? or if she lays on me a portion of herself? My friend, 8
Vagellius,[1] in that famous poem of his, says finely:

If fall I must, I should desire to fall from the height of heaven.[2]

We may adopt the language. If fall I must, let the earth be shaken at my fall; not that one ought to pray for a public disaster, but it is a great solace of death to see that the earth is likewise subject to death.

[1] The name is doubtful, as is, indeed, the quotation also.

[2] The sense may be: I would have the heavens fall along with me; this meaning would suit the context better.

III

1 It will be useful also to be assured that none of these things is the doing of the gods, and that the moving of heaven or earth is no work of angry deities. Those phenomena have causes of their own. It is not by special command that they put forth their rage, but, just as in our own bodies, the disturbance arises from certain inherent imperfections; at the moment when they seem to inflict injury, they sustain it. Through our ignorance of the truth all these things are terrible, the more as
2 their infrequency increases our alarm. Familiar occurrences seem less serious; the unusual causes greater terror. But why is anything unusual in our estimation? The reason is that we grasp the meaning of nature only superficially, and not rationally; we dwell too exclusively on what she has done, and do not consider what she can do. Accordingly, we pay the penalty of this neglect in our terror of things that we suppose unprecedented, when they are not really unprecedented, but merely unusual. For instance, are not superstitious fears inspired both privately and even for the safety of the State, if either the sun has been seen in eclipse or if the moon, whose obscuration is more frequent,
3 has partially or wholly been concealed? And is not this far more so in the case of such sights as we have spoken of: torches driven athwart the heavens, the sky on fire over the greater part of its extent, comets, mock suns, stars appearing in the daytime, the sudden passage of stars that mark their trail with a bright light? Our wonder

at these is in no case free from fear. As the cause of the fear is ignorance, is it not worth while to gain the knowledge that will dispel it? How much better it would be to inquire into the causes of the alarming sights, to bend, in fact, our whole mind to the task? Nothing, surely, could be found more deserving than that, of having the mind's energies not only lent to it, but devoted to it.

IV

LET us ask ourselves, therefore, what it is that stirs 1
the earth to its foundation, what moves a mass of such weight, what it is that is stronger than the earth, and that in its violence can shake such a load. Let us inquire why at one time the earth trembles, at another is loosened and sinks, and again is divided into parts and opens a chasm; or why on some occasions the intervals of destruction are prolonged, on others are suddenly cut short. What is the cause why it now consigns to its depths rivers of renowned greatness, and now causes fresh rivers to issue? why does it sometimes open up springs of hot water, sometimes freeze them 2
with cold? and why at times are fires caused to shoot out through some hitherto unknown opening in mountain or crag, while sometimes well-known fires, that have been famous for centuries, are suppressed? The earthquake produces a thousand strange sights, changing the aspect of the ground, levelling mountains, elevating plains, exalting valleys, raising new islands in the deep. What are the causes that bring these things to pass? That is a subject well worthy our discussion. What, you

say, will be the reward of our labour? That reward, I say, which surpasses all others, the
3 knowledge of nature. Among the many serviceable lessons to be derived from such researches, no feature is more commendable than this, that man is thereby made to dwell upon the sight of his own grandeur[1]; the study is pursued, not in hope of gain, but from the wonder it excites. Let us inquire, therefore, what it is that brings about all this. The inquiry is so fascinating to me that although long ago in my youth I published a volume on earthquakes, I am anxious to make another trial of my powers, and to see whether age has added anything to my knowledge, or, at any rate, to my industry.

V

1 THE cause of earthquakes has been assigned variously by different authorities to water, fire, air, and to the earth itself; some assign it to a combination of several of the causes, others, to a union of them all. Certain writers have stated that it was plain to them that some one of these causes produced the earthquake, but it was not plain which. Let us look at the various opinions in detail. First of all, I feel bound to say in general terms that the old views are crude and inexact. As yet men were groping their way round truth. Everything was new to those who made the first attempt to grasp it; only later were the subjects accurately investigated. But all subsequent discoveries must nonetheless be set down to the credit of those early
2 thinkers. It was a task demanding great courage

[1] The meaning may rather be—the grandeur of the subject.

to remove the veil that hid nature, and, not satisfied with a superficial view, to look beneath the surface and dive into the secrets of the gods. A great contribution to discovery was made by the man who first conceived the hope of its possibility. We must, therefore, listen indulgently to the ancients. No subject is perfected while it is but beginning. The truth holds not merely of the subject we are dealing with, the greatest and most complicated of all, in which, however much may be accomplished, every succeeding age will still find something fresh to accomplish. It holds alike in every other concern; the first principles have always been a long way off from the completed science.

VI

WATER is the first cause alleged: more authors than 1
one adopt this view, but it is not stated by all in the same terms. Thales of Miletus is convinced that the whole earth floats, and is upborne by moisture lying beneath it, which you may call either Ocean or the great sea, or still mere elemental water of a different character from the sea, the simple ingredient, moisture. In these waves, in his opinion, the globe is supported like some huge lumbering vessel in the water which bears it. It is unnecessary for me to 2
reproduce his reasons for supposing that the heaviest part of the world cannot be sustained in such a rare and nimble element as air: for the earth's position is not the question here but its movement. By way of argument, to prove that water is the cause, he adduces the fact that in every considerable earthquake, as a rule, new springs burst out. So if

a boat leans over to one side away from the straight, the result is that it ships water. And, generally speaking, in the case of all objects which water supports, if they are unduly sunk, the water either pours over them or at any rate rises to right and left above its ordinary height.

3 Now, no lengthened consideration is needed to prove the falsity of this view. Why, if the earth were supported by water, and from time to time shaken by it, it would be in perpetual shock; the wonder would be not that it was tossed about sometimes, but that it was ever at rest. Then, again, it would be shaken all over and not at a single point: we never find only half the ship tossed by the waves. But, according to present experience, a shock never occurs over the whole earth simultaneously, but is always felt at some particular spot. How, then, can it be that what is carried as a whole is not shaken as a whole, if the shock comes from the body by which it is carried?

4 But, it may be urged, why do waters burst out at the time of earthquakes? Well, in the first place, there has often been earthquake without any fresh supply of water appearing. Secondly, if the supposed cause of the water rushing forth were the true one, it would pour all round the sides of the earth, as we see happening under similar circumstances in sea and rivers: when boats sink, the increase of water shows itself chiefly over the sides. Finally, the outburst of waters which Thales describes would not be so small as he says, nor would it ooze in like bilge-water through a chink, but from the exhaustless reservoir that upbears all creation, a mighty deluge would ensue.

VII

Some, who, like Thales, attribute earthquake to the 1
effects of water, give a different explanation of its
operation. There are, they say, many kinds of
waters running over the whole earth. In one
place there are constant rivers whose size renders
them fit for navigation, even without the aid of
rains. There is the Nile, rolling down its huge
volume all summer long : here are the Danube and
the Rhine separating with their streams the peaceful
from the hostile, the former checking attacks from
the Sarmatians and forming the boundary between
Europe and Asia, the latter keeping back the
Germans, a nation ever keen for war. Then there 2
are lakes of very wide extent, great pools surrounded
by tribes mutually ignorant of each other, marshes
that no boat can struggle through, that cannot be
passed even by the people that dwell on their
borders. Add, then, the multitude of fountains, and
of river sources that belch out of their recesses full-
grown streams. Besides, there are many rushing
torrents that gather only for a time, whose force is
as shortlived as it is sudden. Now there are waters,
in all this variety of form and character, within as 3
well as above the earth. Away there below some are
borne along in vast bulk, and tumble their whole
volume down the steep : others more sluggish are
dammed back in shallows, and flow with gentle, quiet
stream. And can any one deny that within those
vast underground hollows waters are formed, and lie
sluggish and inactive in many places? It needs no
long proof to show that there must be many waters

in the place where all waters are. The earth would not be able to produce so many rivers unless it poured them from a copious reserve.

4 This being so, sometimes below the earth a river must become swollen, and leaving its banks assail with violence all obstacles that meet it. So there will be a movement of some point on which the river has made an onset, and which it will keep lashing until its waters fall. Or it may happen that the constant wear of a stream may eat away some quarter, dragging down thereby some mass above, by whose fall, in turn, the surface which 5 rested on it is shaken. Now surely a man trusts too much to the sight of the eyes and cannot launch out his imagination beyond, if he does not believe that the depths of earth contain a vast sea with winding shores. I see nothing to prevent or oppose the existence of a beach down there in the obscurity, or a sea finding its way through the hidden entrances to its appointed place. There, too, it occupies as much space as here, perhaps more, since the regions up on earth have had to be shared with so many living creatures; but the hidden regions being desert without inhabitant give freer 6 scope to the waves of the nether ocean. And who is there to hinder the sea from swelling there and being tossed by all the winds that every interstice of the earth, and every species of atmosphere can create? So, then, when a storm greater than ordinary has arisen, it may beat upon some one side of the earth with too great vehemence and move it. For on the surface likewise, many places which had been far from the sea have felt the violence of its sudden approach: villas almost out of sight of it have been invaded by the waves which used only

to be heard in the distance. The nether sea, too, can approach and retire; neither of which movements can take place without shock to the earth that stands above it.

VIII

I DO not, indeed, suppose that you will long hesitate 1
to believe that there are underground rivers and a hidden sea. From what other cause could the rivers burst out and come to the surface unless the source of the moisture were shut up within the earth? For instance, when one sees the Tigris interrupted and dried up in the middle of its course, not diverted as a whole, but gradually with imperceptible losses first lessen and then waste away, where do you suppose it goes to if not to the depths of the earth, especially as you see it emerge again not less in volume than its former stream? And 2
what are you to say when you see the Alpheus, so celebrated by the poets, sink in Achaia and, having crossed beneath the sea, pour forth in Sicily the pleasant fountain Arethuse? And don't you know that among the explanations given of the occurrence of the inundation of the Nile in summer, one is that it bursts forth from the ground, and is swollen not by rain from above but by water given out from within the earth?

I have myself heard from their own lips the 3
story told by the two non-commissioned officers sent to investigate the sources of the Nile by our good Emperor Nero, a monarch devoted to virtue in every form, but especially solicitous for the interests of truth. The King of Ethiopia had supplied them with assistance and furnished letters

of introduction to the neighbouring kings, and so they had penetrated into the heart of Africa
4 and accomplished a long journey. "We came indeed," I give their own words, "to huge marshes, the limit of which even the natives did not know, and no one else could hope to know ; so completely was the river entangled with vegetable growth,[1] so impassable the waters by foot, or even by boat, since the muddy overgrown marsh would bear only a small boat containing one person. There," my informants went on, "we saw with our eyes two rocks from which an immense quantity of water issued."
5 Now whether that is the real source or only an addition to the river; whether it rises there or merely returns to the surface after its previous course underground ; don't you think that, whatever it is, that water comes up from a great lake in the earth ? The earth must contain moisture scattered in numerous places and collected at depth in order to be able to belch it out with such violence.

IX

1 FIRE is the cause assigned by some for earthquakes, but they are not agreed as to its method of action. First among them is Anaxagoras, who is of opinion that pretty much the same cause produces concussion in the earth as in the atmosphere. In the nether parts of earth, air (gas) causes explosions of thick atmosphere massed in clouds with the same violence as on earth clouds are wont to be burst. Fire is struck out by this collision of clouds and by the
2 rush of the atmosphere that is forced out. This fire

[1] The so-called "sudd."

in seeking an exit meets obstructions and bursts through all obstacles, until it has either found a way of escape to the light through the narrow passages, or has made one for itself by violence and destruction. Other writers who still believe the cause to lie in fire do not suppose that this is its method of action: they think the fire presents itself in more than one place and burns away everything in the vicinity. Then if the parts eaten away fall in at any time, a shock follows in the portions which are deprived of their supports; they first totter and then collapse; nothing encounters them to support their weight. Then chasms and vast gulfs are opened 3
up, or it may be, after hanging a long time in the balance, the ground settles down over what is still left standing. We see the same thing happen ordinarily as often as a part of the city suffers from a fire. The joists are burnt through, or what gave support to the upper part of the buildings is undermined. Then the roofs after tossing about for a long time fall in; their swaying and oscillating continue until they find a resting-place on solid ground.

X

ANAXIMENES affirms that the earth is itself the 1
cause of the earthquake, and that nothing encounters it from without to give it a shock. Within it, he thinks, certain parts of its substance fall of themselves, either loosened by moisture, or eaten away by fire, or shaken off by the violence of air. But even in absence of such active cause there is not wanting sufficient to account for the loss or removal of some portion of the earth. In the first place, all things

fall through age, for nothing is safe from the ravages of time, which waste even the solidest and strongest edifice. In old buildings parts fall without being knocked off, merely because they have more weight
2 than strength. So in the earth's body as a whole it comes to pass that portions are loosened by age, and being loosened, fall, causing shock to the things above them. This they do primarily while they are leaving their place; for nothing, especially if it is large, can be wrenched off without movement of that to which it adhered. But further, when the objects have fallen, they meet the solid earth and rebound like a ball. When a ball falls, it jumps up and bounces repeatedly, just as often, in fact, as it recoils from the ground for a new flight. If the loosened objects within the earth are carried down into stagnant waters, this accident of itself causes a shock to the vicinity through the wave cast up by the weight of the objects shot suddenly down from a great height.

XI

Some attribute these earthquakes to fire, but give different explanations of its action. When fire causes intense heat at various points beneath the earth, it must roll up a great cloud of vapour, which can find no exit, and which dilates the air by its high temperature. If the pressure of the vapour is excessive, it scatters all obstructions; but if it is comparatively moderate, it merely causes movement of the earth. We observe water smoke when fire is applied. What the fire does to this water in a narrow pot, one may suppose is done on a much greater scale when a violent and wide-

spreading fire causes immense extents of water to boil. It then by evaporation from the overflowing waters shakes violently whatever it strikes.

XII

MANY of the greatest authorities are persuaded that 1
earthquakes are to be attributed to air. Archelaus, who is well versed in the records of antiquity, speaks thus: Winds are carried down into the earth's hollows and recesses. When they are all full, and the atmosphere is condensed to the utmost extent, the air, which continues to come in, forces and thrusts the former air, and with frequent blows first compresses and then dislodges it. The air in its 2
endeavour to find room forces all the narrow passages and tries to burst its barriers. Through the struggle of the air as it seeks for an escape it comes to pass that the earth is moved. This explains why the approach of an earthquake is preceded by still and quiet of the atmosphere; the force of the air which is wont to rouse the winds is held in check in its nether abode. Even 3
on the present occasion of the earthquake in Campania, although the season was winter, the atmosphere was perfectly still and calm for several days before it.[1] Well, then, did an earthquake never take place when there was a wind blowing? On very rare occasions have there been two winds blowing simultaneously. Still, such a thing is possible, and is wont to occur. But if we admit it as an established fact that two winds can be in activity at one and the same time, why shouldn't

[1] The text is uncertain, and the argument down to the end of the chapter rather obscure.

it happen that [at times] one of them agitates the upper air, the other the nether?[1]

XIII

1 In this category you may rank Aristotle and his disciple Theophrastus, a man of pleasant though not of superhuman eloquence, as the Greeks considered him, and of easy, polished style. Let me unfold in more detail what they hold in common: There is always evaporation of some kind going on from the earth, which is at one time dry, at another has an admixture of moisture. When this, rising from the lowest parts of earth, has been raised to the utmost extent, and has no place beyond into which to issue, it is borne back and returns upon itself. The struggle of the air in its ebb and flow tosses to and fro all obstructions it meets, and, whether its egress is stopped or whether it escapes through the narrow openings, it causes movement of the
2 earth and uproar. To the same school of opinion belongs Strato, who made a special study of this department of science, and was a diligent student of natural philosophy. His verdict on the matter is this: Cold and heat always move away from one another in opposite directions, and cannot remain in the same place. Cold flows into the spot whence the influence of heat has departed; and, conversely, there is heat in the place whence cold has been banished. The statement is beyond doubt, but the contrariety of the two may become

[1] The argument seems to be: Two winds can blow simultaneously. One may be beneath the earth (causing or during earthquake), one above. Therefore, stillness of the upper atmosphere is not a necessary concomitant of earthquake. The fact has at times been otherwise.

plain to you from the following: In the winter 3
season, when there is cold on the earth's surface, the wells are warm, and caves and all underground retreats equally so. The heat, yielding possession of the upper regions to the cold, retreats down there. When it reaches the lower regions, and is accumulated there to the utmost, the denser it is, the more powerful is it. To this a further supply is added, to which what has already gathered, and is compressed into a narrow space, of necessity gives way. The same thing happens from the opposite cause when a greater quantity of cold is borne down to these recesses. All the heat 4
that lurks there gives way to the cold, and retires to the narrow passages, and is driven onward with great impetuosity. The nature of the two, as I have said, does not allow agreement, or abode in the same place. In its flight, then, and eager haste to escape at all hazards the air pushes back and tosses about all that lies near it. This is why, previous to an earthquake, a roaring is usually heard, through the tumult of the winds in the earth's bowels. For not otherwise, as our poet 5
Virgil says, could

> The earth bellow beneath our feet and the lofty peaks be moved,

were not this the work of the winds. In this contest again there are ups and downs. There are cessations in the massing of the heat and, in turn, in its emission. Then the cold, too, is restrained and gives way, but some day soon it will be more powerful again. While, therefore, the alternating forces rush to and fro, and the air moves hither and thither, the earth is shaken.

XIV

1 THERE are some who think that, while air and no other cause produces earthquake, it operates in a different way from that which Aristotle supposed. Listen to what they say: Our body is irrigated with blood, and with air which courses everywhere along its own routes. We have some comparatively narrow vessels through which they cannot do more than pass; some wider, in which they accumulate, and from which they are distributed
2 to the members. So this whole body of the earth at large has passages alike for water, which performs the function of blood, and for wind, which might be called simply the breath of its life. These two encounter each other at some points, at some points they are stationary. While in our bodies good health is enjoyed, the movement of the veins preserves its rate undisturbed; but when there is malady the pulse beats more rapidly, the deep breathing and panting betoken laboured, wearied effort. In like manner the earth remains unshaken
3 while it maintains its natural position. But if any flaw occur in it, there is a shaking, just as of a body suffering from disease; for the air which flowed through it with regularity is violently smitten, and causes its veins to quiver; but not, let me add, in the way, described a little above,[1] imagined by those who will have it that the earth is a living creature. In that case the earth, just as an animal does, would feel the agitation equally all over. When a fever seizes any of us, it does

[1] There seems a slight lapse of memory here. Cf. pp. 126, 196.

not delay for a time its attack upon some parts, but with uniform regularity spreads over them all.

Perhaps you had better assume, therefore, that 4
air from the surrounding atmosphere enters the earth. As long as it has free egress, it glides through it without doing harm; but if it meet some obstacle to block its way, then it is, to begin with, weighted with the atmosphere that pours in on the rear; by and by it escapes with difficulty through some chink, and makes its way with the greater violence the narrower the opening is. That cannot take place without a struggle, and a struggle involves shaking of the earth. But if the confined air 5
cannot find even a chink by which to issue, it is massed and becomes furious, and is driven round in this direction and in that, overthrowing or bursting one thing after another. It is excessively subtle, and at the same time exceedingly powerful; it can worm its way into obstructions however great, splitting and scattering whatever it enters. When this occurs, then there is a regular tossing of the earth. For the earth either opens to give room to the wind, or, after giving room, is deprived of its foundation and subsides into the very cavern from which it allowed the wind to issue.

XV

Some entertain the following opinion: The earth is porous at many points, possessing not merely those first shafts which it received as ventilators at its creation, but many subsequently opened up by various changes. In some places water has washed away the soil that was on the surface;

part has been eaten away by torrents, while parts have been exposed by the disruptive action of great tides. Through the interstices thus produced air enters. If it so happen now that the sea has shut it in and driven it deeper, and the waves prevent its escape by the same road, egress and regress being alike closed, the air rolls about within the earth. Its natural tendency is to hurry straight forward, but as that path is closed, it presses upward and lashes the earth, whose weight lies heavy upon it.

XVI

1 I MUST further mention a view held by the majority of writers, which probably I shall myself support. The earth does not lack air within; that everybody knows. I do not mean merely the air which holds it together and unites its parts, which exists even in stones and dead bodies; but I mean that fresh vital air which supports all life. Unless the earth possessed this store of air, how could she infuse it into so many trees and crops, which derive their life from
2 this and no other source? How could she nourish all the different roots that sink into the soil in one place and another, some merely attached to the surface, others sunk deeper, had she not an abundant supply of the breath of life, which produces so many varied growths and rears them with its nourishing draught? These are the slighter arguments that I hitherto urge. Why, all the heaven we see, which is shut in by fiery ether, the highest portion of the universe, all these stars, whose number cannot be conceived, all this concourse of heavenly bodies, and, to mention only one more, this sun, that urges

his course so close to us, many times larger than the whole circuit of the earth—all these draw their nourishment from materials of earth which they share among them, and are sustained, of course, by nothing else than the breath of the 3
earth. This is their nourishment, this their pasturage. Now the earth would be unable to nourish so many bodies of such size, larger even than itself, unless it were full of breath, which it exhales from every part of it day and night. For there must be a large reserve of that from which so much is sought and taken; in fact, the supply to be drawn from it is created for the occasion. The 4
earth would not possess a perennial supply of air sufficient for the wants of so many heavenly bodies, unless the elements issued and returned alternately and were transmutable into one another. But apart from this, it is necessary that the earth be abundantly filled with it, and be able to draw it forth from her hidden store. There is no doubt then that a great quantity of air lurks in the interstices of the earth, and a widely diffused atmosphere occupies the hidden spaces underground. If that is true, of necessity the earth must often be moved, since it is full of a most movable substance. No one, I suppose, can doubt that there is nothing so restless, so capricious, so fond of disturbance as air.

XVII

It follows, therefore, that air should obey the law of 1
its being; what is wont to be moved will sometimes move other things. And when? Whenever its free course is checked. As long as it is not hindered it

flows quietly along. When it is opposed and held back it becomes furious, bursting all obstacles just like that

Araxes that ever spurned a bridge.

2 As long as the river has a free easy channel it rolls down its waters in due and regular succession. But if through chance or by human agency rocks are placed in its way to check its course, then it gathers fresh strength from the barrier, and the more numerous the obstacles opposed to it, the greater the force that it musters to overcome them. For all the water that accumulates behind, constantly increases, and being at last unable to bear its own weight manifests its violence through the havoc it works in its descent, and escapes headlong down its channel, bearing the very obstacles that blocked its
3 path. The same thing occurs with air, only that, in proportion to its greater strength and mobility, it is the more rapidly carried onward, and bursts the more violently all that encloses it. From this, of course, there is a disturbance in the part of the ground under which the struggle has occurred. The truth of this assertion may be proved from the consideration that often when an earthquake has taken place, involving a breach of only some part of the earth, wind has issued from it for several days.
4 This is recorded to have taken place in the earthquake in which Chalcis suffered, as you will find in Asclepiodotus, Posidonius' pupil, in his discussion of my own topic of Physical Inquiries. In other authors, too, you will find it stated that after a chasm had opened up at one spot, in no long time wind issued from it, having no doubt made for itself the way along which it travelled.

XVIII

THE chief cause of earthquake, therefore, is air, 1
an element naturally swift and shifting from place to place. As long as it is not stirred, but lurks in a vacant space, it reposes innocently, giving no trouble to objects round it. But when any cause coming upon it from without rouses it, or compresses it, and drives it into a narrow space, in the first instance, to be sure, it merely retires and roams about its enclosure. But when opportunity of escape is cut off, and resistance meets it on all hands, then

> . . . With deep murmur of the mountain
> It roars around the barriers; . . .

which, after long battering, it dislodges and tosses on high, growing the more fierce, the stronger the 2
obstacle with which it has contended. By and by, when it has traversed the whole space in which it was enclosed, and has failed to find a way of escape, it recoils from the side on which its impact was greatest. It is then either distributed through the secret openings which the earthquake of itself causes here and there, or escapes through a new rent. So uncontrollable is this mighty power. No bolt can imprison wind; it loosens every bond, bears with it every weight, and insinuating itself into the smallest crannies wins its release; for by the invincible power of nature it is free, especially when roused, and asserts its right for itself. Air is 3
a thing no man can tame; nothing will be found which,

When the winds struggle and the tempests roar,
Can restrain them by its sway and rein them by bonds and prison.

Doubtless the poets wished the place in which the winds lay pent up underground to be considered a prison. But they did not perceive either that what was shut up is no longer wind, or that what is wind can no longer be shut up. What is shut up is at rest, and the atmosphere is at a standstill; whereas all wind is in flight.
4 Besides these arguments, there is a consideration by which it becomes manifest that motion is brought about by air, namely, that our bodies never tremble except when some cause produces disturbance of the internal air,[1] which is contracted by fear, grows sluggish in old age, languishes when the veins are numbed, is checked with cold, or after some attack of fever is quite driven from its wonted course. As long as it flows unimpeded, and moves in its wonted fashion, there is no quivering of the body. When anything intervenes to prevent its functioning, then being no longer able to maintain what it upheld by its vigour, it fails, causing a collapse of everything that it had sustained when unimpaired.

XIX

1 We must now hear what Metrodorus of Chios desires to urge by way of opinion. I do not allow myself the liberty of passing over unnoticed even opinions that I disapprove; it is better to have the largest possible variety of views, and to condemn
2 rather than omit what we do not approve. Well, then, what has Metrodorus to say? He compares the

[1] Or spirit: there is almost a play upon the ambiguous meaning of the term.

subterranean disturbances to the voice of a person who puts his head into a barrel and begins to sing out. In that case there is a kind of quavering as the voice extends and resounds through the whole hollow space; slight as the movement is, it passes all round the vessel in which it is enclosed, grazing its sides and causing disturbance all through. In the same way the vast empty caverns that stretch down beneath the earth have atmosphere of their own, on which other air coming from above falls with violence. The agitation produced differs in no wise from that of the empty vessels which I have just mentioned, when they resound through shouting into them.

XX

LET us now go on to consider the authors who 1
have alleged as causes all the different factors mentioned, or, at any rate, several of them. Democritus is one of those who think that several are concerned. He asserts that the earthquake is produced sometimes by air, sometimes by water, sometimes by both. He pursues the argument in the following way: Some portion of the earth is hollow, in which a large quantity of water has gathered. Part of this water is thinner and less dense than the rest. When it is driven back by a heavy mass descending upon it from above, it comes violently against the earth, causing a commotion of it. The fluctuating movement of the water cannot take place without corresponding movement of the body on which it impinges. Besides, what we said a little above regarding air 2

must be repeated in regard to water. When it is accumulated at one place, which becomes too small to contain it, it inclines in some particular direction, and opens up a passage for itself, at first by its mere weight, afterwards by the gathering force of its current. Being long shut up it cannot escape except down an incline, and it cannot drop straight down with any gentleness, or without violent shaking of the parts through which and on which it
3 falls. Now, if after it has begun its rapid downward movement it is checked at any point, and the force of the current is thrown back upon itself, it is driven back on the earth which encounters it, and attacks the earth at the point where it is most insecure. Moreover, the ground is sometimes so saturated with the moisture it has received into its heart that it subsides to a lower level and its very foundation is destroyed. The pressure is then exerted on the part toward which the weight of the descending waters most inclines. Air, too, sometimes urges the water. If it presses with some degree of violence, it naturally moves the part of the earth toward which it has urged the gathering of the
4 waters. Sometimes, again, the air is driven into passages through the earth, and in its search for a way of escape causes a general movement. The earth, as we know, is pervious to wind; air is too subtle to be excluded, too violent to be resisted when excited to rapid movement.

Turning from Democritus to Epicurus, we find the latter to assert that all the foregoing may be causes of earthquake, but he tries to introduce some additional ones. He criticises other authors for affirming too positively that some particular one of the causes is responsible, as it is difficult

to pronounce anything as certain in matters in which conjecture must be resorted to. As he says, 5
then, water is capable of producing earthquake by washing and rubbing off certain portions, the weakening of which removes the support of what was upborne by them when unimpaired. The force of air is also capable of moving the earth. Perhaps the air within the earth is set in violent agitation by other air entering from without. Or, perchance, it may be that the earth receives an internal blow from the sudden fall of some portion of it, and derives thence the shock. Or, perchance, some portion of the earth is upheld, as it were, by certain pillars and stakes, the injury or withdrawal of which causes a tremor to run through the mass they support. Or, perchance, a quantity of hot air 6
turning to fire and assuming the character of lightning courses along to the widespread destruction of all obstacles it encounters. Or, perchance, some wind stirs the sluggish marshy waters, whose stroke in consequence shakes the earth; or the tossing of the air, increasing to violence through the mere movement, is carried from the lowest depths right up to the surface of the earth. Still, Epicurus is satisfied that there is no more potent cause of earthquake than air.

XXI

We Stoics also are convinced that it is only air that 1
can attempt such a feat as the production of an earthquake, for than it nothing in the whole realm of nature is more powerful, more energetic; in absence of it even the elements that are most violent lose their force. It is by air that fire is kindled;

if you withdraw wind, water is sluggish. Water becomes impetuous only when the blast tosses it with violence. This force it is that has power to scatter vast spaces of earth, to raise from the depths new mountains, and to set in mid-ocean
2 islands hitherto unseen. Can any one doubt that There and Therasia and this island which in our days under our very eyes rose out of the Aegean Sea, were carried up to the light by the force of air?

Posidonius will have it that there are two different varieties in the movements of the earth, each with its distinctive name. The one is a quaking when the earth is shaken and moves up and down; the other is a tilting when, like a
3 ship, it leans over to one or other side. I am of opinion that there is still a third variety, which we have a special term to denote. Our forefathers had good reason for speaking of a trembling of the earth, for it is unlike either of the other kinds of movement. On such an occasion things are neither all shaken nor all tilted, but they quiver. In a case of this kind no great damage is usually done; while, on the other hand, a tilting is far more destructive than a shock; for unless a contrary movement set in very quickly from the other side to restore the level, downfall follows of necessity.

XXII

1 THESE movements being dissimilar, their causes are likewise different. Let us deal first with the shaking movement. If great loads are being conveyed by a row of many waggons, and the wheels, under

the unusual strain, fall into the ruts of the road, one feels the earth shaken. Asclepiodotus has put it on record that on one occasion the fall of a rock that was torn off from the mountain-side caused by the tremor the collapse of some houses in its vicinity. Just the same thing may occur beneath the earth; parts of the overhanging crags may be loosened and fall with great weight and noise upon the floor of the cavern beneath, and with a violence proportionate to the weight of the mass and the height of the fall. The whole roof of the subterranean valley is disturbed by an occurrence of this kind. It is conceivable, too, that rocks are 2
not always wrenched off by their own weight; when rivers roll over them, the constant moisture weakens the joints of the stone, and day by day bears away part of its fastening, causing abrasion, so to speak, of the skin in which the stone is enclosed. The long waste of ages, through constant daily rubbing, by and by so weakens the fastenings that they cease to be able to sustain their burden. Then blocks 3
of vast size fall down, then the crag hurled headlong will not suffer anything to stand that it strikes in the rebound from its fall, but

> Comes away with a roar; and all things seem suddenly to rush headlong,

as our countryman Virgil says. Such must be the cause of the earthquake that shakes the ground beneath. Now I must pass on to the second kind.

XXIII

THE earth is naturally full of cavities, containing 1
much empty space. Through these cavities air

roams. When an excessive quantity has entered and cannot escape it shakes the earth. This explanation is approved by others, too, as mentioned a little above. Perhaps the crowd of witnesses will impress you. The view has the adhesion of Callisthenes, and he is a man not lightly to be set aside. He was endowed with a lofty intellect, and he dared to brave the wrath of a king. His death is an eternal blot on the memory of Alexander, which no valour and no success in
2 war can ever remove. As often as it is said, Alexander slew many thousands of the Persians, the retort will be, And Callisthenes too. As often as it is said, He slew Darius, in whose hands there was then a mighty kingdom, the retort will be, Yes, and Callisthenes too. As often as it is said, He conquered all lands right up to the Ocean, the Ocean likewise he essayed with fleets strange to its waters, from a corner of Thrace he extended his empire to the bounds of the East; it will also be said, Yes, but he slew Callisthenes.
3 Granted that he surpassed all former precedents of generals and kings, yet of all that he did, nothing will match his guilt in slaying Callisthenes.

Well, this Callisthenes, in the treatise in which he gives details of the sinking of Helice and Buris, and discusses the disaster which sent them into the sea, or the sea into them, says what I have said at a previous point. Air, he says, enters the earth by hidden openings under
4 the sea, just as everywhere else. By and by, when the path is blocked by which it had descended, and the resistance of the water in the rear has cut off its retreat, it is borne hither and thither, and encountering itself in its course it

undermines the earth. That is the reason why land over against the sea is most frequently harassed by earthquakes; and hence it is that Neptune has been assigned this power of moving the earth.[1] Any one who has learned the elements of Greek knows that he is called among the Greeks Earthshaker (Ἐνοσίχθων).

XXIV

I SHALL be ready to allow that air is the cause of 1
this form of destructive earthquake. But I shall have some criticism to offer as to the method by which it enters the ground. Does it enter by fine openings that the eye cannot detect, or by larger and more evident ones? Does it come from the depths of the earth, or does it pass through the surface too? The last-mentioned view seems inconceivable. In our bodies the skin keeps out air, which finds no entrance except that through which it is inhaled. And even when taken in by us, it cannot settle except in the looser portion of the body. It does not remain among the sinews 2
or muscle, but in the bowels and the open vessels of our internal organs. The same arrangement may be suspected in regard to the earth's interior from the very fact that the movement in an earthquake is not on the surface of the earth or about the surface, but beneath in the lowest parts. A proof of this is that seas of immense depth are tossed up, no doubt from the movement of the ground over which they spread. It is therefore probable that the earth 3
is moved in its depths, and that the air is formed

[1] The usual reading, *maris* = sea, contradicts the argument; it cannot surely be right.

there in the immense caverns. Nay, says some critic, but just as when we shiver from cold a trembling follows, so, too, the earth is shaken by air affecting it from without. This I deny can by any possibility occur. Why, the earth must get a chill in order to have the same happen to it as to us, whom an external affection drives into
4 a shuddering fit. I should quite allow that the earth shows symptoms of much the same kind as we do, but the cause is wholly different. An injury of a deeper kind, more toward its centre, must affect it, the very strongest proof of which may be found in the fact that when through violent earthquake the soil is laid open in wide destruction, the chasm sometimes takes in and buries whole cities.
5 Thucydides tells us that, about the time of the Peloponnesian War, the island of Atalanta, either wholly, or, at any rate, for the most part, was swallowed up. You may take Posidonius for witness that the same thing happened to Sidon. But we do not require evidence of this. Within our own memory the earth has been torn by internal movement, adjoining places have been rent asunder, whole plains have disappeared. I will now explain how I suppose this sort of thing to occur.

XXV

1 When air has completely filled a large vacant space within the earth, and has begun to struggle and meditate escape, it lashes again and again the sides of the enclosure within which it lurks, and right over which, as it happens, cities are sometimes situated. The shaking is at times so violent that buildings

standing above the area of disturbance are thrown down. Sometimes it goes to such lengths that the walls by which the whole roof of the cavern is supported fall right down into that vacant underground space, and cities sink entire into the unfathomed depths. Long ago, if one may believe 2
the story, Ossa and Olympus were united; subsequently they were separated by an earthquake, and the one great mountain was split into two. Then the Peneus made its escape, draining the marshes with which Thessaly was overspread, and drawing off the waters, which from want of exit had hitherto formed a lake. It was an earthquake that let loose Ladon, the river which flows between Elis and Magalenopolis. What, it is asked, do these facts go to prove? Simply that air gathers in the spacious 3
caves—for what other name can I apply to the empty places under the earth? Were this not so,[1] great spaces of the earth would be convulsed, and many of them would totter to ruin at one and the same time. As it is, only small portions suffer, nor does a shock ever extend as much as two hundred miles. Look at the recent one, the marvellous tales of which have filled the whole world; it did not pass beyond Campania. Need I say that when 4
Chalcis felt the earthquake shock Thebes did not fall? when Aegium suffered, Patras, which is quite close by, only learned by report about the earthquake? That mighty shock, which swallowed up the two cities Helice and Buris, stopped short of Aegium. Plainly, then, the movement extends only such distance as the empty space underground stretches.

[1] *I.e.* were the air distributed all through the earth.

XXVI

1 To prove my point I might have used, somewhat unfairly perhaps, the authority of the great writers who relate that Egypt never experienced an earthquake shock, the reason they allege for it being that it is all composed of mud. If one may believe Homer, Pharos used to be as far from the mainland as a ship under full sail could reach in a day's voyage; but it has now become attached to the mainland. The Nile's swollen stream brings down great quantities of mud, and by adding it from time to time to the existing land it has by an annual increase constantly carried
2 forward the coast of Egypt. The country thus is composed of rich loamy soil without interstices, as it has become solid just by the drying up of the mud. The composition of the mud was close and firm, the particles of it being stuck together; no vacant space could intervene, since the solid was always being added to by the liquid and soft slime. But Egypt is, as a matter of fact, subject to earthquake; and Delos, too, though Virgil bade it stand fast,

> And granted that it should be a settled land of tillage, and should laugh the winds to scorn.

The philosophers, too, a credulous set of people, relying on Pindar's authority, said that it did not experience movement. Thucydides asserts that in former times it was unshaken, but sustained a shock about the time of the Peloponnesian War.
3 Callisthenes asserts that the same thing happened on another occasion also. Among the numerous portents—these are his words—by which warning was

given of the overthrow of the two cities Helice and Buris, the most remarkable were the appearance of a huge pillar of fire and the earthquake shock in Delos. Yet he will have it that the island is comparatively firm for the reason that it is placed on the sea and has hollow crags and porous rocks, which afford a way of escape to air imprisoned in them. For this reason, too, islands have, he thinks, a 4
firmer soil, and cities are safer in proportion to their proximity to the sea. The falsity of such an opinion surely Pompeii and Herculaneum learned to their cost. Add now the fact that every sea-coast is particularly subject to earthquakes. Paphos, for instance, was more than once ruined, and the famous Nicopolis is already intimately acquainted with this mischief. Cyprus is surrounded by a deep sea, but is subject to shocks. Tyre is as regularly shaken by earthquake as it is washed by the waves. Such, then, are for the most part the explanations that have been suggested for the trembling of the earth.

XXVII

We must now essay an explanation of certain 1
peculiar features which are said to have occurred in the recent Campanian earthquake. A flock of six hundred sheep is asserted to have been killed in the district near Pompeii, and there is no reason to suppose that this happened to the sheep through fright. We have said that after great earthquakes it is usual for a pestilence to occur. And no wonder, since in the depths of earth many deadly poisons lurk. In fact, the very atmosphere there, 2

being stagnant through some fault in the earth or the sluggish movement and the everlasting darkness that prevails, is dangerous to breathe. Or being poisoned by the fumes of the internal fires, when it is released from its long inactivity, it taints and pollutes this pure clear air above, and brings new forms of disease to those who inhale the unwonted draught. You remember, too, that we found the water lurking in the secret depths to be useless and even pestilential, since activity never stirs it, and the free breath of heaven never ruffles it.

3 Being therefore thick and covered beneath gross eternal darkness it contains only elements that are pestilential and injurious to our bodies. So, too, the atmosphere, which mingles with it and lies amid these marshes, scatters far and wide its poison when it issues out, and kills those who breathe it. The flocks, which the pestilence is wont to attack, feel the poisonous effects more readily, because they are more greedy in feeding. They live for the most part in the open, and they drink a great deal of water, which is chiefly responsible for the pestilence.

4 Sheep are of rather delicate constitution, and, as they keep their heads close to the earth, I am not surprised at their being attacked by the infection; they receive the blasts of tainted air just as it issues from the ground. If it had issued in greater volume, it would have injured man too. But the abundant supply of pure air counteracted it before it could rise high enough to be breathed by any human being.

XXVIII

Now you may infer that the earth contains many 1
deadly elements from the mere fact that so many poisons grow of themselves without being sown; the soil no doubt contains seeds of evil as well as of good. Is it not the case that, earthquakes apart, in several places in Italy a pestilential steam is emitted through certain openings, which it is not safe for either man or beast to breathe? Even birds, if they meet it before it is neutralised by the purer breath of heaven, fall in mid-flight; their bodies become livid, and their jaws swell just as if they had been strangled. As long as this air is contained in 2
the earth and escapes by a narrow opening, it has no greater power than to kill creatures that look down into, or voluntarily approach too near, it. But when for centuries darkness has brooded over it, and the gloom of the place has increased the infection, it becomes more dangerous through mere lapse of time; the more sluggish it is, all the more deadly does it become. Then when it has gained an exit it lets loose all that mischief conceived in the cold shades through endless ages of nether darkness, tainting with it the atmosphere of our realms of earth. The better is ever conquered by the worse. 3
Even that purer air of heaven then changes to pestilential. Thence come sudden and continuous deaths, and portentous forms of disease that spring from unexampled causes. The disaster is long or short lived, according to the strength of the sources of infection. Nor does the plague cease until the freedom of heaven and the tossing of the winds have banished[1] that fatal air.

[1] Or purified.

XXIX

1 THROUGH fear some people have run about as if distracted or mad. For fear, even when in moderation and confined to individuals, shatters the mind's powers. But when there is public alarm through fall of cities, burying of whole nations, and shaking of earth's foundations, what wonder that minds in the distraction of suffering and terror should have wandered forth bereft of sense? It is no easy matter in the midst of overmastering evils not to lose one's reason. So it is, as a rule, the feeblest souls that reach such
2 a pitch of dread as to become unhinged. No one, indeed, has suffered extreme terror without some loss of sanity; one who is afraid is much like a madman. But some quickly recovering from the alarm regain self-possession. Others it more violently disturbs and reduces to sheer madness. Hence during times of war lunatics are to be met wandering about. On no occasion will one find more instances of raving prophets than when mingled terror and superstition have struck men's hearts.

I am not surprised that a statue is split by an earthquake, after I have recounted that mountains have been separated from mountains and the ground itself burst asunder down to its depths.

3 These places, once convulsed by the force of vast ruin—
Such the power of change in the lapse of lengthened ages!
Leaped asunder, they tell us, whereas hitherto both lands
Were one; into their midst rushed the deep with its mighty billows,
Cutting off the Italian from the Sicilian side; fields and cities
Were parted in sea-line and washed by the narrow tide that flowed between.

One sees whole regions torn from their place, and what was once contiguous, now lying beyond the sea. One sees a separation of cities and nations when a part of nature is roused by internal motion, or the sea or fire or air has assailed some point; for their force is marvellous, since it has a boundless reserve from which to draw. Though its rage is vented at but one 4
point, yet it has the world's whole strength to reinforce its wrath. Thus it was that the sea tore away Spain from the mainland of Africa. Thus it was by the flood, which the greatest of poets have celebrated, that Sicily was cut away from Italy. The movements that proceed from depth have much more force. They are more energetic, as their effort is concentrated upon a narrow area. Enough has now been said to show what mighty deeds these earthquakes have wrought and what wondrous sights they have displayed.

XXX

WHY, then, should one be amazed that the bronze 1
of a single statue is burst, and that, not even solid, but hollow and thin? as likely as not air in seeking an escape has got enclosed in it. And does not every one know that buildings are sometimes observed in time of earthquake to split at the corners and be united again? Other things badly set upon their base, and loosely and carelessly put together by the workmen, have been known to be welded firmly together by the repeated shaking of the earthquake. If it splits whole walls and whole 2
houses, and rends the sides of great towers, which are constructed of solid masonry, and scatters the piles that support the foundations of great works,

why should one think it worthy of remark that a statue had been cut equally into two from base to summit? But why, it may be asked, did the shock last
3 for several days? For Campania went on trembling continuously, more gently it is true, but still causing great damage, because what it shook was already shaken and crushed. Things stood so insecurely as to require only a slight shake, but not a push, to bring them down. The explanation of the prolonged shaking is no doubt that all the air had not yet escaped, but though the greater part was discharged, a remnant was still roaming about here and there.

XXXI

1 THERE is yet a further proof that you may unhesitatingly add to the others that go to show that all these phenomena are the outcome of air. After the most violent shock that cities and provinces can experience has spent itself, another of like violence cannot immediately follow; after the crisis there are only slight shocks, just because the most violent one has opened a way of escape for the struggling winds. The remains of the air that is left have not the same power, nor do they require to struggle; they have now found a way of escape, and follow the path by which the first and greatest shock issued.

2 I am of opinion, too, that the observations of a certain learned and grave philosopher of my acquaintance deserve to be put on record; he happened to be taking a bath when the earthquake occurred. He asserted that he saw the tiles with which the floor of the bathroom was paved, separate one from another and unite again. At one moment,

when the pavement opened, the water was taken in through the joints, the next, when the pavement closed, it was forced out all bubbling. I have heard the same learned man relate that he had seen soft materials undergo more frequent but more gentle shocks than materials naturally hard.

XXXII

So much, my esteemed Lucilius, with respect to the 1
mere causes of earthquakes. Now we must adduce some considerations that will tend to reassure us in face of the perils of earthquakes. After all, it concerns us more closely to acquire resolution of mind than erudition, and yet the former cannot be had without the latter. Assurance comes to the mind from no source but elevating studies and the contemplation of nature. Is there any one, I say, that reflects upon causes, who will not be reassured and emboldened by this late catastrophe in Campania to face disasters of all kinds? Why should 2
I fear man or beast, bow or lance? Far greater perils are ever lurking for me. Lightning and earth shock, and all the great forces of nature, aim their blows at us. Death must therefore be resolutely[1] challenged whether its attack be with vast[1] overpowering onset or by ordinary means of daily occurrence. It is of no moment how threatening its approach, or how great the engine it brings up against us. The life it asks of us is a very little thing. It will be taken from us by old age, or by 3
a little pain in the ear, or by a superabundance of tainted moisture within, by food that the stomach

[1] It would seem that *ingenti* and *aequo* have by some means got transposed in the ordinary texts. Gercke reads *saevo* for *aequo*.

cannot assimilate, or by a slight injury to one's toe. Man's life is a paltry affair, but a mighty affair is the contempt of life. He who can despise life may look unmoved upon the tossing of the sea, even though all the winds have roused it, even though by some upheaval of the world the tide has turned
4 the whole Ocean bodily upon the land. Unmoved he will behold the fierce forbidding aspect of the thundering heavens, yes, though heaven itself be crushed and unite its fires for the destruction of mankind and of itself first of all. Unmoved he will behold earth's framework rent and earth's foundations yawning beneath. Though the realms of the nether world be uncovered, he will stand over the abyss still dauntless, and into the pit into which he is doomed to fall he will perhaps leap. What is it to me how great the powers by which I perish? To perish is itself no great matter.

5 Wherefore, if we desire to be happy, to be harassed by no fear either of men, or gods, or circumstance, to despise fortune with her superfluous promises and her contemptible threats, if we desire to live the peaceful life, and to vie with the very gods in happiness, then we must carry our life in our right hand. Whether snares or diseases attack it, the swords of foes or the crash of falling tenements, or the downfall of earth itself, or the violence of widespread fire enveloping city and field in common disaster, let who will take it.
6 What more do I owe life than to encourage it on its journey, and to despatch it with good wishes? *Go resolutely, go prosperously!* There must be no hesitation in rendering back life. It is merely a question of time, not of fact. What you are doing must be done some day. Beseech

not nor fear, nor draw back as if starting to face some peril. Nature, who bore you, waits your coming to a place better and safer than earth. There is no earthquake there, friend, no 7
winds clashing with loud noise of cloudy sky, no fires to waste province and city, no fear of shipwreck swallowing up whole fleets, no armies arrayed with opposing banners, or common fury of hosts prepared for mutual destruction, no plague, no pyres lit up around the promiscuous resting-place of slaughtered nations. If death is a light affair, why fear it? If it is heavy, then rather let it fall once for all than be always hanging over us. Should *I* fear to perish when earth must perish 8
before me, when the powers that shake are shaken, when they hasten to our destruction only through their own? The sea received Helice and Buris entire; shall I fear for one poor body? Ships sail over the site of two towns, aye, towns that we know well, that the record preserved by letters has brought to our intimate knowledge. How many others have been sunk in other places? how many nations has either earth or sea engulfed? Shall I rebel against my end when I know that 9
I am not endless? nay, when I am fully assured that all things come to an end, shall I fear my latest sigh?

Wherefore steel yourself, Lucilius, with all your might against fear of death. This fear it is that drags us down; this it is that torments and destroys the life it tries to preserve. It magnifies all those dangers, earthquakes and lightnings, and the rest. You will be able to bear them all resolutely if you but reflect that short and long in life make no difference. It is but hours we lose. 10

But suppose it is days, or months, or years, what we lose is, surely, bound to perish. What difference, pray, is it whether I manage to reach them or not? Time flows on; it leaves behind those most eager to seize it. Neither what is to be is mine, nor what was. I am poised upon a point of fleeting time; it is a great thing to have been moderate in one's ambitions. Laelius the Wise made a neat retort once to a person who said, I am
11 sixty years old: you mean, said he, the sixty you no longer *are*.[1] We show our failure to grasp the terms of this elusive life of ours, and the conditions of time that is never our own, in reckoning up as ours years that are now lost. Let us fix this in our minds, and constantly remind ourselves, I must die. When? What matter is that to you? Death is a law of nature; death is a tribute and a duty imposed on mortals; it is the remedy of all ills. Whoever now fears it will one day long for it. Giving up all else, Lucilius, make this your one meditation, not to dread the name death. By long reflection make death an intimate friend, that, if so required, you may be able even to go forth to welcome it.

[1] It is almost impossible to express in English the play on *habeo* = have; French is more amenable. "J'ai soixante ans! Parlez-vous des soixante ans que vous n'avez plus?"—NISARD.

BOOK VII

WHICH TREATS OF COMETS

I

No man is so utterly dull and obtuse, with head 1
so bent on earth, as never to lift himself up and rise with all his soul to the contemplation of the starry heavens, especially when some fresh wonder shows a beacon-light in the sky. As long as the ordinary course of heaven runs on, custom robs it of its real size. Such is our constitution that objects of daily occurrence pass us unnoticed even when most worthy of our admiration. On the other hand, the sight even of trifling things is attractive if their appearance is unusual. So this concourse of stars, 2
which paints with beauty the spacious firmament on high, gathers no concourse of the nation. But when there is any change in the wonted order, then all eyes are turned to the sky. The sun has no observer unless he is in eclipse. No one watches the moon unless she suffer obscuration. But then whole cities cry out, groundless superstition drives every one into panic. And yet how much greater 3
are the ordinary movements of the sun! He takes, so to speak, as many steps as there are days, completing the year in his circuit. From the summer solstice he turns back to the lessening days, from the solstice he slopes his rays,[1] and gives more

[1] There is some corruption in the text, but no probable restoration has been suggested. From the Latin words it would appear that this clause is merely an explanation of the previous one, inserted by some officious copyist and therefore spurious.

room to the nights; he occults the planets; though so much larger than the earth he does not burn it up, but cheers it by his heat, which he so regulates as to make it alternately more intense and more subdued. He never fills up with light, nor yet obscures, the
4 moon, except when she is right opposite to him. All this we allow to pass unnoticed as long as the usual order is preserved. But if there is any disturbance or any extraordinary light displayed in the sky, we gaze at it, ask questions, and point it out to our neighbours. So natural is it to admire what is strange rather than what is great.

The same thing holds in regard to comets. If one of these infrequent fires of unusual shape have made its appearance, everybody is eager to know what it is. Blind to all the other celestial bodies, each asks about the newcomer; one is not quite sure
5 whether to admire or to fear it. Persons there are who seek to inspire terror by forecasting its grave import. And so people keep asking and wishing to know whether it is a portent or a star. But, by my honour, no one could embark on a more exalted study, or master a more useful branch of knowledge than that which treats of the nature of the stars and planets. Are they a concentration of flame as our vision avers, and as the very light that streams from them,[1] and the heat that descends from them suggest?
6 Or are their orbs not of flame, but, as it were, solid bodies of earth that glide through tracts of fire, and having no light of their own draw thence their brightness and heat? That is an opinion that has been held by great men who have believed the stars to be compact of hard material, and to be nourished by fire that is not their own. Flame

[1] The common reading, *aliis* = others, seems an error for *illis* = them.

by itself, they argue, would be dissipated and would have nothing to hold or to be held by. If it were merely massed and not attached to a solid body, the universe would assuredly long since have scattered it in its impetuous whirl.

II

In view of this inquiry it will be well to ask 1
whether comets are wholly analogous to stars and planets. They seem to have certain elements in common with them — for example, rising and setting — as well as their general form, although comets are more scattered, and end in a longer tail. They are alike, too, in their fiery bright appearance. So, if all the stars are earthy bodies, comets must share the same lot. But if the 2
stars are pure fire and nothing else, remaining for six months at a time unbroken by the rapid whirl of the universe, then comets, too, may consist of some rarefied material, which is not broken up by the constant revolution of the sky. It will also tend to clear up this point if we endeavour to ascertain whether the earth stands still while the universe revolves round it, or whether the converse is the truth, the universe standing still while the earth revolves. There have been persons who made bold to say that it is we that all unwitting are borne round by the frame of things, that risings and settings are not produced by a movement of the heavens, but that we ourselves rise and set. The subject well 3
deserves our study, if we are to know where we really stand, whether the abode we have obtained

as ours is the most sluggish or the swiftest of motion, whether God causes all things to revolve round us or causes us to revolve. Now, for this it is essential that we have a record of all the appearances of comets in former times. For, on account of their infrequency, their orbit cannot as yet be discovered or examined in detail, to see whether they observe periodic laws, and whether some fixed order causes their reappearance at the appointed day. Such a development of astronomy is recent, having been lately introduced into Greece.

III

1 DEMOCRITUS, the most acute of all the ancient philosophers, says he suspects there are several stars whose orbits are erratic. But he has given neither their number nor their names, as the motions of the five planets were not in his time understood. Eudoxus was, in fact, the first to import from Egypt into Greece the knowledge of these motions, though he says nothing about comets. From this it becomes plain that, even among the Egyptians, the people that bestowed most care on observation of the sky, the portion of astronomy that relates to comets had not been
2 worked out. Subsequently Conon, who was himself a careful investigator, made a record of the sun's eclipses that had been observed by the Egyptians; but he made no mention of comets, though he would certainly not have omitted anything definite on the subject that he had learned in Egypt. So much is certain; two authors, Epigenes and Apollonius of Myndus, the latter highly skilled in cast-

ing horoscopes, who say that they studied among the Chaldaeans, are at variance in their accounts. The latter asserts that comets are placed by the 3
Chaldaeans among the number of the wandering stars (*i.e.* planets), and that their orbits have been determined. Epigenes, on the contrary, asserts that the Chaldaeans have ascertained nothing regarding comets, which are thought by them to be fires produced by a kind of eddy of violently rotating air.

IV

In the first place, if it like you, let us set down 1
the views of the last-mentioned author and refute them. He supposes that the planet Saturn has most influence in determining all motions of the heavenly bodies. When it presses upon the constellations next Mars, or crosses to the neighbourhood of the moon, or encounters the rays of the sun, being naturally cold and windy, it contracts and masses the atmosphere at more than one place. By and by, if Saturn absorb all the sun's rays, there 2
is thunder and lightning. If he has Mars in agreement, the lightning is forked. Moreover, he continues, forked and sheet lightning contain different materials. Evaporation from water or other moisture produces only gleams that threaten but stop short of striking. The hotter and drier exhalation of the earth forges the bolts of forked lightning. Beam meteors and torches, which differ 3
from one another only in size, are produced in this same way. When any ball of air—what we call a whirlwind—encloses moist earthy matter, wherever it rushes it presents the appearance of an extended

line of fire, which lasts just so long as the mass of air remains, which carries within it the supply of moist earthy matter.

V

1 THIS account of Epigenes is a tissue of falsehoods. To begin with the nearest one, the last, it is not true that torch and beam meteors are due to the violent action of a whirlwind. The whirlwind is formed in the neighbourhood of the earth, and there it runs its course. This is the reason why it tears up trees by the roots, and wherever it swoops down it lays bare the soil, carrying off in the meanwhile woods and roofs of houses; as a rule, it is lower than the clouds, and assuredly never higher. But, on the contrary, it is the more exalted part of heaven that displays beam meteors, and so they never intervene between us and the clouds. Besides, a whirlwind is borne along more swiftly than any cloud, and
2 rotates as on a pivot. And in addition to this, it ceases all of a sudden, bursting by its own force. "Beams," on the contrary, do not run or fly across, like torches, but remain shining for some time in the same quarter of the sky. Charimander, too, in the book he wrote on comets, asserts that a great and unusual light in the sky of the size of a large beam was once seen by Anaxagoras, and continued to shine for a long period. Callisthenes puts it on record that a similar appearance of a trail of fire was observed before the sea
3 swallowed up Buris and Helice. Aristotle says it was not a "beam," but a comet; the characteristic dispersion of the fire was not seen at first on account of its excessive brightness, but, in process

of time, when the glare began to die down, it recovered the distinctive appearance of a comet. In this fiery phenomenon there were many points worthy of remark, none more so than this, that, immediately it shone in the sky, the sea came over Buris and Helice. Did Aristotle, then, one 4
may ask, believe that not merely that beam but all beams are comets? Surely not, for there is this difference, that beams have their fire continuous, while in the other bodies it is dispersed. Beams have a regular flame, not interrupted or dull at any point, while in the end parts it is condensed, just like what Callisthenes describes the one to have been, to which I referred a moment ago.

VI

THERE are, Epigenes goes on to say, two classes 1
of comets. One kind sheds its light on all sides without changing its position; the other extends a loose kind of fire in one direction, after the fashion of hair, and passes through among the stars; of the latter kind were the two seen in our own days. The former variety, with hair on all sides, that do not move, are usually low down, and arise from the same causes as beams and torches, that is, from a distempered thick atmosphere that carries in it many of the earth's exhalations, both dry and moist. Air driven out through narrow apertures 2
is capable of setting on fire the atmosphere situated over it, which is full of elements suitable for feeding a fire; and it is able after that to drive it forward from the clear space, lest from any cause it should fall back and relax its force. After that, it can rise

again on the next and following days and set fire to the same spot. As presumptive proof of this, we see winds return during several days at their set time. Rain, too, and storms in other forms recur
3 according to appointment. His opinion may be briefly expressed by saying that he supposes comets to be formed pretty much in the same way as fires excited by whirlwind. There is this one difference, that those whirlwinds are pressed down to earth from a higher region, while these others are raised from earth to the upper regions.

VII

1 A GREAT deal can be urged against this view. First of all, if wind were responsible, a comet would never make its appearance without wind. As a matter of fact, it appears when the air is perfectly still. In the next place, if it were due to wind, it would fall with the wind; and if it began through wind, would increase with increase of wind, and would be the brighter the more furious the wind was. This point, too, has to be added to the foregoing: while the wind impels many parts of the atmosphere, a comet appears in one spot. The wind does not mount up high, but comets are seen higher up than
2 the winds are permitted to go. Epigenes afterwards goes on to speak of the comets that, he says, have a more definite resemblance to stars, traversing an orbit and passing through the zodiacal signs. He attributes their origin to the same causes as produce those that he called lower comets, the only difference being that the earth's exhalations in this case contain many dry elements, and therefore seek

the higher region, and are driven by the north wind toward the more exalted portions of the heavens. But, surely, if the north wind urged them, they would always be borne toward the south, whither this wind urges its course. And yet, as a fact, they 3
have had different movements, some to east, others to west, all in a curved path, a direction which the wind could not impart. Besides, if the impulse which produced the comet carried up on high those north winds from the earth, comets would not arise when other winds blew; yet they do arise.

VIII

Let us now refute this other explanation of 1
Epigenes, for he employs two. He believes that when all the moist and dry exhalations of the earth unite, the mere discord of the different bodies turns the air into whirlwind. Then the force of that wind as it revolves sets fire by its rapid motion to all that it embraces in itself, and raises it on high. The gleam of the fire that is thus extracted remains as long as there is sufficient nutriment; when the fuel fails, the fire subsides too. Now, one who talks 2
thus pays no attention to the nature of the course of whirlwinds as compared with that of comets. The career of the former is swift and violent, more rapid than the winds themselves. But a comet's movement is so gradual as to render imperceptible the space traversed during a day and a night. Besides, whirlwinds have an erratic, disorderly, and, to use a word of Sallust's, eddying, motion. Comets have a regular course, which observes the appointed track. Surely none

of us will believe that either the moon or the five planets are carried by the wind or spun round
3 by the whirlwind. I trow not. And why? Just because they have not an irregular and unrestrained motion. Let us apply the principle to comets. They do not move in confusion or irregularity so as to justify the belief that they are impelled by unruly and fickle forces. Besides, even if those eddies could enclose moist earthy elements, and had power to raise them from the depths to the heights, still they could not carry them up higher than the moon. All their force is spent when they reach the region of clouds. But as for the comets, we see them sailing through the upper regions, mingling with the very stars. It is, therefore, improbable that a whirlwind could persist over such a long distance, for the greater it is, the more rapidly is it spent.

IX

1 Let Epigenes, therefore, make his choice of the two alternatives: if the force is small, it cannot reach so high; if it is great and violent, it will the more quickly break up. But further, according to the opinion of people like Epigenes, these lower comets do not mount higher because they have too much earthiness in them. Their weight keeps them in the neighbourhood of earth. And yet these other comets, which are higher and last longer, must have a more abundant material. For they could not last so long were their supplies not
2 replenished from a larger stock. I said a moment ago that the whirlwind's eddy could not long endure, nor could it mount higher than the moon, or as far

as the place of stars. Of course, the whirlwind is caused by the mutual struggle of several winds, and the contest cannot be kept up for any long time. When the wandering uncertain air assumes a rotatory form, in the last instance the force of all the winds yields to the single strongest one. No 3
hurricane lasts long. The more strength squalls have, the shorter their duration. When winds reach their maximum, they quickly abate all their violence. By that headlong speed they must needs hasten to their own destruction. So no one has ever seen a whirlwind last a whole day, or even an hour. Its velocity is astonishing, its brevity no less astonishing. Moreover, on the earth and near it, its 4
rotation is swifter and more violent; the higher it is, the less condensed and compact is it, and that is the reason of its more rapid dissipation. Add the fact, too, that even if it reached the highest region where the stars' path lies, it would most certainly be broken up by the motion which causes the universe to revolve. For what can compare in rapidity with the revolution of the world? Thereby the strength of all the winds combined in one would be shattered, aye, and the strong solid chain that binds the earth, not to say a wisp of whirling air.

X

Again, a fire carried along by a whirlwind cannot 1
remain on high unless the whirlwind also remain. But then what is so inconceivable as any prolonged duration in a whirlwind? Above all, the whirlwind motion is neutralised by the opposite motion of the heavens. That region on high to which it

is alleged to mount has an eddying motion of its own, which carries onward the sky,

> And drags the lofty stars, and turns them in rapid whirl.

And even though one grant some duration to whirlwinds, which is quite contrary to the fact, yet what is to be said of the comets that have con-
2 tinued in sight for six months? Then, as hinted above, there must be two motions in the same spot —one that constant motion of the heaven, accomplishing its task without intermission, the other a strange new motion conveyed by the whirlwind. The one must inevitably obstruct the other. And yet that motion we see of the moon in her orbit, and of the other heavenly bodies that pass above the moon, is irrevocable. It nowhere falters or stops, nor does it convey to us the slightest suggestion
3 of an obstacle being ever placed in its way. It is utterly beyond belief that a whirlwind, the most violent and unruly species of storm, should reach the very centre of the ranks of the stars, and should find a sphere for its boisterous activity in that ordered peace of heaven. Supposing that the revolution of a whirlwind kindles fire, which is shot up to the heights, furnishing apparent ground for the belief that what we see is a trail of fire ; yet surely the shape of the fire ought to be something
4 like that which produces it. Now a whirlwind is round in appearance ; it remains in the same track, and revolves after the fashion of a rotating pillar. The fire, therefore, that is enclosed ought to resemble it in shape. But in reality it is a trail of scattered fire, and resembles anything rather than fire gathered into a ball.

XI

LET us now say good-bye to Epigenes, and proceed 1
to examine the opinions of other writers. But before beginning to set them forth, I must first, by way of preface, remark that comets are not observed only in one part of the sky, nor merely in the zodiac, but in the east as well as in the west, more frequently, however, toward the north. Nor is 2
their shape uniform. The Greeks, indeed, distinguished three classes of them: those from which the flame hangs down, after the fashion of a beard; those that shoot out what looks like hair round them on all sides; and those which have a scattered kind of fire, which, however, stretches toward an apex.[1] But all the classes have a common characteristic, and are rightly called comets (*i.e.* long-haired). As the different shapes present themselves only at long intervals, it is difficult to compare them with one another. Even at the time of their appearance 3
spectators are not agreed as to their shape. According as one's eyesight is keener or duller, one asserts that the comet is brighter or redder, and that its hair is compressed toward the interior of the star, or spread out toward its sides. But whether or not there are any differences in comets, they must all be produced by the same method. The 4
one fact about which there ought to be agreement is, that a star of strange unwonted appearance is beheld which drags along with it scattered fire. Some of the ancients are convinced of the truth of this explanation: When one of the planets has come into conjunction with another, the light of the

[1] *I.e.* are cone-shaped.

two blends in one, producing the appearance of a more elongated star. This happens not merely when star touches star, but even when one approaches another. The space between the two is in that case lit up by both, and seems aflame, producing the trail of fire.

XII

1 Our first answer to this theory is that the number of moving stars (planets) is fixed. It is quite usual for them and comets to appear at the same time; whence it is manifest that the comet is not due to the conjunction of planets, but is a distinctive independent star. Besides, it is a matter of frequent occurrence for a star to come under the orbit of a more elevated star. Saturn, for example, is sometimes above Jupiter; Mars looks down in
2 a straight line on Venus or Mercury. But yet no comet is formed from this movement whereby the one planet approaches the other. Were it otherwise, there would be a comet every year, for every year there are planets in the same constellation. Again, if the approach of star to star produced a comet, the latter would cease to be in a moment. The transit of stars takes place with the utmost rapidity, thence all eclipse of heavenly bodies is of brief duration; by the same motion they are as swiftly separated as they were brought
3 together. The sun and the moon, as we see, part company within a brief space after the eclipse has begun. How much swifter must be the separation of stars, which are so much smaller? Yet comets last for six months at a time, which would not

happen if they sprang from the union of two stars. The stars cannot stick to one another for any long time, and the law of their swift motion must ever drive them asunder. Besides, those stars appear to 4
us to be close to one another, but in reality are separated by immense distances. How, then, could the one star transmit fire to the other so that the two should seem in union, when they are thus parted by an immense tract? The light of the two stars, it is replied, mixes, furnishing the appearance of one. I suppose this means that the phenomenon is much the same as when a cloud takes a ruddy colouring from the rays of the sun striking on it, or as when there is the golden glow of evening or morning, or as when the bow is painted in its varied hues, but only in sunshine.

Well, my first criticism is that all the instances 5
mentioned are the result of great force. It is the sun that lights them up. The stars do not possess anything like the same power. My second remark is that none of the phenomena arises except below the moon in the vicinity of the earth. The upper regions are pure and spotless, always retaining their own colour. I remark further, that if anything of the kind did occur, it would not last but would speedily disappear, as halos which surround the sun or moon fade in a very brief space of time. Even 6
the rainbow does not long remain. If there was anything of the kind supposed, to unite the space between the two stars, it would disappear with equal rapidity. In any case it would not remain as long as comets are in the habit of doing. The planets have their orbits within the zodiac, they lie near this circle; but comets are seen in all parts of the sky. Their time of appearance is no more

certain than the limits of the space which they may not exceed.

XIII

1 In reply to arguments like mine it is urged by Artemidorus that the five planets are not the only stars with erratic courses, but merely the only ones of the class that have been observed. But innumerable others revolve in secret, unknown to us either by reason of the faintness of their light, or the situation of their orbit being such that they become visible only when they reach its extremities.
2 It is thus, he says, that certain new stars enter our field of vision, mingling their light with the fixed stars, but displaying a brightness greater than is usual in stars. This is the least serious of his lies: his account of the universe is from end to end a shameless tissue of lies. For instance, if we are to believe him, the upper regions of heaven are perfectly solid—a lofty thick vault, as hard as the roof of a house, formed by the accumulation of masses of atoms. The surface immediately above it is of fire so compact that it cannot be broken up
3 or altered. Nevertheless, it has certain ventilators, and, as it were, windows through which portions of the fire stream from the outer part of the universe, but not so large as to cause commotion in the inner; and again the fires pass from the world back into the outer spaces. These extraordinary appearances, therefore, Artemidorus supposes, have streamed in from that mass of matter which lies outside the world. To set about disproving such a theory is nothing short of beating the air for the sake of exercising the muscles!

XIV

STILL, I will descend to the task. Let the man 1
who has placed such a solid roof on the world tell
me what reason there is for believing his statement
that the heavens have such a thickness. What was
it that took all these solid bodies up there and kept
them there? Then, a firmament of such thickness
must necessarily be of immense weight too. How
is it that heavy bodies remain aloft? How is it
that the huge mass does not come down and smash
itself by its own weight? It is, I imagine, a 2
physical impossibility that such a vast weight as
Artemidorus has brought to the support of the
heavens should hang suspended, or be supported by
a slight foundation. Nor can it be alleged that
there are stays[1] of some kind outside by which it
is prevented from falling. Nor again can there be
any support in the centre[2] to receive and prop up
the threatening mass. And again, no one will
venture to assert that the universe is being con-
stantly carried down through the immensities of
space, falling all the time, though it is not evident
that it falls, because its headlong course is to all
eternity, having no final obstacle with which to
collide. This is indeed a statement people have 3
made about the earth, when they could discover no
explanation for a mass standing poised in air. It is
borne down, say they, for ever; but it is not evident
that it falls because the space into which it falls is
endless.

[1] The word is usually applied to a flexible fastening, hawser, cable, or the like.

[2] Or, between the earth and it.

Well, what argument[1] then justifies the assertion that it is not merely the five planets that move, but that there are many such in many quarters of the universe? Or if there is no probable proof of this, one may rejoin: What is there to prevent one from saying either that all the stars
4 move or that none of them does? Besides, your argument is in no way helped by that crowd of stars which you assume to be everywhere roaming about! For the more there are of them, the oftener will they meet with others; whereas comets are rare, and for that reason marvellous. And will not every age give evidence against you by noting and recording for the use of posterity the emergence of such stars?

XV

1 After the death of Demetrius, king of Syria, whose kingdom was divided by his sons Demetrius and Antiochus, a little before the Achaean War, a comet blazed forth not inferior to the sun in size. Its orb was at first fiery red, and emitted a bright light sufficient to dispel the darkness of night. By and by its size was gradually reduced and its brightness waned. Finally it went completely out. How many stars, suppose you, would require to
2 combine to make up such a huge mass? You might collect in one a thousand of them without ever matching the size of the sun. In the reign of Attalus a comet appeared, moderately small in size to begin with. By and by it mounted up and spread out and moved as far as the equator, equalling in

[1] The argument is resumed from the beginning of XIII. after the digression about the "firmament."

the extent of its immense length the whole quarter of the sky which we call the Milky Way. How many planets must have combined to occupy with an unbroken line of fire such a long tract of the sky?

XVI

I HAVE refuted the argument; I must now discredit 1
its authors. It requires no great effort to strip Ephorus of his authority; he is a mere chronicler. Some of his class seek to recommend their narrative by incredible stories, and by their marvels try to interest the reader, who would probably soon find some other occupation if he were called on to wade through their tedious narrative of ordinary events. Some, again, are too credulous, some too careless, some are deluded, some delighted, by falsehood. The former do not shun it, the latter go in quest of it. The whole clan of them have this in common; 2
they fancy their work cannot merit approval, and become popular unless they freely interlard it with lies. Ephorus is not a person of any scrupulous honour; he is often duped, often he tries to dupe. For example, he asserts that the great comet which, by its rising, sank Helice and Buris, which was carefully watched by the eyes of the whole world since it drew issues of great moment in its train, split up into two stars; but nobody besides him has recorded it. Who, I wonder, could observe the 3
moment at which the comet broke up and was resolved into two parts? And if there is any one who saw it split up into two, how is it that no one saw it first formed out of the two? And why did Ephorus not add the names of the two stars into

which it was broken up, since they must have been some of the five planets ?

XVII

1 Apollonius of Myndus differs in his view from Epigenes. He asserts that a comet is not one star made up of many planets, but that many comets are planetary. A comet, he goes on, is not an illusion nor a trail of fire produced on the borders of two stars, but is a distinctive heavenly body, just as the sun or the moon is. Its shape is not limited to the round, but is somewhat extended and produced lengthwise.
2 On the other hand its orbit is not visible. It cuts (= intersects) the upper part of the universe, but only emerges when at length it reaches the lowest portion of its course. There is no reason to suppose that the same comet reappears ; for instance that the one seen in the reign of Claudius was the same as the one we saw in the reign of Augustus ; or that the recent one which appeared during the reign of Nero Caesar—which has redeemed comets from their bad character—was similar to the one which burst out after the death of the late Emperor Julius Caesar, about sunset on the day of the games to
3 Venus Genetrix. Comets are as varied as they are numerous. They are unequal in size, unlike in colour. Some are ruddy without any light ; others are bright with a pure clear light ; others are flame-coloured, but the flame is not a pure thin flame, but is enveloped in a mass of smoky fire. Some are blood-stained and threatening, bringing prognostication of bloodshed to follow in their train. They wax and wane like other planets. They are brighter

when they come down toward us, and show larger from a nearer point, smaller when they depart from us, and dimmer when they retire to a greater distance.

XVIII

THE reply is ready to this last statement, that the 1
same thing does *not* happen in comets as in the other stars. Some comets attain their maximum on the very first day of their appearance. But, according to the argument, they ought to increase the nearer they approach. As it is, their first aspect remains until they begin to fade. Besides, what has been said in reply to former authorities applies here too: If the comet had an erratic orbit, and were a true planet, it would move within the limits of the zodiac, within which all the planets confine their orbits. Again, a star is never seen through another 2
star. Our sight cannot pierce through the centre of a planet so as to view through it what lies beyond. But through a comet the further regions are discerned as through a cloud. Whence it is evident that it is no planet but an insubstantial, irregular fire.

XIX

THE following is the opinion of our Stoic sage Zeno. 1
He is convinced that the stars act in concert, and unite their rays with one another—a partnership in light which creates the image of a more elongated star. Therefore some persons suppose that comets have no real existence, and that it is only the appearance of them that is reproduced through the reflection

of neighbouring stars or the union of stars that
2 stick together. Some, again, say that comets are true stars, but with orbits of their own, and that after certain periods they come out into the view of mankind. Some allow their existence but refuse them the title of stars, because they glide out of sight without long duration, and within a brief space are scattered to the winds.

XX

1 Most of our Stoic brethren entertain another view, which they do not regard as inconsistent with fact. Let me explain it. We observe many species of fire engendered on high, now the heavens ablaze, now

Long glistening trains of flame behind,

now huge torches of fire being hurried along. The lightning itself, whose velocity is so marvellous that it at once blinds, and at the same instant restores, the sight, is fire arising from the friction of air that suffers more violent internal pressure
2 than usual. That is why it does not remain long, but glides off once it issues from the cloud, forthwith perishing. But other fiery appearances remain for a considerable time, and do not break up until all the fuel on which they fed has been used up. Here belong the strange sights recorded by Posidonius —pillars and shields all ablaze, and other flames of marvellous strangeness. They would attract no attention if they ran their course after customary laws ; but now the sight of them sends all men agape.
3 They bring down sudden fire from the heights of heaven, sometimes producing a flash which is gone

in a moment, sometimes compressing the air, which is forced into a glow; it is a miracle all the same. Yes, and is not sometimes a gulf opened in the ether, which seems to retire on all sides, with a great glare of light in the hollow centre? You are ready to cry out. What is this?

> . . . I see the very centre of heaven open,
> And the stars wandering in the sky. . . .

These stars sometimes do not wait for night to show their light, but burst out in the full light of day. The reason, however, for the stars show- 4
ing at a time not their own is different from that alleged; it is well known that they are there all the time, though hidden. Many comets, too, we cannot see because they are obscured by the sun's rays. Posidonius, in fact, tells us that during an eclipse of the sun a comet once appeared which the sun's proximity had hitherto concealed. Often, when the sun has just set, straggling fires[1] are seen close to him. No doubt the nucleus of the comet is bathed in sunlight, and therefore cannot be discerned; but the tail escapes the effect of the sun's rays.

XXI

Our Stoic friends, therefore, are satisfied that, like 1
trumpet meteors and beams, and other portents of the sky, comets are formed by dense air. They appear in greatest number toward the north, because there is most of the sluggish air there. Why, then, you naturally ask, does the comet not remain stationary, but advance in the sky from day to day? Let me explain. The comet, according to

[1] *I.e.* the tail of a comet.

this account, pursues its fuel just as fires do. Although its tendency is to rise to the upper regions, still, if material fail it, it retrogrades and sinks. In the air, too, it does not pursue a direct path to right
2 or left. It has no particular route assigned to it; wherever the supply of its fuel leads it, thither it crawls; it does not advance in its orbit as a star, but feeds as a fire. Why, then, does it appear for a long period, and why is it not quickly extinguished? For the recent one which we saw during this joyous reign of Nero displayed itself to view for six months, revolving in the opposite direction to the former one in Claudius' time. That one rising from the north up toward the zenith made for the east, always growing dimmer. This one began in the same quarter, but making toward the west, turned finally toward the south, where it withdrew from
3 view. No doubt the former found moister elements, more suitable for its fire, and pursued them; the latter in turn chose a richer and more substantial district. So they descend toward the direction in which they are invited by their material, and not by a definite path, which in the two we have seen was different, since the one moved off toward the right and the other toward the left. Now all stars[1] have their orbit in one direction, namely, contrary to the motion of the universe. The latter moves from east to west, the stars go from west to east. For this reason they have a double motion,—one, their own proper motion; the other, which carries them round along with the heavens.

[1] Planets may be specially referred to; the Latin word is the generic one, *stella*.

XXII

I DO not agree with my school here, for I cannot 1
think a comet is a sudden fire, but I rank it among Nature's permanent creations. First of all, everything that the atmosphere creates is short-lived; such things arise in an element that is fugitive and changeable. How can anything continue the same for long in the air, which itself never remains the same? It is always in a state of flux, and its quiet is short-lived. It changes within a brief moment to another condition from that in which it had been. It is now rainy, now clear, now alternates from 2
one to the other. The clouds, so intimately connected with it, into which it collects and from which it is released again, now gather, now disperse, but never remain at rest. Fire cannot possibly abide securely in a volatile body, nor can it keep its place so persistently as does a fire that Nature has fixed never to be dislodged. Further, if the fire stuck close to its fuel, it would always sink. For the air 3
is the thicker, the nearer it is to the earth. But a comet is never depressed to the lowest strata of the atmosphere, nor does it ever approach the ground. Besides, fire either goes in the direction its nature prompts, that is, upwards, or else in the direction in which it is drawn by the material on which it has fastened, and on which it feeds.

XXIII

IN none of the ordinary fires in the sky is the route 1
curved; it is distinctive of a star (planet) that it

describes a curve in its orbit. Whether other comets had this circular orbit I cannot say. The two in our own age at any rate had. Again, everything kindled by a temporary cause quickly gives out. Thus torches gleam only while they flit across the sky; thus lightning has strength for just one stroke; thus so-called shooting and falling stars fly
2 past, cutting through the air. No fires have any considerable duration unless their strength is inherent. I mean the divine fires which the universe maintains eternally, because they are its parts and works. These, I say, are always active; they have an orbit the even tenor of which they preserve, and they are uniform. They would on alternate days be larger or smaller if the fire was merely casual, the sudden outcome of some accidental cause. Such a fire would be greater or less according as it was fed more abundantly or more scantily. I said a moment ago that no fire could be lasting which
3 arose from some defect in the atmosphere. I have now to add further, that it can by no means be fixed and steady. Both torch and lightning and shooting star, and any other kind of fire forced out of the air by pressure, are in flight; none of them is visible save in the course of its fall. But a comet has its own settled position. For that reason it is not expelled in haste, but steadily traverses its course; it is not snuffed out, but takes its departure. If it were a wandering star (*i.e.* planet), says some one, it would be in the zodiac. Who, say I, ever thinks of placing a single bound to the stars? or of cooping
4 up the divine into narrow space? These very stars, which you suppose to be the only ones that move, have, as every one knows, orbits differing one from another. Why, then, should there not be

some stars that have a separate distinctive orbit far removed from them? What reason is there why there should not be passages into the heavens at some part of them?[1] But if you are convinced that every star (planet) cannot but touch the zodiac, then I say the comet might have such a wide orbit that at some point it may coincide with the zodiac. This is not necessary, but it is possible.

XXIV

CONSIDER whether it is not more in keeping with 1
the size of the universe that it be supposed to be divided into many routes, and do not keep this one beaten track while every other portion is a waste. Do you suppose that in this great and fair creation, among the countless stars that adorn the night with varied beauty, never suffering the atmosphere to become empty and sluggish, there are only five stars that are allowed to move freely, while all the rest stand still, a fixed, immovable crowd? Should 2
any one here ask me: Why, then, has their course not been observed like that of the five planets? my answer to him shall be: There are many things whose existence we allow, but whose character we are still in ignorance of. We shall all admit that we have a mind, by whose behest we are urged forward and called back; but what that mind is which directs and rules us, no one can explain any more than he can tell where it resides. One will say that it is breath; another, a kind of harmony; another, a divine force and part of God; another, subtlest air;

[1] The meaning seems to be, there may be passages—inlets and outlets—by which occasional visitants like comets may temporarily enter the heavens as we know them, and subsequently pass out of them. The text is doubtful.

another, disembodied power. Some will even be found to call it blood, or heat. So far is the mind from being clear on all other subjects that it is still in search of itself.

XXV

1 WHY should we be surprised, then, that comets, so rare a sight in the universe, are not embraced under definite laws, or that their beginning and end are not known, seeing that their return is at long intervals? It is not yet fifteen hundred years since Greece

Counted the number of the stars and named them every one.

2 And there are many nations at the present hour who merely know the face of the sky and do not yet understand why the moon is obscured in an eclipse. It is but recently indeed that science brought home to ourselves certain knowledge on the subject. The day will yet come when the progress of research through long ages will reveal to sight the mysteries of nature that are now concealed. A single lifetime, though it were wholly devoted to the study of the sky, does not suffice for the investigation of problems of such complexity. And then we never make a fair division of the few brief years of life as between study and vice. It must, therefore, require long
3 successive ages to unfold all. The day will yet come when posterity will be amazed that we remained ignorant of things that will to them seem so plain. The five planets are constantly thrusting themselves on our notice; they meet us in all the different quarters of the sky with a positive challenge to our curiosity. Yet it is but lately we have begun

to understand their motions, to realise what their morning and evening settings mean, what their turnings when they move straight toward us, why they are driven back from us. We have learned but a few years ago whether Jupiter would rise or set, or whether he would retrograde—the term that has been applied to his retirement from us. People 4
have been found bold enough to say to us: You are mistaken in thinking that any star ever stops or wheels in its course. The heavenly bodies may not stand or turn away. All advance; once the signal is given they start on their race. Their career will end only with their existence. This eternal creation has motions that suffer no recall. Should they once be arrested, they will encounter obstacles in front which are meantime held in place by the ordered, regular march of the universe.

XXVI

WHAT then is the reason, you may ask, for the 1
apparent retrogression of some heavenly bodies? The appearance of slowness in their motion is caused by their encountering the sun, as well as by the character of their paths and the position of their orbits, which are at certain periods calculated to deceive the eye. Ships in the same way moving under full sail seem withal to be stationary. Men will some day be able to demonstrate in what regions comets have their paths, why their course is so far removed from the other stars, what is their size and constitution. Let us be satisfied with what we have discovered, and leave a little truth for our descendants to find out.

We cannot, Apollonius says, see through the stars what is beyond, but sight passes easily
2 through the comets. Well, in the first place, if that is the case, it is not so in the part of the body which consists of dense solid fire, but only where the dispersed glow extends as it breaks up into the appearance of hair. One can see through the gaps in the fire and not through the fire itself. Stars again, it is said, are all round, comets extended; whence it is plain that they are not true stars. But who, pray, will allow that comets are long? Their tendency like that of other stars is to a globe shape, only the light from them is prolonged. The sun shoots out his rays far and wide, but has himself a shape different from that of the light that streams from him. So in comets, the body is rounded, but the glow from them presents the appearance of being longer than that of the other stars.

XXVII

1 Why is this so, you ask. Do you tell me first why the light the moon receives is wholly unlike the sun although she receives it from the sun. Why is it now ruddy, now pale? why is her colour ashen or black when she is cut off from the sun's view? Or tell me why all the stars have aspects to some extent dissimilar to one another and all as different as possible from the sun. It is no hindrance to their being true stars that they are not all alike; so there is nothing to prevent comets from being permanent through all time, sharing the same destiny as the other stars, even though they have not an appearance
2 like theirs. Besides, is not the universe, if you will

only examine it carefully, made up of contrarieties? Why is it that the sun should be always blazing hot in Leo, scorching the ground with his fierce glow, while in Aquarius he brings winter's chain and closes the rivers with ice? The one constellation is subject to the same law as the other, though its characteristics and influence are so different. Aries again rises in a moment, Libra lifts its scales very slowly; yet the one sign is of the same nature as the other, though that one mounts in a brief space, this comes forth very deliberately. Do you not see, too, how contrary the elements are to one another? They are heavy 3
and light, cold and hot, moist and dry. The whole concord of the universe is a harmony of discords. You say a comet is not a star, because its form does not correspond to the type, but is unlike other stars. You can see, no doubt, how very like that star that returns to its place after thirty years is to this which revisits its haunt within the year! Nature does not turn out her work according to a single pattern; she prides herself upon her power of variation. She 4
has made some things larger, some swifter than others; some stronger, some more limited in power; some she has separated from the crowd, that their splendid isolation might render their progress conspicuous; some she has consigned to a place in the common herd. He has little conception of nature's power who thinks that she may not do exceptionally what she does not do repeatedly. She does not often display comets; she has assigned them a different place, different periods from the other stars, and motions unlike theirs. She wished to enhance the greatness of her work by these strange visitants whose form is too beautiful to be

thought accidental, whether you consider their vastness or their brightness that surpasses in size and brilliance all other stars. Their appearance has, in truth, an exceptional distinction; they are not cribbed and cabined within narrow bonds, but let loose to roam freely, to range over the region of many stars.

XXVIII

1 ACCORDING to Aristotle, comets give indications of storm and disturbances that bring wind and rain. Well, then, are you of opinion it is not a star because it foretells what is coming? True the comet is not a sign of storm in the same way as it is a sign of coming rain when

> The oil splutters, and rotten fungus covers the wick;

or in the same way as it is a forecast of a raging sea—if

> the sea
> Coots[1] sport on land; her haunts in the marshes
> Are deserted by the heron, and she soars above the heights of cloud:

2 but in the same way as the equinox is a sign of the turn of the year toward cold or heat, or as the predictions of the Chaldaean soothsayers who tell what sorrow or joy is determined at birth by the natal star, are indications of coming events. To convince you of the truth of this, I must warn you that the rising of a comet does not convey a threat of wind and rain in the immediate future, as Aristotle says, but casts suspicion over the whole year. Hence it is plain that the comet has not derived prognostications from its immediate surroundings to reveal for the

[1] Perhaps cormorants: the identity of the bird is difficult to determine.

immediate future, but that it has them stored up and buried deep within by the laws of the universe. The comet which appeared in the consulship of Paterculus and Vopiscus fulfilled the anticipations of this kind entertained by Aristotle, and for that matter by Theophrastus; for there were everywhere severe 3
and prolonged storms, while in Achaia and Macedonia cities were overturned by earthquakes. The slowness of the comets' motion, Aristotle says, is a proof that they are rather heavy, containing much earthy matter. So are their orbits too, for they are usually confined to the neighbourhood of the poles.

XXIX

Both statements are false. Let me take them in 1
their order. Well, it is asserted, is it, that all bodies are heavy that move more slowly? What! is the planet Saturn, which accomplishes its circuit most slowly of all the planets, heavy? It has, in fact, a proof of lightness in being higher than all the rest. But, you say, it takes a wider sweep, and does not go more slowly than the others, but only a longer distance. Let me suggest that I can make the same statement of the comets; even if their course is more sluggish, they have farther to go. But it is a falsehood to assert that they 2
move more slowly. For this last comet traversed within six months half the span of heaven; the previous one withdrew from sight in a shorter period. But again, it is urged, on account of their weight, they are borne down lower. Well, in the first place, a comet is not borne down, but round. In the second, this recent one began its motion in the

north, and passing by way of the west, reached the southern quarters, and was elevating its orbit when
3 it faded from sight. That other one, in Claudius' reign, also first appeared in the north, and continued without intermission to rise straight up to a higher elevation until it disappeared. Such are the matters relating to comets which have had weight with others and with myself. Whether they are true or not, those who attain knowledge of the truth must decide. We are permitted only to conjecture and grope in the dark, with no assurance of discovery, and yet not without hope.

XXX

1 ARISTOTLE has finely said that we should never be more reverent than when we are treating of the gods. We enter a temple with all due gravity, we lower our eyes, draw up our toga, and assume every token of modesty when we approach the sacrifice. How much more is all this due when we discuss the heavenly bodies, the stars, the nature of the gods, lest in ignorance we make any assertion regarding them that is hasty, or dis-
2 respectful; or lest we wittingly lie. Let us not be surprised that what is buried so deeply should be unearthed so slowly. Panaetius and others, who will have it that a comet is not an ordinary star but the mere counterfeit of a star, have bestowed careful treatment on the question whether all seasons of the year are equally fitted to produce comets, and whether all quarters of the sky are equally suitable for their creation. They have inquired, too, whether they can be formed in all regions

through which they can pass, and have discussed other points of a like kind. But all these questions are foreclosed by my statement that they are not accidental fires, but inwoven in the texture of the universe, directed by it in secret, but not often revealed. And how many bodies besides revolve 3
in secret, never dawning upon human eyes? Nor is it for man that God has made all things.[1] How small a portion of His mighty work is entrusted to us? But He who directs them all, who established and laid the foundations of all this world, who has clothed Himself with creation, and is the greater and better part of His work, He is hidden from our eyes, He can be perceived only by thought.

XXXI

MANY things, moreover, akin to highest deity or 1
holding power near it, are still obscure. Or, perhaps, one may be still more surprised to find that they at once fill and elude our sight. Either their subtlety is too great for human vision to grasp, or such exalted majesty conceals itself in the holier sanctuary, and rules its kingdom, which is itself, without permitting access to any power except the spirit. What that is, without which nothing is, we cannot know: and when God, the greatest part of the universe, is an unknown God, we are surprised, are we, that there are some specks of fire we do not fully understand? How many animals we have come to 2
know for the first time in our own days! Many, too, that are unknown to us, the people of a coming day will know. Many discoveries are reserved for

[1] Another reading runs: Nor has God revealed all things to man.

the ages still to be, when our memory shall have perished. The world is a poor affair if it do not contain matter for investigation for the whole world in every age. Some of the sacred rites are not revealed to worshippers all at once. Eleusis retains some of its mysteries to show to votaries on their second visit. Nature does not reveal all *her* secrets at once. We imagine we are initiated in her mysteries: we are, as yet, but hanging around her
3 outer courts. Those secrets of hers are not opened to all indiscriminately. They are withdrawn and shut up in the inner shrine. Of one of them this age will catch a glimpse, of another, the age that will come after.

When, then, it may be asked, will all these things come to our full knowledge? Great schemes mature slowly, especially if effort is relaxed. There is one object we are bent on, heart and soul, —to be as wicked as possible—and we have not
4 yet attained perfection. Vice is still making progress. Luxury is constantly discovering some new outlet for its madness, indecency some new form of insult on itself. Dissolute effeminacy and corruption are constantly discovering some more refined and delicate means of self-destruction. We have not yet wholly cast off our vigour. We are still doing our best to extinguish any spark of virtue that is left. By the smoothness and polish of our bodies we men have outdone the refinements of women; we have adopted the colours of harlots, that even an honest woman would
5 not put on. With delicate mincing step we check our gait; we do not walk, with measured pace we go. We adorn our fingers with rings. A precious stone sparkles on every joint. Day by day we devise means of wronging and degrading our manhood,

vexed that we cannot strip it off. One becomes a eunuch, another assumes the scandalous part of a gladiator, and, hired for death, arms for disgrace. The very pauper selects a victim on whom to sate his morbid lust.

XXXII

Do you wonder that wisdom has not yet attained 1
her perfect work? Why, vice has not wholly revealed itself. It is still in its infancy, and yet on it we bestow all our efforts; our eyes and our hands are its slaves. Who attends the school of wisdom now? Who thinks it worth while to have more than a bowing acquaintance with her? Who has regard for philosophy or any liberal pursuit, except when a rainy day comes round to interrupt the games, and it may be wasted without loss? And so the many sects of philosophers are all dying out 2
for lack of successors. The Academy, both old and new, has left no disciple. Who is there to hand down the precepts of Pyrrho? That famous school of Pythagoras, despised of the rabble, can find no master. The new sect of the Sextii, which contained the vigour of Rome, started with great enthusiasm, but on the very threshold of its career is also dead.

But what anxious care we bestow that the name 3
of no actor may be lost! The house of Pylades and Bathyllus stands in a long line of successors. For arts of that kind there are plenty of pupils and plenty of teachers. The actor's platform resounds in every private house in the whole city. On it men and women alike practise the ballet step. Husbands and wives vie in paying court to actors. By and by, when the brow is rubbed smooth by

long wearing of the mask, the transition to the
4 brothel is easy and natural. Philosophy gets never a thought. And so it comes to pass that, far from advance being made toward the discovery of what the older generations left insufficiently investigated, many of their discoveries are being lost. But yet, on my soul of honour, if we urged on this task with all our powers, if our youth in sobriety braced themselves to it, if the elder taught it and the younger learned it, even then scarce should we reach the bottom of the well in which truth lies. As it is, we search for her on the surface, and with a slack hand.

NOTES ON SENECA'S "QUAESTIONES NATURALES"

By Sir ARCHIBALD GEIKIE, K.C.B., Pres.R.S.

THE treatise of which the present volume is a translation possesses a twofold interest. In the first place, it is probably the last literary work of a man who filled a large space in the Roman world of his day. After a varied career as philosopher, barrister, politician, statesman, courtier, and man of letters, he at last incurred the implacable enmity of Nero, to whom he had been tutor. Having in his youth paid some attention to physical inquiries, he had then been led to prepare and publish a book on earthquakes. But in subsequent years the absorbing cares of State probably left him little leisure to continue these studies, for which, however, he had retained his taste. Hence, when in his last days he sought in retirement to devote himself to philosophical pursuits, he naturally turned to some of the physical problems that had interested him in earlier life. The earthquake which on 5th February A.D. 63 had done much damage to the towns of Campania, revived his youthful enthusiasm for the investigation of such phenomena, and may possibly have suggested to him the preparation of another volume dealing with this and other scientific matter. We know at least from the book itself that he wrote a part, if not the whole, of it after that date (221, 230),[1] and that he took pains to collect information about the catastrophe.

[1] The numbers within parentheses throughout these Notes refer to the pages of the Translation.

As he was in the habit of sojourning on the shores of the Bay of Naples, he probably visited the scene of destruction himself for the purpose of his book. We learn from Tacitus that it was immediately after his return from Campania to his villa near Rome, bringing with him, we may suppose, his nearly completed manuscript, that Seneca received the Emperor's order to commit suicide.

In the second place, Seneca's work on *Natural Questions* stands out as one of the few treatises on physical science which have come down to us from antiquity. It is interesting alike for the quotations it contains from the works of previous authors, some of which have not survived, and for the criticisms and opinions which he himself expresses on the various subjects of which he treats. It can hardly, however, be regarded as an original contribution to science. Its author's life had been spent in other and widely different pursuits, which led him far away from scientific inquiry. But as a summary of the general state of knowledge in his day, made by a man of strong intellect, who had been trained in the legal and philosophical schools of the time, and had read widely and reflected much on these matters, the book may be taken to afford a fair presentation of the manner in which a number of questions in astronomy, meteorology, and physical geography were regarded by thoughtful minds in the first century of our era.

In judging of the intrinsic merit of such a work as the present, the modern reader finds a difficulty in realising from the broad platform of natural knowledge which, after the labours of the intervening centuries, has now been laid, how exceedingly narrow was the circle of ascertained fact available to the student two thousand years ago. The spirit of scientific observation and experiment had not then been developed, yet the familiar phenomena of every-day life pressed, as they still do, for explanation. Man's knowledge of nature was then too limited to furnish a basis for distinguishing what was fact from what was mere guesswork. In the infancy of our race, as in the childhood of the individual, the tendency of the human mind is to

perceive resemblances rather than differences. Analogies are readily observed and, in default of knowledge of the facts involved, are mistaken for identical sequences of cause and effect. Throughout the interpretations of natural phenomena given by the philosophers of antiquity, it is remarkable to what a large extent the meaning of one appearance is explained by comparing it with another to which in reality it may bear no resemblance. Seneca's volume abounds in examples of this use of analogy.

The authority of great names exercised a wonderful fascination on the minds of the early investigators of nature. Generation after generation of writers were led to accept with little or no modification the dicta of eminent philosophers who had preceded them. An observer might sometimes recognise the erroneousness of the opinion of a predecessor, and yet lack the means of detecting the falsity of his own, which nevertheless he propounded with full assurance of its truth. In such circumstances criticism had no secure foundation, while credulity, rampant in the world outside, could hardly fail to show itself in philosophic circles. Even the most cautious and truth-seeking inquirer might easily and almost inevitably be led to accept statements which did not seem to him unreasonable, and which no previous experience of his own or others warranted him to disbelieve or even to suspect.

It behoves us, therefore, to be on our guard lest, from our much higher standard of knowledge, we may be tempted to look with amused contempt on the puerile conceptions of nature to be met with in the writings of the ancients—the grave assertion of absurdities as actual facts, the inept analogies, the confident explanations which are no explanations at all, and the complete absence of any attempt to test by examination or experiment the validity of statements which with but little trouble could have been disproved.

These evidences of the exceedingly imperfect knowledge of his time are fully illustrated in Seneca's chapters. He quotes some two dozen of previous writers who had dealt

with the same or cognate subjects. It is needless to say that they were Greeks, no place having yet been found in Latin literature for treatises on Science. The author most frequently cited by him is Aristotle, whose *Meteorologica* he had evidently studied with care. He gives frequent quotations from that work, but even where he does not specifically quote, his views generally accord with those of the great philosopher and naturalist.[1] Almost the only quotations from the works of his own countrymen are verses from some of the poets, especially from Virgil and Ovid. It is remarkable that he makes only one quotation from Lucretius, although he would have found in that poet's noble work many passages more apposite to his subject than those which he has taken from the *Aeneid*, the *Georgics*, and the *Metamorphoses*. We may suppose that these works were favourites with him, and that he knew much of them by heart, but that he was less familiar with the *De Rerum Natura*.

It is manifest from the present volume that its author, like Lucretius before him, had a lofty conception of the dignity and moral influence of the study of nature. This pursuit seemed to him to raise us above the sordid things of life and to withdraw the mind from the body—a dissociation so eminently beneficial to our higher aspirations. He believed that in the study of the hidden phenomena of the universe a mental alacrity is developed which will be found to be not without practical utility in the conduct of affairs that lie nearer the surface (113).

With this clear recognition of the importance of his theme he resolved in his old age to enter upon a task which other less worthy pursuits had hindered him from pursuing. He would now attempt to survey the universe, unravel its secrets, and give the results of his studies to the world (109). It was not, however, his aim to compose a systematic treatise on Natural Philosophy, but rather to take up some special subjects and deal with them in

[1] Seneca's indebtedness to Aristotle is emphatically expressed by Barthélemy Saint-Hilaire in the Dissertation prefixed to his translation of the *Meteorologica* (*Météorologie d'Aristote*, 1863, pp. lxix-lxx).

the light of what had already been written upon them, and of what his own reflections suggested. His undertaking assumed the form of a series of epistolary essays addressed to his friend Lucilius Junior, procurator of Sicily. The literary shape thus selected allowed the use of an unconstrained, almost colloquial, style which would not have been suitable to a more ambitious work.

Had Seneca designed to prepare a formal or methodical treatise, he would doubtless have planned it to include the three sections which he regarded as comprising every inquiry that can arise as to the nature and constitution of the Universe (*Universum*)—celestial, atmospheric, and terrestrial (*Caelestia*, *Sublimia*, *Terrena*, 51). The world (*Mundus*) in his view comprehends all things that come or can come within our cognisance (54). Instead of entering upon a full discussion of any one of his three sections, he selected from them a few topics which had probably more particularly engaged his attention. Most of these belong to the second or atmospheric division of his scheme of arrangement, to which he devotes six of his seven books, the remaining one being given to the discussion of some celestial phenomena. Certain subjects which we should naturally range in the terrestrial series, such as the source and flow of rivers and the nature and origin of earthquakes, he explicitly includes among his atmospheric phenomena (51).

It appears to be probable that Seneca had neither finished nor revised his manuscript at the time of his death. Parts of the work are obviously incomplete, though some of these gaps may be due to defects of transcription or to the subsequent loss of parts of the text. The obscurities of language, which are not infrequent, may likewise have partly arisen from lack of the author's revision of his original copy. His discussion of the problem of the rise of the Nile suddenly breaks off in such an abrupt manner as to suggest the loss of a portion of the original volume. One of the most important omissions is the absence of any account of the phenomena of volcanoes. The author does indeed refer in several places to this

subject, but with Aetna before him, of which so many Greek and Latin poets had sung, and which had so often been referred to in the writings of the philosophers, he could hardly have meant to offer no commentary on so notable a feature in the geography and history of his own country. We know indeed that he was keenly interested in this mountain, and that he wrote to Lucilius to ascend the volcano and send him particulars about it. In the letter conveying this request he alludes to some of the Roman poets who had sung of its wonders, and urges that a description of Aetna should form part of a poem on which his correspondent appears to have been then engaged.[1] Another important subject in physical geography finds no place in Seneca's volume—the Sea. Of the outer ocean it was not to be expected that he could have had much to say, but we can hardly suppose that he would have considered his essay complete without some discussion of the various phenomena presented by the Mediterranean Sea.

A century before Seneca's prime, the immortal *De Rerum Natura* of Lucretius had appeared at Rome, wherein the origin and constitution of the world were sung with the intense earnestness, brilliant imagination, and resounding cadence of a great poet and with the grasp and penetration of a great philosopher. In this splendid work some of the problems discussed by Seneca were considered, and explanations were given of them with the usual undoubting confidence of olden time. In literary quality the two writers stand far apart, yet it is not uninteresting to compare their respective views of nature. The vivid and often majestic diction of the one is not more diverse from the somewhat familiar and conversational tone of the other than are their respective creeds. Lucretius was a convinced and enthusiastic Epicurean, and in accordance with the teachings of his master denied the existence of any divine co-operation in the plan and government of the Universe,

> nequaquam nobis divinitus esse paratam
> naturam rerum,[2]

[1] Seneca, *Epist.* lxxix.

[2] *De Rerum Natura*, v. 198.

although no writer either of ancient or modern time has had a more overpowering sense of the beauty, majesty, and order of this world. It was his earnest purpose to show men how, by a contemplation of the face and ordered scheme of nature, they could free themselves from the bond of religious superstition and the fear of death.[1]

Seneca, on the other hand, held the Stoic belief in an all-wise and omnipotent Creator. In an eloquent exordium to his volume, and in a peroration near its end, he affirms his conviction that this Divine Being is all in all, at once within and without his works; He has clothed himself with creation, but is hidden from our eyes and can be perceived only by thought (3, 7, 305). Our philosopher could not conceive of anything more beautiful, more orderly, and more consistent everywhere in plan than the world around us. That such a world should have resulted from the tumult of chaos, by the mere chance collocation of atoms, appeared to him the madness of vulgar error. Yet it was only too true, though it might be thought hardly credible, that even philosophers had been tainted with this pernicious doctrine. Hence it would be in the author's judgment a profitable task to inquire into the truth concerning these matters. To explore this world, he remarks, is far more than enough for a single lifetime. Whether what we may be led to believe regarding it shall be true must be decided by those who may attain the knowledge of the truth; we can but examine and conjecture, with no certain assurance of discovery, yet not without hope (304). It behoves us to be ever watchful against forming conclusions rashly, disrespectfully, or ignorantly, and of being knowingly untrue. In this quest after knowledge, while much may be found out which will be of practical useful-

[1] rursus in antiquas referuntur religiones
et dominos acres adsciscunt, omnia posse
quos miseri credunt, ignari quid queat esse,
quid nequeat, finita potestas denique cuique
quanam sit ratione atque alte terminus haerens.—*Op. cit.* v. 86.

hunc igitur terrorem animi tenebrasque necessest
non radii solis neque lucida tela diei
discutiant, sed naturae species ratioque.—i. 146.

ness, we are encouraged to advance, not by any hope of gain, but by the wonder with which the inquiry fills the soul. To obtain a knowledge of Nature is the highest reward to which the mind of man can aspire (230, 304). Seneca's practical conclusion was thus much the same as that of Lucretius. He does not, however, attempt in this volume to enforce it with the solemn earnestness shown by the poet, though he loses no opportunity of inveighing against the follies and vices of his time. In discussing natural phenomena his first desire is to explain them, and in so doing to animadvert on the explanations of previous writers, with perhaps a not unnatural wish to show his own ability as a critic and expositor.

It was in due accordance with the principles of his school, as well as with his own natural temperament, that Seneca should continually be led to draw ethical lessons from the physical phenomena which he discussed. The interpolation of some of these reflections may occasionally seem to a modern reader rather irrelevant and far-fetched, but there can be no question as to the spirit of reverence with which he approached his subject. Like other philosophers who had preceded him, he maintained this spirit, while at the same time he had discarded the crowded and confused polytheism of the prevalent mythology. But he here keeps this antagonism in due restraint, only occasionally expressing his dissent from the popular creed. He would not admit that even the old philosophers could have been so foolish as to credit the gods with some of the acts which had been popularly attributed to them. He refused to believe that the guardian and ruler of the Universe hurled thunderbolts with his own hand. Still less could he suppose that the gods had lighter bolts with which they amused themselves in play. His expression (fulminibus lusoriis, 91) recalls the bitter irony of Lucretius and the sarcasm of his question whether, when the gods aim at lonely places or at the sea, they are only at practice to strengthen their arms.[1] But Seneca held with Lucretius that in the contemplation of nature we obtain

[1] an tum bracchia consuescunt firmantque lacertos?—vi. 397.

the courage and elevation of mind which fit us for the trials of life and the coming of death (113).

In the treatment of scientific problems Seneca displays the same unhesitating assurance of the truth of his opinions, which was characteristic of the philosophers of antiquity. These writers had hardly a glimmering conception of nature's infinite complexity, of the extreme diversity and intricacy of natural processes, of the unbroken and endlessly ramifying relations of cause and effect, of the long and patient investigation by which alone these relations could be unravelled, and of the caution and diffidence with which conclusions regarding them should at least for a time be formulated. Seneca frequently passes caustic criticisms on the views expressed by his predecessors. He styles the philosophers, as a body, "a credulous folk." Some of them he even goes so far as to accuse of perpetrating deliberate falsehoods (276, 286, 289). Nor does he hesitate to banter his brethren of the Stoic School, whose "absurdities," as he calls them, he cannot refrain from quoting.

Yet when his own opinions are examined in the light of the present day, they are found to be in many cases no nearer the truth than those which he rejected with contempt. It is, indeed, sometimes difficult to realise the mental position of a man who could adopt and propound them. In many cases he accounts for a phenomenon by the analogy of another to which it has no real affinity, as where he explains halos by the circular undulations produced on a surface of water into which a stone is thrown (13). He sometimes suggests an experiment to prove the truth of his assertion, but if he had made the experiment he would have found how completely it failed to support him, as, for instance, when he states that a large pond of water reflects only one image of the sun, but that, if it is divided into several smaller ponds by the insertion of partitions, it will show as many images as there are divisions (18). Striking also and numerous are the examples of his credulous acceptance of statements which, had it occurred to him to test them by actual

examination, he could easily have found to be erroneous. He affirms, for instance, more than once, that while lightning melts metals, it freezes wine, and he gravely alleges that when the wine is thawed and imbibed, it either kills or drives mad those who partake of it (79, 97). He asserts that the waters of certain rivers have the power of dyeing whole flocks of sheep, black fleeces being changed into white, and white into black (137), that some waters are so dense that even the heaviest objects will not sink in them (138); that the heat of the sun in the Nile valley is so great as to melt silver and the joints of statues (173). When he proceeds to explain the reason of such abnormalities he expresses no hesitation, but delivers his opinion with the assurance of a professor who has obtained the experimental demonstration in his laboratory.

It is remarkable that although some progress had been made in astronomy, especially by Greek philosophers, before the beginning of the Christian era, the conclusions arrived at by these observers regarding the relations of the earth to the other heavenly bodies met with but little acceptance for many centuries, even among reflecting minds. Lucretius, for example, still believed the earth to be the centre of the Universe to which all the heavier materials had converged, while the fire-laden ether escaped to the outer boundaries of space, sun, moon, and stars occupying an intermediate place. He did not think that the sun can be much larger than it looks to be to our senses, nor was he quite sure whether it is the same sun which, passing under the earth, reappears in the morning, or if at the close of each day the sun is extinguished and a new collection of fires makes a fresh sun in the morning. He was quite aware of the different views of Chaldaean sages and astronomers, but in such questions he could see no reason why one theory should be better than another.[1]

Seneca, however, had, on the whole, a more advanced appreciation of the relations of the earth to the heavenly bodies. He believed the sun to be larger than our globe,

[1] *De Rer. Nat.* v. 564, 650, 680, 727.

and that a thousand stars might be put together without equalling his mass (284, 288). He thought the heavens to be so vast as to afford space for the swiftest of the planets to rush along with uninterrupted speed during full thirty years (7). He showed his enlightened outlook upon astronomical possibilities when he surmised that comets may have orbits that carry them far beyond the Zodiac, and when he conjectured that other planets than those then known remained to be discovered (296-299). And yet, sharing these more enlarged conceptions, he clung with curious pertinacity to some of the old childish faith which was natural in the infancy of mankind. He knew that some philosophers held that it is the earth which revolves and not the heavens, and though he does not deliberately reject this opinion, it is evident that he still held that the heavens circle round the earth.[1] Again and again he expresses his conviction that the force which sustains the energy of the sun and the stars consists of the exhalations that arise from the surface of the earth. These exhalations, he says, are the pasturage of the heavenly bodies, the breath of the world. It would be impossible, he asserts, for the earth to furnish so ample a store of nourishment to bodies larger than itself unless it were full of breath which is passing off from every part of its surface both by day and night. To the obvious objection that the supply of this energy would soon become exhausted, he has the reply that this exhaustion would certainly take place were it not that the elements are in a condition of continual transformation, issuing in one form, passing into each other, and returning to their original positions, thence to begin their cycle anew (55, 198, 244-5). In this universal transmutation water passes into air, air into water; air likewise is changed into fire, fire into air, while earth is formed from water, and water from earth (120).

In his general conception of the universe, Seneca, as a Stoic philosopher, recognised a principle of evolution. He believed that the world embraces in its constitution

[1] See *postea*, Notes on Book VII.

everything that it is destined to experience from its beginning to its end. As a human embryo contains the germ of the future man, so at the first creation of the universe, sun and moon, the changes of the stars, and the birth of living things were all embraced. And there were likewise included the forces whereby the earth is affected, and which will ultimately lead to the final destruction of the globe (151).[1]

With regard to the earth itself, whether it is to be regarded as a soul or as an organised body, Seneca announced his conviction that it has been constructed much after the plan of our human bodies. As in these bodies, veins and arteries are provided for the reception of blood and breath, so in the earth there are passages, some for the transport of water, others for the flow of air (126). He was sure, also, that everything on the surface of the earth has its counterpart beneath—caves, mountains, lakes, and rivers.

[1] Lucretius, too, had his views on evolution, which are well expressed in four lines of verse :

> mutat enim mundi naturam totius aetas,
> ex alioque alius status excipere omnia debet,
> nec manet ulla sui similis res : omnia migrant,
> omnia commutat natura et vertere cogit.
>
> —*De Rer. Nat.* v. 828.

BOOK I

In this part of his Essay the author has grouped together a variety of phenomena, some of which are meteorological (in the modern sense of that word), and belong therefore to his class of Sublimia, while others are astronomical, and would be properly placed among his Caelestia. They all have reference to light in some form, and doubtless for that reason were considered as a series. Seneca, largely swayed by the opinions expressed in Aristotle's *Meteorologica*, agrees with that philosopher in the belief that the earth gives forth various kinds of exhalations, among which some contain the seeds of fire. He thought that high up in the air, among dry and hot elements, these fires may be kindled by the sun's rays, and further, that when the atmosphere becomes violently disturbed its friction may give rise to fires (9, 10, 39).

With these ideas, which he held as established truths, it is easy to understand that he should have regarded as extremely foolish the notion that any of the lights which move rapidly across the sky are of celestial origin. Had such been their source, he felt sure that by this time there would have been none left in the firmament; yet although no night passes when some of them may not be seen, each star in the sky is found to maintain its place and its size. Hence he confidently concluded that the meteors, which are seen at night, and sometimes even by day, have their birth far below the stars, and are soon extinguished in their course because they have no solid and abiding resting-place. Single aerolites and even showers of stones had been recorded in Roman literature as having fallen from heaven, but it had not yet occurred to any observer to connect them with the shooting stars which gleam across the nocturnal sky, and are now recognised to be due to meteorites of different sizes, entering our atmosphere with planetary velocity, there breaking up with varying luminosity, and remaining visible for shorter or longer intervals of time.

The author appears to have regarded as akin to these meteors

the star-like balls of light, which in stormy weather are sometimes seen on the masts of vessels at sea, and which before his time had been observed on the points of the spears of an army in the field. This luminous appearance, regarded by the Romans as a sign of the friendly presence of Castor and Pollux, is entirely atmospheric, and has no connection with shooting stars. It is now known as St. Elmo's Fire, and has been shown to be a gentle continuous electric discharge from the earth towards a cloud.

Seneca next describes in some detail a series of optical appearances connected with the sun and moon. Until the laws of the reflection and refraction of light had been discovered, it was obviously impossible to account for these phenomena. There is, therefore, much interest in following the lines of thought by which the old philosophers attempted to explain them. Seneca clearly perceived that the halos and coronae seen round the sun and moon in certain states of the atmosphere do not belong to these luminaries, but to our own air, and may furnish indications of coming weather. He remarks shrewdly enough that appearances akin to those seen in the sky may sometimes be observed in the thick moist air of a bathroom. But when he confidently proceeds to explain the meteorological phenomena he betakes himself to analogy, as he is so fond of doing. He remarks that when a stone is thrown into a pond a succession of circles is produced on the surface of the water, which continually widen from the point of impact until they lessen and disappear. In like manner he believes that when the light of the sun or moon strikes the cloudy air it produces a similar effect, for as every kind of light is round in shape, the air is thus driven into a circular form. His love of analogy generally, as in this instance, leads him far away from the truth, and prevents him from seeing the palpable flaws in his reasoning. But the apparent similarity of appearances, which are in reality entirely dissimilar, contents him with his explanations.

His discussion of the rainbow (16-33) is one of the most detailed and vivacious in the whole volume. It takes the form of a sustained argument, in which the author cites various authorities, and replies to objections brought by a supposed opponent to his thesis, which is that the rainbow is unquestionably an image of the sun received in a very moist cloud which has the shape of a round concave mirror (20, 27). He quotes with apparent approbation the opinion that in a shower of rain each falling drop is a mirror reflecting an image of the sun, and that when an observer stands directly between the sun and the shower he sees the reflections of the countless drops blended into one continuous semicircle. But as the discussion proceeds the writer denies that the

cloud consists of separate rain-drops, and he maintains that even if it did they would not unite to give one unbroken image. In proof of his contention he urges the fallacious assertion that if a number of mirrors are joined together and a man is placed before them, each gives its own reflection, and thus a single man becomes multiplied into a crowd. If he had ever tried the experiment or had visited the shop of a mender of mirrors, he would have seen that the separate pieces, if strictly arranged on the same plane, reflect a single image. His imaginary antagonist asks for an explanation of the rainbow-like colours displayed by the spray from a burst water-pipe, or the splash from an oar, which are, of course, cases strictly parallel to the falling shower of rain (24). The resemblance is at once granted, but is explained away on the ground that the drops fall so quickly that they cannot form reflections of the sun, and that to produce such reflections the medium must be at rest. The objector once more strikes in with a reference to the rainbow colours to be seen in a glass rod which is placed obliquely in the path of the sun's rays (30). These prismatic tints, as has long been known, are due to the same decomposition of white light, as in the rainbow. But Seneca claims the illustration as furnishing additional arguments in his favour. He maintains that no colour is really produced in the rod, but only a false appearance of colour, his idea being apparently that unless the colour is inherent in an object apart from direct sunlight, it is only apparent and not real. The glass, he says, tries to reproduce the sun's image, but fails because of its unsymmetrical form, the reflections being crowded together and confused into the appearance of a single band of colour. In regard to the falling drops of rain in a shower he contends that they receive the colour but not the image of the sun, and he is led away by the false analogy of the varying tints of a peacock's neck as the bird tosses its head (25). At one part of the discussion he affirms that the colours of the rainbow come partly from the sun and partly from the moist cloud (21). Further on, however, he agrees that they proceed from the sun, but are only apparent, for if another cloud comes across the face of the luminary they at once vanish (29). The greater diameter of the rainbow compared with that of the sun as seen by us he accounts for by the analogy of a concave mirror, which greatly enlarges the objects reflected from it. At the conclusion of the discussion he repeats his belief that the rainbow and the corona or halo have no definite material inherent in them, but are like a mirror which reveals only a deception, the mere phantoms and empty imitations of real bodies, which certainly do not exist in the mirror, and therefore cannot come out of it (41).

In Chapters XVI. and XVII. the author indulges in one of his favourite moralising episodes, suggested by the topics he has been discussing in the previous pages. He takes the existence of reflecting surfaces as his text, and from the calm surface of still water passes on to artificial mirrors, contrasting the manners and morals of early mankind, who had only pools and lakes in which to see their faces, with the luxury and vice of later ages, when the use of metals led to the invention of metallic mirrors. In this retrospect, however, he places the discovery of the use of iron before that of the other metals. The priority of bronze and the reason for it are accurately stated by Lucretius:

> et prior aeris erat quam ferri cognitus usus,
> quo facilis magis est natura et copia maior.[1]

BOOK II

In this division of his work the author discusses various aspects of the atmosphere and offers an explanation of the phenomena which he describes. He distinguishes between the very bright ether on high, and the moist, denser atmosphere which underlies it, but thinks that they must pass insensibly into each other (66). The atmosphere he regards as a continuous non-composite body, capable of great range in tension, and forming the vehicle through which the exhalations from the earth pass outwards to the sky. It does not everywhere possess the same qualities. In its lower parts next the earth it is dense and misty, owing to the terrestrial exhalations, and is there warmed by the earth's breath, by the reflection of the sun's rays from the ground, and from the fires, artificial and subterranean, as well as from the warmth communicated by living animals and plants, for life cannot exist without heat. The highest portions of the atmosphere are exceedingly dry, hot, and attenuated, owing to their nearness to the eternal fires and the heat of the heavenly bodies. The middle parts, on the contrary, are intermediate in character, but colder than what lies above and below them (60, 61). It is the lower portions that are subject to the greatest changes, for they receive the earthly elements which involve such constant turmoil. The instability of the air arises also in part from the motions of the earth and from those of the sun, moon, and stars, to which cold, rain, and other atmospheric disturbances are due (56, 61).

Seneca, in passing on to discuss the nature and origin of

[1] *De Rer. Nat.* v. 1287.

thunder and lightning, divides the phenomena into three kinds —lightning-flashes, thunderbolts, and thunderings (62). After citing and commenting on the opinions of various philosophers he proceeds to give his own views regarding these appearances. The lightning flash (*fulguratio*) he looks upon as fire widely spread out, the thunderbolt (*fulmen*) as fire condensed and hurled with violence (66). The difference between the two is in force rather than character; a flash is a bolt without strength enough to reach the earth, while a thunderbolt is lightning in its most intense form (69). With regard to the origin of the fire he points out that fire may be artificially produced in two ways: either by percussion, as when stones are struck; or by friction, as when two bits of wood are rubbed against each other. He thinks that probably in both of these ways clouds may emit fire, and that in the violence of storms a source of energy is supplied whereby the warm or smoky exhalations from the earth may be kindled and fall with a fierce glow to the earth (70, 101). These exhalations contain dry and moist bodies, to which heavier elements may be added. A combination of such materials will form a thicker and more solid cloud than one of pure air, and such a cloud may burst with a loud report (78). There can be no peal of thunder unless the hollow clouds are broken up with great violence (76). The characteristic path of the thunderbolt is determined by the oblique current of air in which, while the natural tendency of the fire is upward, the violence of its discharge presses it downwards and compels it to take up a zig-zag course. The peculiar ozone odour noticed during thunderstorms, and long popularly known as the smell of sulphur, is alluded to by Seneca (69, 97) and by Lucretius.[1]

The discussion of these subjects leads on to a disquisition on the portents that may be drawn from different kinds of thunder and various forms of lightning. Seneca infers from the effects produced by it that lightning possesses an inherent divine power. Among these effects he enumerates some in which he seems to have thoroughly believed, such, for instance, as the smashing of a wine jar already quoted, and the freezing of the wine for the space of three days thereafter. He is thus disposed to attach credit to the opinion that future events are foretold by both

[1] Similar views on thunder and lightning are expressed in the *De Rerum Natura*:

> semina quod nubes ipsas permulta necessust
> ignis habere.—vi. 206.
>
> post ubi conminuit vis eius et impetus acer,
> tum perterricrepo sonitu dat scissa fragorem.—*Ibid.* 128.
>
> . . . notaeque gravis halantis sulpuris auras.—*Ibid.* 221.

lightning and thunder. Yet he cannot change his Stoic faith that fate, that is, the necessity for the happening of all things and all actions, can be set aside by no force, can be altered by no portents, nor averted by any prayer or sacrifice. Though he admits that vows and supplications may be useful to the worshippers, he knows that even these also are included in the decrees of fate.

These reflections lead the philosopher to a characteristic peroration on the moral lessons to be derived from the subjects he has been discussing. From the dangers incident to thunderstorms he passes to the enforcement of the Stoic doctrine that death must be despised, and everything which leads to death will then cease to have any terror.

BOOK III

The subjects comprised in this section of the treatise have reference chiefly to the springs and rivers which appear on the surface of the earth or flow underneath it. The Book begins with a preface, which may have been originally designed to stand at the beginning of the volume. It bears internal evidence of having probably been written at the time of the author's resolve to take up the discussion of physical problems, as it speaks of old age pressing upon him and leaving him but a short while to cover the immense field which he wished to survey. The years lost among vain pursuits must be repaired by diligence in the task now undertaken; night must be added to day, and every social or business care which can possibly be set aside must be abandoned. The contemplation of the work before him then leads the philosopher into his moralising mood, wherein he inquires what should be the principal object of human life, concluding with the reflection that the best thing a man can set before himself, among the ups and downs of this world, is courage to accept them calmly and to be ready to meet death boldly whenever summoned. To the acquisition of such a courage a contemplation of nature will greatly conduce.

Seneca begins his discussion of the various forms of water by grouping them into two chief classes, standing in collected sheets, as in lakes, or running in channels, as rivers above ground and springs underneath. After a brief enumeration of various qualities of water, he inquires whence the vast volume of water comes that is carried down by rivers to the sea, and how it happens that neither is the earth sensible of this daily loss, nor does the ocean

show any perceptible gain. He merely notices the opinion which some philosophers had expressed that the sea does not get larger because it restores to the earth as much water as it receives, allowing its own saline water to sink through endless subterranean winding passages wherein it is purged of its saltness and rises on the land as pure fresh water.[1] Another view, that most of the water supplied by rain eventually finds its way into the rivers, is approximately that at which modern research has arrived, but it meets with our philosopher's strong opposition. His first objection is derived from his own observation. He tells us that, as a diligent digger among his vines, he can confidently affirm that even the heaviest rain does not penetrate to a depth of more than ten feet from the surface. What is not absorbed by the upper crust of the ground runs at once into river channels, and thence into the sea. He next asks how rain, which immediately flows off the surface of naked rocks, can possibly be the source of the springs and rivers that issue from bare crags, or how springs that appear on the very summit of mountains can be due to rain. Though he could not but be aware of the close connection everywhere observable between evaporation, rainfall, and the volume of springs and rivers, he does not seem to have reflected on its meaning—how in seasons of drought the surface waters fail first, how by degrees the springs begin to lessen and even to cease, how the rivers dwindle until in many cases their beds become almost or quite dry, and yet how, when welcome rains set in, the springs and rivers gradually resume the bulk they had before the dry weather impoverished them. He had made no study of the way in which rain percolates through the soil, subsoil, and rocks underneath, though there are places, such as his vineyard may have been, where, from some impervious material, only a feeble or inappreciable flow of moisture descends beyond a few feet from the surface. Nor was he aware of the innumerable lines of joint by which the most solid rocks are traversed, and which serve as passages for the descent and ascent of water. Had he climbed many mountains, he would have failed to find a spring on the summit of any one of them, unless there had been a sufficient area of higher ground at hand to serve for the supply of the water.

The origin of underground water is regarded by Seneca as

[1] This is the view expressed by Lucretius :

> . . . ut in mare de terris venit umor aquai,
> in terras itidem manare ex aequore salso ;
> percolatur enim virus, retroque remanat
> materies umoris et ad caput amnibus omnis
> confluit, inde super terras redit agmine dulci.
>
> —*De Rer. Nat.* vi. 633.

due to three causes. The earth itself contains moisture which it forces out at the surface; it includes also air which in the darkness of the subterranean wintry cold is condensed into moisture; by the principle of interchangeability, whereby one element passes into another, the earth in its interior resolves itself into moisture. If it be urged that the rivers are too vast to draw their supplies from these sources, the ready answer comes that the internal reservoir is quite spacious enough for the purpose, and that it might as well be matter of surprise that, with all the winds that constantly blow, the supply of air does not fail, or that a single wave of the sea should be left to follow so many breakers. If the questioner, still unsatisfied, should demand to know how water is produced, he is met with the query how air is produced on earth. There are in nature four elements, and he is not entitled to ask where one of them comes from. Each is a fourth part of nature, and it is obvious that what has an element as its source cannot fail. Hence the philosopher in pronouncing water to be an element has given it enough, and more than enough, of strength. In short, rain may give rise to a torrent, but not a river flowing steadily between its banks. Heavy rains will swell such a river, but cannot produce it.

Having, as he believed, cleared the ground in this way, Seneca proceeds to consider the distribution of water within the earth. He opines that as in our body, so in the earth, there are channels by which both air and liquids flow. He states his conviction that the earth contains not only veins of water, but also large streams, and in a later part of the volume he speaks of both underground rivers, huge lakes, and a hidden sea from which rivers at the surface are supplied (154, 233, 235). He is aware that some of these subterranean reservoirs contain fish, about which he has some incredible tales to tell. He makes mention of rivers that sink underground and reappear, as if a matter for great astonishment. But examples of it may be found in many limestone districts, where the solution of the rock by underground water has given rise to tunnels, passages, and caverns into which, when their roofs give way, surface streams may be engulfed, to break out again from other openings at lower levels (141). The author concludes this part of his argument by asking if anybody is ignorant that there are some standing waters which have no bottom, whence, he contends, it is shown that this water is the perpetual source of large rivers.

The various kinds of taste possessed by natural waters are then discussed, and some marvellous illustrations are given of their effects. Allusion is made to medicinal springs, to petrifying waters, to some with extraordinary dyeing properties, and to

others with neither taste nor smell, but rapidly fatal to the drinker by immediately hardening and binding the intestines. Reference is also included to certain kinds of springs, of which the volcanic tracts of Italy supply good examples. Such were those which killed visitors who peered down into the caverns where their waters lurk, and suffocated birds that flew over them. Doubtless many tales were told of the effects of such emanations of carbonic acid gas, like that of the Grotto del Cane which, near Naples, still preserves their classic reputation (134, 261). Again, the same volcanic districts furnished instances of warm, sometimes even boiling, springs, and in alluding to them the author quotes the opinion of Empedocles, who was doubtless familiar with them in Sicily. To complete his record of marvels, the author cites some lakes on which islands float to and fro, of which good illustrations, due to a matted growth of vegetation, were then well known in the Vadimonian Lake (Lago di Bassano),[1] and he mentions other lakes in which he had equal faith, with water so heavy that brickbats would float upon it, and nothing, however heavy, not even hard solid stones, would go to the bottom.

Seneca is inclined to agree with some philosophers that certain rivers of peculiar and inexplicable character were created along with the world, and he specially cites the Danube and Nile as examples, these vast streams being too remarkable to have had the same origin as other rivers. Accordingly he reserves the Nile for consideration in a later part of his volume (166). There is another kind of water which, with his Stoic brethren, he places at the beginning of the world—the great ocean and every sea that flows from it between the lands. Yet he found no place in any part of the treatise for a discussion of the phenomena of the ocean.

The Book closes with a vivid description of the probable catastrophe by which the end of the world will be brought about. That the present condition of things will be swept away to make room for another and better race of men he assumes as a matter of certainty, and he tries to picture by what physical means the destruction will probably be effected. He is certain that it will be by no one agency, but that all the energies of the world will be called forth to compass the destruction of the human race, nothing being difficult to nature, especially when she is hurrying towards her end. The picture which is given of the progress of the great deluge forms by far the most striking piece of writing in the volume. It ends somewhat inartistically in some gibing criticism of a quotation from Ovid. But the poetic afflatus had not been quite quenched. The author immediately returns to

[1] Pliny, *Hist. Nat.* ii. 96. Pliny the Younger, *Epist.* viii. 20.

the subject in the succeeding and final chapters, and after enumerating the different agencies that may be called out to effect the destruction of the world, he draws a lurid scene when a single day will see the burial of the whole human race.[1] After this act of divine wrath has been accomplished, the waters will disappear below ground, the sea will retire to its own abode, and on the renovated earth every animal will be created afresh, and a new race of men will be installed, ignorant of sin and born under better auspices.

BOOK IV

This section of the treatise begins with a denunciation of flattery and ends with another against luxury. Neither the preface nor the concluding chapter have any obvious connection with the text between them. It is curious to note that while Seneca here warns his friend Lucilius against flatterers, and inculcates how their approaches are to be met, he himself in this very volume perpetrates four pieces of flattery to the despicable but all-powerful Nero. He quotes a prosaic line from a poem of the emperor's, which he characterises as "most elegant" (*disertissime*, 25). He refers to Nero as most devoted to truth as well as to the other virtues (235); he refers to the advent of a comet which appearing in Nero's reign had redeemed these heavenly bodies from their evil repute (290), and he describes that reign as "most joyous" (*laetissimus*, 294). The old courtier, so long habituated to the language of flattery, was perhaps hardly conscious that he was here making use of it, or he may naturally have reflected that at a time when the emperor had ceased to bear him any good will, the absence of the customary adulation might cause as much offence as if a direct insult were intended.

When from his ethical lecture he turns to resume his physical disquisitions, it is the mysterious Nile to which he devotes attention. After a brief contradiction of the statement of some philosophers that the Nile and the Danube are similar in their characters, he enumerates some of the well-known peculiarities of the river of Egypt. A problem which greatly exercised the minds of the philosophers of antiquity, and which has only been finally solved in our own day, was the cause of the annual rise of the Nile on which the fertility of Egypt depended. Seneca

[1] So Lucretius:

> . . . maria ac terras caelumque—
> una dies dabit exitio.
>
> —*De Rer. Nat.* v. 92, 94.

says with justice that if the point of the river could be ascertained where the rise begins the question would be settled. He does not appear to have known much about the river, for he believed that the water is for the first time collected into a single channel at Philae. In his account of that place and of the cataract there (168, 169), he speaks of the river's egress from Ethiopia, and of deserts which are crossed by the trade route to the Red Sea. In a subsequent part of the treatise he gives the interesting and important information that he had himself seen and conversed with two centurions who had been despatched by Nero to discover the source of the Nile (235). From them he learnt that they had penetrated far into the heart of Africa, and had reached a region of illimitable marshes where the river was so covered and impeded with vegetation that neither on foot nor by boat could it be ascended. There can be no doubt that these enterprising explorers had come to the *sudd*, which in recent years has been found so serious an impediment to navigation. They informed Seneca that in the marsh region they had seen with their own eyes "two rocks from which an enormous body of the river came out." There are apparently no rocks along the course of the Nile in the present marsh region, which is a vast flat, and it is therefore difficult to conjecture to what the two military surveyors allude. Possibly they saw the mouth of some affluent of the main stream such as the Khor Adar, or the *sudd* may have extended further north than it does now.

Seneca's account of the Nile derived from travellers and previous writers gives a clear summary of what was then known about the river, but of more interest is his discussion of the opinions that had been propounded before his time as to the cause of the annual rise. He first quotes the view of Anaxagoras, shared by the Greek tragedians and widely accepted, that this rise was due to the melting of snow on the uplands of Ethiopia. This idea he cogently combats by adducing various kinds of evidence of the great warmth of the climate in those southern regions. Some of these proofs, indeed, are exaggerations, as where he affirms that silver is unsoldered or melted. But one of his proofs, drawn from the habits of the animals of the country, is worthy of notice. He remarks that no hibernating creature is found there, and that even in midwinter the serpent is seen above ground. He argues that in Africa, as in Europe, melting snow would swell the rivers in spring and early summer, whereas the Nile flood continues to rise later during four months.

In a subsequent part of this treatise (235) allusion is made to an explanation which had been given of the rise of the Nile, that it is due not to the fall of rain from above but to the outflow of

water from within the earth, and it is in connection with this opinion that he cites the experience of Nero's two centurions above referred to, as if he were disposed to believe that what these explorers saw was really a vast body of water issuing from underground.

The opinion of Thales is next criticised that the Etesian or northerly winds drive the waters of the Mediterranean against the mouths of the Nile and consequently pond back the waters of the river. This view was of course entirely erroneous, but though Seneca rejects it, he does not seem to have quite understood it, for he argues that, coming from the same quarter as the winds, the Nile water should not have been turbid, but clear and blue, like that of the sea. In commenting upon the futile support given by Euthymenes of Marseilles to the idea of Thales, Seneca throws light on the wide extent to which the coasts of the outer sea had then been made known by trading vessels.

In rejecting another explanation proposed by Oenopides of Chios, the author shows that he is aware of the fact that caves and wells are warm in winter and cool in summer, and that he has partly divined the reason, when he states that in winter they are warm since they do not admit the frosty air from without and in summer they feel cold because the warm air from outside has not penetrated into their recesses. He returns to this subject in Book VI. (241).[1]

After mentioning and dismissing a grotesque suggestion of Diogenes of Apollonia, Seneca suddenly drops the discussion of the Nile and passes on to the subject of hail. It is obvious that there is here a serious gap in the text. It is not probable that he meant to leave off his examination into the probable sources of the Nile without stating his own view of a matter which had been so long the subject of wonder and debate. Either, therefore, he never completed this section of his treatise, or a portion of the work has been lost.

The remainder of Book IV. is taken up with a desultory discussion of the subjects of hail and snow, written when the author must have been in a somewhat frivolous mood. He begins by telling Lucilius that if he were to assert that hail is produced as ice is with us, a whole cloud being frozen, he would be rather audacious. So he will imitate the chroniclers, who after they have told a great many lies, refuse to be responsible for some one statement, and refer for its truth to the authorities.

[1] The various ancient interpretations of the cause of the Nile's annual rise are succinctly given by Lucretius (*De Rer. Nat.* vi. 712-37), but he does not indicate a preference for any one in particular, though he devotes most space to the influence of the Etesian winds.

If, therefore, his friend doubts his word, he will call in Posidonius, who will tell him that hail is formed from a watery cloud just turned into liquid. No teacher is needed to explain why pellets of hail are round, for all drops take that shape. Hail is nothing else than suspended ice, and snow is suspended hoar-frost. In this light vein Seneca thinks he has finished the subject and might dismiss it, but he cannot resist the temptation to continue the persiflage a little further. He quotes in a bantering style some of the opinions of his brother Stoics, and after this long preamble begins an inquiry into the distribution of density and temperature in the atmosphere.

It would have been interesting had he seriously and fully stated what was known or surmised on this last topic, but he dismisses it in three short chapters. We learn from these that he regarded the air to be densest next the earth, and that as all things retain heat better the denser and more compact they are, so the air becomes less warm in proportion to its height (184).[1] The opinion of some persons, that the air on mountain summits ought to be warmer because they are nearer the sun, is sagaciously controverted, and the insignificance of all inequalities on the surface of the earth in comparison with the distance from the earth to the sun is forcibly expressed and illustrated.

The subject of snow and hail is briefly reintroduced at the end of the Book, probably for the purpose of affording a convenient introduction to the invective against luxury which fills the concluding chapter. The preservation of snow in ice-houses, and its use in the reparation of jaded appetites by cooling drinks, calls forth a denunciation of the young rakes of his day, which closes the discussion.

BOOK V

The movements of the atmosphere form the subject of discussion in this part of the treatise. In the first chapter the author seeks for an exact definition of the term "Wind" (*ventus*), and ends by adopting one which is obviously inaccurate—"wind is air flowing in one direction,"—for as he afterwards speaks of whirlwinds he was well aware that the movement may be in every direction, or vorticose. Dismissing the opinion of Democritus as to the origin of wind, he states that in his judgment wind may arise from four different causes. First; The earth itself breathes forth a vast amount of air from its interior, where there are large

[1] This view hardly agrees with what is expressed in Book II. (60, 61), but it more accurately expresses the fact.

rivers and lakes, and where the moist air naturally gives rise to blasts of wind. Second; Long-continued evaporation carries the terrestrial emanations aloft, where the intermingling of the breath results in wind. Third; Much more important is the fact that the air in its very constitution possesses an innate power of motion; we cannot imagine that while we ourselves are endowed with a capacity of movement—and water has this power also—the atmosphere should be left inert and immovable (197). Fourth; Sometimes the sun is itself the cause of wind, when he loosens and expands the thick air (198).

In this enumeration allusion is made to one or two features of natural history which the author appears to accept as fact. He thinks there must be some vital force in water, otherwise it could not bring forth animals and plants, as we know it does. But not only water; fire, too, which devours everything, possesses this generative capacity, for, unlikely as it might be thought, it is nevertheless true that fire gives birth to some animals. The air, too, has some vital energy, as it alternately thickens, contracts, and expands, and rids itself of its impurities. The portion of it contained within the earth is asserted in a later part of the volume to be the source of the life of the vegetation at the surface (244).

The local winds, now known as "land and sea breezes," are next discussed (198). Instead of the simple explanation which in our own day has shown these aerial currents to be beautiful examples of the results of diurnal variations of atmospheric pressure, the ancient theory represented that during the day the exhalations from the land are borne on high to supply the sun with nourishment, while at night, as they are not needed for that purpose, they accumulate until they have filled up a given space enclosed by mountains. When in such a space there is no more room, they move towards the quarter to which they can most easily escape; hence the wind. It is curious, however, to note that Seneca only describes the land breeze, which falls away as the morning advances. He does not specially refer to the equally characteristic sea breeze, which springs up after the other dies down, and continues during the day, until in the evening it is again replaced by the land breeze.

The important Etesian or northerly winds, with all their important local modifications in the Mediterranean basin, must have been a subject of constant observation to the Greeks and Romans. There was a general belief that as these winds reappeared regularly in summer, they were in some way connected with the position of the sun in the firmament. Seneca, after briefly stating this opinion, dissents from it on the ground that,

as the sun reduces the strength of the morning or land breeze, it cannot be through his influence that the Etesian winds then begin to blow. But he does not explain how he would himself account for their occurrence. They are now known to be further illustrations of the influence of atmospheric pressure. In summer, when the hot region of the Sahara becomes a vast area of low pressure, the air streams into it from the north across the Mediterranean basin.

The account given of cloud winds (203) is an excellent illustration of the utter ignorance of the philosophers of antiquity of the very rudiments of meteorology, and, at the same time, of the confidence with which they offered their explanations of the phenomena of the atmosphere. Even now, after prolonged investigation, the laws that regulate the production of furious winds and gusts connected with clouds are far from being fully understood. The boldest meteorologist of to-day, with all his detailed experience, would hesitate to express his opinion as dogmatically as is done in the text. The idea that air accumulating either above ground or below acquires a vast disruptive force, obtained wide credence in early times. It was this pent-up accumulation which was supposed to burst clouds asunder and produce thunder-storms, while the same energy in caverns under ground led to earthquakes and the eruptions of volcanoes.

The occurrence of whirlwinds is explained by Seneca from the analogy of eddies in a river. As the water meets with impediments in its flow, it is driven back and made to whirl round before it can continue the onward current, so the wind, as long as it meets with no obstacle, sweeps on, but when it is thrown back by any projection in its course, or is collected together into a highly inclined narrow pipe, it whirls round upon itself like the eddies of a river. But the cause of the vorticose movement where there is no visible impediment is, of course, left unaccounted for.

In the fifteenth chapter of this Book a story is told of Philip of Macedon, who sent down a party of miners to examine an old mine. The men brought back to daylight a wonderful tale of vast caverns with high over-arching roofs, and filled with huge rivers and vast lakes. If the author's intention was to connect the spaciousness of these underground chambers with the operations of ancient miners, he was sadly mistaken, since at no time has metal-mining led to the excavation of huge caverns; on the contrary, it has always been pursued in narrow shafts and passages. If the report brought back to the king was veracious, his emissaries had only come upon a series of natural grottos and tunnels, such as are of common occurrence in limestone districts, and

which have no connection whatever with mining.[1] But the narrative served Seneca's purpose, since it furnished him with the occasion for a diatribe against the cursed love of gold, which had apparently been rampant in days long before those of Philip, and allowed him to supply from his own imagination some additional lurid horrors of the underground world.

When he gets back to his subject, he enters upon an enumeration of the various winds known to the ancients. He himself thinks that as the heavens are divided into twelve sections, so there are twelve distinct winds, not all felt everywhere, but never exceeding that number. He does not attempt, however, to account for them. In his reference to the names given to the various winds, he gives a quotation from Ovid's *Metamorphoses*, in which the more conspicuous winds from the different quarters are mentioned. To this quotation he adds a line from Virgil's graphic picture of the storm in the first book of the *Aeneid*, where Aeolus opens his cave and the south-east, south, and south-west winds rush out in fury upon the sea. Seneca remarks, in passing, that such a collocation of winds as Virgil enumerates could never have happened in a single tempest. The poet, however, has made no mistake. In a great cyclonic storm the wind veers round with the compass from south-east by south to south-west. And even if Virgil had added the north wind, which the philosopher says he left out, he would only have followed the invariable course of the winds in the cyclones of the northern hemisphere, which circle round towards the north as the storm area is passing eastward.

In conclusion, the author points out the teleological significance of the winds, and is thence led to repeat the time-honoured reproach against human iniquity which turns the winds from their beneficent intention to purposes of war.

BOOK VI

This is, perhaps, the most valuable part of the volume, for it contains more of the author's own observations than the rest of the work. It deals more particularly with the great earthquake of 5th February A.D. 63, which occurred in his own country, and about which he could collect information at first hand. As already mentioned, the subject of earthquakes had long fascinated

[1] It is possible that these ancient mines were driven in search of metal seams or veins traversing limestone, like those of lead among the caverned limestones of Derbyshire.

him, and he had published, in his youth, a volume about it. The calamity which brought so much injury to the towns of Campania was more especially likely to enlist his vivid interest, for the region that had been convulsed was with him a well-known and favourite part of Italy, where he often came to spend, on the shores of the Bay of Naples, such leisure as the life in Rome allowed him. Besides, it was the native district of Lucilius, to whom the volume was addressed, and whose town of Pompeii had suffered from the shock.[1] Hence he here plunges at once into details of the damage caused by this particular earthquake. As a prelude to his inquiry into the whole question of the origin of such catastrophes, he indulges in reflections on their appalling nature. Some of the unfortunate residents in the convulsed district had fled from it, vowing never to return. But where, the writer asks, can they be sure of safety, seeing that no quarter of the world is exempt from this form of danger? He urges that it is at least some consolation to be assured that such calamities are not the work of angry gods, as was popularly believed, but are traceable to their own special causes in the processes of nature (228).

He then considers the various opinions entertained on this subject by earlier writers, which, on the whole, he regards as crude and inexact. The cause of earthquakes had been found in water, fire, air, and the earth itself, or in a combination of several of these agencies, or even in the co-operation of the whole of them. As regards the action of water, he dismisses the opinion of Thales (231), but in the statements of other authors, who maintain the power of internal water in causing earthquakes, he sees a greater probability of truth. He fully admits the existence of large rivers and extensive lakes inside the earth, and that in these dark uninhabited regions flooded rivers undermining their banks, and a swollen sea lashed into fury by the subterranean winds, may communicate shocks to the surface of the earth (234).

That fire is the origin of earthquakes had been held by various philosophers, who, however, differed as to the manner in which the fire acts. Anaxagoras thought it was by explosions caused from the collision of underground clouds (236); others held that the immense mass of vapour produced by the subterranean conflagrations as it accumulates may exert such a pressure as to

[1] In Seneca's letters, frequent reference is made to his visits to the district. He seems generally to have taken a villa at Baiae, or some adjacent place on that western part of the coast. He appears to have been a poor sailor, glad to make for the nearest landing-place between Baiae and Naples, so as to escape from the pangs of sea-sickness. On one of his excursions he revisited Pompeii, and was set into a reverie of his youth there. See his *Letters*, 49, 51, 53, 55, 57, 70, 77.

disrupt all obstructions; or when the pressure is less may cause no more than a heaving of the surface. The idea that the shock of an earthquake results from the removal of material underneath, whereby the stability of the overlying portion is undermined, and a collapse of the ground ensues, was held in various forms. Some thought that this destruction arose from extensive combustion within the earth. Anaximenes supposed that just as at the surface, rocks and old buildings yield to the ravages of time and fall down, so in the interior of the earth similar landslips may occur and cause shocks to the districts above them (237).[1]

But the favourite opinion of antiquity regarded earthquakes as primarily due to the violent commotion of air. Seneca comments on the views of various philosophers, and more especially Aristotle's, as to the way in which the air acts, and he then proceeds to deliver his own judgment. He has no doubt that, though some of the other agencies may co-operate, the chief motive force in earthquakes is air. By no part of nature, he affirms, is such violent energy displayed as by air; it kindles fire, tosses the surface of the waters into waves, destroys large tracts of the earth, uplifts new mountains, and raises in the midst of the sea islands never seen before. Not only does air exist above ground, but it also fills the hollows and interstices of the interior of the earth, into which it freely enters from the surface. Nothing in nature is so restless as air, and the earth cannot but be affected by the movements of the air included in its inside. The author agrees with the general opinion that when the air begins to be agitated in a subterranean cavern which it has filled, pressed by that which is still entering, it struggles to escape, and, when it does so, emerges with a violence proportionate to the narrowness of the passage for its exit. But if unable to make its way out, it becomes furious, acts like a swollen impetuous river, and that overthrows everything in its path.[2]

It is not difficult to realise how this explanation should have been accepted in antiquity, and should have held its ground down even into modern times. The violence of the commotions of the atmosphere was a familiar feature on the surface of the earth, although its physical causes, variously guessed at, were utterly unknown. To minds that had no conception of the very

[1] The collapse of the roofs or sides of underground caverns may undoubtedly be in some instances the cause of local earthquakes. This origin is enforced by Lucretius:

> terra superne tremit magnis concussa ruinis,
> subter ubi ingentes speluncas subruit aetas.
>
> —*De Rer. Nat.* vi. 544.

[2] Lucretius gives a picturesque recital of these views (*De Rer. Nat.* vi. 535-607).

rudiments of meteorology, there seemed to be no reason why air inside the earth should not be affected by as violent hurricanes as the air outside. And as such hurricanes were the most powerful natural agencies known, their action was not unreasonably invoked to account for the phenomena of earthquakes. Assuming that the air in a large subterranean cavern would behave as the free open atmosphere does, the old philosophers did not find themselves under the necessity of explaining what was to set the air in motion within the subterranean recesses and lash it into fury there, any more than they had to account for tempests above ground.

Obviously, if the air found its way from the outside into the internal parts of the earth, it must have had equal facilities for egress. And in the convulsions of an earthquake it might be supposed to issue with violence through some of the previous openings or from the rents made at the time. In corroboration of the truth of the prevalent opinion, it was asserted that after an earthquake air was found to issue from the ground, but no account appears to have been preserved of any violent outrush of air. As a further evidence that it is to the force of air that all these internal disturbances are due, the author remarks that after a violent earthquake another shock of equal violence cannot occur, because the first has opened a passage for the struggling winds.

The progress of investigation has, in modern times, thrown a flood of light on the phenomena of earthquakes, though there still remain many problems in the subject which await solution. It is needless to say that no foundation whatever has been found for the ancient faith that the air plays the chief part in these subterranean commotions.

Seneca discusses the nature of earthquake motion. He recognises three kinds of movement—quaking (*succussio*), tilting (*inclinatio*), and trembling (*vibratio*)—and he gives illustrations of the kind of causes to which they may be referred (252). He believes that the extent of country convulsed by an earthquake depends upon the area of the subterranean cavern in which the wind performs its exploits, and as these internal cavities do not continuously underlie vast tracts of the earth's surface, no large spaces of that surface are simultaneously shaken. In his day there appears to have been no record of a shock affecting the whole basin of the Mediterranean Sea. He thinks that no earthquake ever extends as much as two hundred miles. He cites the recent calamity in Campania, which did not pass beyond that district, though marvellous tales about it had spread far and near, and he gives other examples of the markedly local character of the phenomena, so far as then known. He affirms that maritime districts are those most frequently shaken (255, 257),

in proof of which he gives various instances, including the late disaster to Pompeii and Herculaneum in a region which had never been known to be shaken before.

He had received information about the Campanian shock, and the narrative in which he embodies it has the interest of being the most detailed account of an earthquake that has come down to us from antiquity. First of all, as already mentioned, he states that the movement was confined to the district of Campania, no mention being made of its having been felt even so near as Rome. He notices the injury done to Herculaneum and to Naples by the damage of public and private buildings; bronze statues were split open and some people were driven out of their minds. He records that Campania continued to tremble for some days after the great shock. He had heard that a flock of six hundred sheep was said to have been killed near Pompeii. Accepting the report as true, he sees no reason to suppose that the animals died of fright, but thinks it not unlikely that they were poisoned by the ascent of pestilential vapours from the ground. This conjecture of his receives perhaps some support from the fact that in this volcanic district, after an eruption of Vesuvius, so much carbonic acid gas has been said to escape from the ground as to suffocate hundreds of hares, pheasants, and partridges. But the most vivid experience of the earthquake which he narrates is that of a grave philosophic friend who, when in his bath, saw the tiles of the floor separate from each other, allowing the water to sink through the opened joints, while the next moment, as the pavement closed again, the water was forced out all bubbling. A better illustration of the transit of a wave of shock could not be desired.

Seneca was prepared to believe that great changes had been wrought by earthquakes on the face of the land. He cites in support of this view some remarkable examples which had occurred within the times of human history, such as the sinking of the towns of Buris and Helice, the disappearance wholly or partially of the island of Atalanta, and the subsidence of Sidon (256). He refers also to various striking features of landscape in different regions which had been popularly assigned to the work of earthquakes, such as the separation of Ossa and Olympus, the disruption of Sicily from the Italian shore, and the severance of Spain from the continent of Africa (263).

That the phenomena of earthquakes are closely connected with those of volcanoes was the general belief in antiquity, and continued to be accepted up to the middle of last century. It was believed in early days that just as the collision of clouds during storms produces the fire seen in lightning, so during the tempestuous agitation of the air within the earth, such heat is generated

as to set fire to beds of sulphur or other combustible materials, and thus that rocks are melted and are forced up to the surface by the vast energy of the escaping air.[1] It is to be regretted that Seneca has not left an account of his own opinions on this subject, but from the allusions in the present treatise he may be inferred to have held the prevalent opinion. He alludes in various passages to volcanic eruptions that had taken place in his own time, or not long before, in the Mediterranean basin. An eruption of Etna is briefly noticed, when the mountain was in violent eruption, ejecting such a quantity of fine burning sand and dust as to turn day into night, accompanied with much thunder and lightning (77). This may have been the eruption alluded to in similar language by Cicero, who adds that for two days nobody could see his neighbour.[2] Seneca further cites two eruptions in the Aegean Sea, one of which had taken place in his own time, when a new island was upraised "by the force of air." He alludes to Thera and Therasia, and the interesting account given by Posidonius of the uprise of an island in the same sea, with attendant circumstances closely resembling those of the eruptions at Santorin in modern times (73, 252). According to Asclepiodotus, the fire, after overcoming the resistance of the thick mass of sea, shot up above sea-level to a height of two hundred paces.

From a consideration of the causes of earthquakes the author is led by his accustomed train of thought to draw the ethical lessons which the subject suggested to him. He repeats his belief that against the perils of earthquakes, as against all the other dangers and fears of life, the only assurance is to be obtained from elevating studies and a contemplation of nature (265). It matters not when or in what form we shall quit life, whether from some trifle or from a world-wide catastrophe. To be happy without fear of anything that may befall us, we must carry our life in our hands, steeling ourselves against fear, and prepared even to welcome death as the advent of a friend.

BOOK VII

After a brief introduction, marked by no little elegance and literary skill, the author introduces the subject of the heavenly

[1] This view of the nature of volcanic energy is graphically expressed by Lucretius (*op. cit.* vi. 639-702).

[2] *De Nat. Deor.* ii. 38. See also Lucretius (*ib.* vi. 641), who describes the more conspicuous features of an eruption, and concludes with the line

ne dubites quin haec animai turbida sit vis (693).

bodies, and more especially of Comets which he is to discuss in this Book. He proposes at the outset to endeavour to ascertain whether the earth stands still while the universe revolves round it, or if it is the universe that remains at rest while the earth revolves. But he is led on from one topic to another, without having arrived at a definite solution of this problem when the volume comes to an end. From various expressions, however, it may be inferred that he adhered to the primitive belief that it is the universe which goes round the earth. Thus in Chapter IX. he speaks of the movement that drags the universe along and asks what is swifter than that revolution (281). The heavenly bodies may not stand or turn aside, they all move onward with the irrevocable movement of this eternal creation (299).

The opinions of various philosophers on comets are quoted and criticised. He is especially severe in his comments on Epigenes, who thought that comets are produced somewhat as fires are excited by whirlwinds. The Greek threefold classification of comets is cited, and then Artemidorus comes in for his share of vituperation; to disprove his theory of the firmament being a solid roof to the world would be, in the author's opinion, nothing but beating the air. Ephorus fares no better, being briefly dismissed as often deceiving and often deceived. Apollonius of Myndus held that many comets are distinct planetary bodies, which wax and wane like the planets, being brightest when they are nearest us and growing dimmer as they recede to a greater distance. But Seneca refuses to admit that they have the character of true planets; in his view they are insubstantial irregular fire (291). But he does not agree with his Stoic brethren in regarding them as generated in dense air and pursuing their course according to where they can find fuel to sustain them (292-4). He conceives that they are not mere sudden and transient fires, but belong to the eternal works of nature. They steadily traverse their course, and he can understand that they may have such wide orbits as to carry them far beyond the limits of the Zodiac (296). He can see no reason why the five planets then known should be the only stars that move across the sky, though others had not yet been discovered. Astronomy, he remarks, is in its infancy, many mysteries of nature remain still to be discovered, and the day will come when posterity will marvel at our ignorance of things which will then appear to be so evident. Some future observer will demonstrate the paths of the comets, why they wander so far from the other stars, and what is their size and constitution. We may be content with what we have found out, and leave something for posterity to discover.

In a tone of sad pessimism he brings his volume to a close. From a contemplation of the glories that might be achieved by mankind in searching out the marvels of creation he turns to his own age and his own country, only to see on every side proofs of decadence. No one now cared for the pursuit of wisdom. Philosophy and every liberal study were neglected. The schools of philosophy were dying. If his countrymen even now would set themselves with all their energy to the task, if the young would give their sober attention and the elders would teach them, they would scarcely succeed in reaching the bottom of the well in which truth lies. Meanwhile they were searching merely on the surface of the ground and with but a slack hand.

NOTES BY TRANSLATOR

"AIR"

THE word "air" occurs in the text over 200 times, but not always as a translation of the same Latin word. With a term so elastic and so ambiguous it would have been mere pedantry to attempt a uniform rendering; and indeed such uniform rendering would have been more misleading than the course adopted of rendering according to the context, which the idiom of our language seemed to demand.

Seneca has two main terms for air—*aër* and *spiritus*. *Aër* means, generally speaking, either air generically, or the atmosphere specifically. *Spiritus*, on the other hand, denotes air under certain conditions of tension, or strain, or pressure, when it is capable of exerting force or violence; to its influence are attributed many effects due in reality to gases, or other causes. On p. 52, l. 1, we have the definition "air (*spiritus*) is the atmosphere (*aër*) in violent motion"; and on p. 205 the concluding words of V. xiii. are "air differs from wind in degree alone. A more violent air is a wind; air in turn is gently flowing atmosphere," where again *spiritus* is "air" and *aër* "atmosphere."

Again, in the *Aetna*, l. 212, we read, "The winds when inflated are called *spirit*; when in subsidence, *air*" (Professor Ellis's translation), where the same terms *spiritus* and *aër* are employed.[1]

Now if our author had been consistent in the use of the words, there would have been a strong case for a uniform adoption of "air" and "atmosphere," whenever they occurred. But numerous passages might be cited to show that he interchanges the words without apparent motive, just as we do "air" and "atmosphere." For example, on p. 69, l. 2, "So fire will pass

[1] For a discussion of the meaning of the term *spiritus* and the parallelisms in its use by Seneca and the author of the *Aetna*, see Professor Ellis's edition of that poem, Prolegomena, pp. xl-xliii.

into air (*spiritus*)," while on p. 71, l. 9, "the air (*aër*), which is interchangeable with fire." Again, on p. 75, l. 6, "When the clouds have enclosed air" (*spiritus*); l. 26, "atmosphere (*aër*) shut up in a hollow cloud." A still more conclusive case, though the passage is probably in other respects corrupt, occurs in the last sentence of c. xxix. p. 77, where the first "air" is *spiritus*, the second, a mere synonym or variant, is *aër*. Cf. p. 187, l. 27, and the passages cited below from pp. 245, 249, 251, 259, 260.

The translator has little choice. He must follow his author, and, where the latter makes a distinction, must endeavour to reproduce it; otherwise he must, as the author did, observe the idiom of his own language.

In accordance with this principle *aër* is usually translated "atmosphere," and *spiritus* "air"; but circumstances have rendered unavoidable a considerable number of exceptions.

The discussion of phenomena in which air plays a part is contained chiefly in Books II. and VI., and here the distinction of terms in English has been, so far as practicable, maintained. In Book II. "air" is a translation of *aër* about a dozen of times out of a total of over fifty times that "air" occurs, and in Book VI. about half a dozen out of a total of nearly seventy.

The following is a list of the places in which "air" translates *aër*:—

Book I. throughout.

Book II. pp. 56, ll. 20, 21; 57, ll. 17, 22; 58, l. 3; 59, l. 26; 61, l. 18; 66, l. 12; 71, l. 9; 72, l. 22; 77, l. 17; 98, l. 26; 101, l. 28.

Book III. pp. 120, ll. 8, 9 (four times); 121, ll. 11-20 (five times); 123, l. 28; 129, l. 3; 134, ll. 26, 28; 135, l. 1; 140, l. 29.

Book IV. pp. 176, ll. 6, 9; 184, l. 2; 186, l. 16.

Book V. pp. 195, l. 32; 196, l. 7; 198, l. 3; 199, l. 16; 202, l. 6; 205, l. 11; 206, l. 3; 211, ll. 14, 20.

Book VI. pp. 245, l. 28; 249, l. 10; 251, ll. 8, 9; 259, l. 7; 260, ll. 26, 29.

Book VII. throughout, with *three exceptions*, viz. pp. 277, l. 26; 279, l. 16; 281, l. 4.

In a few cases "air" occurs as a more explicit representation of a pronoun or an adjective which implies it: in these instances the context is generally a sufficient guide. *Spiritus*, too, has sometimes quite a different rendering, *e.g.* breath.

On pp. 111, 139, 152, "air" is used of a very slight breeze, the very gentlest breath of wind, and represents *aura*—a good illustration of the ambiguity of language.

QUOTATIONS

SENECA is fond of illustrating his subject by passages from the poets. His favourites are Virgil and Ovid, and only once does he quote Lucretius, whose work was much more analogous to his own. The quotations are apparently from memory and betray occasional inaccuracies, as even the best memories will.

The following is a list of the references :—

Book I. Pref., 8 (p. 6). Virg. *Aen.* iv. 404.
i. 4 (10). Virg. *Aen.* v. 528.
iii. 4 (17). Ovid, *Metamorp.* vi. 65 7.
v. 6 (25). Nero in an unknown poem : one or two other tags of that versatile tyrant have been preserved.
vi. 1 (28). Virg. *Georg.* i. 380. 1.
xi. 2 (35). Virg. *Georg.* ii. 95. 6.
xiv. 2 (38). Virg. *Georg.* i. 367. (cf. VII. xx. 1).
xvii. 5 (45). Virg. *Eclog.* ii. 25. 6.

Book II. i. 2 (51). Ovid, *Metamorp.* i. 55.
xliv. 1 (91). Ovid, *Metamorp.* iii. 305-7.

Book III. Pref., 3 (109). Origin unknown : a somewhat similar sentiment occurs in *Aetna*, 24.
i. 1 (114). Ovid, *Metamorp.* iii. 407.
i. 1 (114). Virg. *Aen.* i. 245. 6.
i. 1 (114). Lucilius, to whom the *Q.N.* was addressed. If he was the author of *Aetna*, as seems not improbable, he may have written other poems on Sicilian topography.
xx. 2 (133). Ovid, *Metamorp.* xv. 313. 4 (cf. *Ibid.* xi. 3 *sqq.*).
xx. 4 (134). Ovid, *Metamorp.* xv. 321.
xx. 5 (134). Ovid, *Metamorp.* xv. 330. 1.
xxvi. 3 (142). Ovid, *Metamorp.* xv. 273-6.
xxvi. 5 (142). Virg. *Eclog.* x. 4. 5.
xxvii. 12 (147). Ovid, *Metamorp.* i. 292.

Book III. xxvii. 12 (147). Ovid, *Metamorp.* i. 304.
xxvii. 13 (148). Ovid, *Metamorp.* i. 285. 290.
xxviii. 2 (148). Ovid, *Metamorp.* i. 272.
Book IV. Pref., 17 (165). Virg. *Aen.* iv. 373.
Pref., 17 (165). Ovid, *Metamorp.* i. 241. 2.
ii. 2 (168). Tib. *Eleg.* I. vii. 26.
iii. 3 (178). Ovid, *Ars Amat.* i. 475. 6.
iii. 3 (178). Lucret. *De Rerum Nat.* i. 313.
iv. 2 (179). Virg. *Georg.* i. 313.
Book V. i. 1 (193). Virg. *Eclog.* ii. 26.
xiv. 1 (206). Ovid, *Metamorp.* i. 388.
xvi. 1 (208). Ovid, *Metamorp.* i. 61-6.
xvi. 2 (209). Virg. *Aen.* i. 85.
Book VI. ii. 1 (225). Virg. *Aen.* ii. 354.
ii. 8 (227). Both quotation and author are doubtful: another reading attributes the poem to A. Gellius.
xiii. 5 (241). Virg. *Aen.* vi. 256.
xvii. 1 (246). Virg. *Aen.* viii. 728.
xviii. 1 (247). Virg. *Aen.* i. 55. 6.
xviii. 3 (248). Virg. *Aen.* i. 53. 4.
xxii. 3 (253). Virg. *Aen.* viii. 525.
xxvi. 2 (258). Virg. *Aen.* iii. 77.
xxix. 3 (262). Virg. *Aen.* iii. 414-9.
Book VII. x. 1 (282). Ovid, *Metamorp.* ii. 71.
xx. 1 (292). Virg. *Georg.* i. 367 (cf. I. xiv. 2).
xx. 3 (293). Virg. *Aen.* ix. 20. 1.
xxv. 1 (298). Virg. *Georg.* i. 137.
xxviii. 1 (302). Virg. *Georg.* i. 392.
xxviii. 1 (302). Virg. *Georg.* i. 362.

SOME OF GERCKE'S READINGS

Rendering in the Text.	Translation of Gercke's Text.
I. p. 5, § 7, the Strymon.	the Danube and the Balkans.
8, 1, the explanation . . . Philosophy.	my opinion.
9, 2, such as . . . answer me.	which each knows the other cannot answer.
20, 10, an oar . . . water.	an oar is covered with shallow water and presents a broken appearance.
37, 1, *Bothynae* (cave-like . . .).	*putei* (well-like . . .).
40, 3, one has seen . . . (= star-struck).	what is struck by them we call smitten with a flash, that is, struck without lightning-bolt, what the Greeks call ἀστερόπληκτα (= star-struck).
40, 4, of which more anon.	of which we have spoken.
41, 7, For we judge . . . foreign body.	But we judge that it is the deceptive appearance of a mirror, which merely gives a counterfeit representation of a foreign body.
II. 51, 2, After "rain, snow,"	add "winds, earthquakes, lightnings."
56, 2, hold together as one body.	be subject to tension.
63, 4, on account of . . . clouds.	when it has accumulated, is thrust violently upward by the massing of the clouds.

II. 75,	2, and it might . . . bladder.	and which might with greater accuracy be called harsh, because it emits a sound like that heard when a bladder.
95,	2, a third neither.	a third mixed, a fourth neither.
98,	1, (c. lv.) dry air.	air in rapid motion.
III. 122,	3, when trees are cut down.	when trees are full of sap and not cut down.
123,	1, air is produced.	Gercke places c. xiv. immediately after this.
132,	3, concealed throughout, until.	after "throughout" insert "in others they run above ground for some distance."
142,	5, you have yourself . . . Virgil.	you, my dear Lucilius, believe the story as (I said) in the first part [of my book], and so does Virgil.
149,	4, nor do the waters, etc.	nor do the waters find this a hard task since the sea mounts from an elevation equal to that of the earth (or land). If the heights be calculated (or if the average be taken over the heights), it will appear that the surface of the sea is of uniform level.
IV. 161,	8, the stature . . . arena.	the text and meaning are somewhat conjectural. Gercke reads "the stature of an ape matched against a Thracian in the arena." For "Apollonius Pycta" he reads "A. the boxer."
173,	19, nor yet the Caÿstrus . . . deep.	nor the Caÿstrus which lies beneath Mount Tmolus increases in summer, and yet deep snow lies there constantly as is natural in those northern regions. "*Tmolo*" is an ingenious and probable emendation.

IV. 186,	1, no one . . . virtuous.	by which one may become only more lettered and not more virtuous.
VI. 232,	2, and, generally speaking . . .	if the boats are unduly sunk, the water uses the whole force of the burthens it upbears, in order either to pour over them, or at any rate to rise to an unwonted height to right and left.
244,	(c. xv.) to hurry straight forward.	to blow where it lists.
258,	2, philosophers.	scholars, [or philologists].
265,	2, (c. xxxi.) soft materials . . . hard.	walls undergo more frequent but more gentle shocks than the nature of hard material allows.
VII. 296,	4, every star cannot but touch . . . zodiac.	no star can traverse its course without touching the zodiac, then I say a comet may have a different kind of orbit and yet some point in it may coincide with the zodiac.

INDEX TO THE "QUAESTIONES NATURALES"

[a] prefixed to a name indicates authorities used by Seneca.

[a] Academy, 307. School and followers of Plato.
Achaia, 142, 224, 225, 235, 288 (adj.), 303. District in N.W. of southern part of Greece (Morea).
Actors, regard for, 307.
Adriatic, 153.
Adversity, to be faced with joy, 111, 112.
Aegean (Sea), 73, 252. Eastern part of the Mediterranean.
Aegium, 257 (2). A leading town in Achaia on the Gulf of Corinth.
[a] Aeschylus, 172.
Africa, 117, 212, 236, 263.
Africus (Wind), 210.
Air, tension of, 58; wide diffusion of, 60; transformed into water, 119, 121; transformed into fire, 120, 121, 205; kindled by friction, 205, 206, 277; kindled within the earth, 236, 251; the cause of earthquakes, 239-48, 251, 254, 255; enters interior of earth, 254, 255.
Albula, 134. Small stream flowing into the Arno near Tibur (Tivoli) some 16 miles E. of Rome.
Alexander (the Great), 110, 215, 254 (2).
Alexandria, 273.
Alpheüs, 142 (2), 235. River in Elis in Southern Greece.
Alps, 110, 173, 184.
Ambracian (Gulf), 153. On W. of Greece (Gulf of Arta).
Ammon; *see* Jupiter.
Amphitheatre, jets of water in, 59.
[a] Anaxagoras, 63, 68, 172, 178, 236, 276. Celebrated Ionian philosopher, 500-428 B.C.
[a] Anaximander, 67. Ionian philosopher, 610-547 B.C.
[a] Anaximenes, 67, 237. Ionian philosopher about 500 B.C.

Animals, blind in subterranean waters, 129.
Animals, new forms of, discovered in Seneca's time, 305; many still to be found out, 305.
Antiochus, 288. King of Syria, 137-128 B.C.
Antony (Mark), 172.
Ants, mankind compared to, 6.
Apennines, 184.
Apollonia, 12, 68, 176. Town in Illyria.
[a] Apollonius (of Myndus), 274, 290, 300. Said to have flourished about the time of Alexander the Great (330 B.C.). There may be some confusion in the text between him and the celebrated Pythagorean philosopher, A. of Tyana, who was born shortly before the Christian era.
Apollonius Pycta (or pyctes = the boxer), 161. Unknown otherwise; apparently a gladiator.
Apulia, 211. District in S.E. of Italy.
Aquarius (sign of the Zodiac), 301.
Aquilo (Wind), 209.
[a] Aratus, 37. Of Cilicia, astronomical poet, flourished 270 B.C.
Araxes, 246. River in Armenia (Aras).
Arcadia, 122, 137. District in centre of Southern Greece.
[a] Archelaus, 239. Philosopher, flourished about 450 B.C. Pupil and partly disciple of Anaxagoras.
Arethusa, 142 (2), 235. Celebrated fountain in Syracuse in Sicily.
Argestes (Wind), 210.
Argolic, 142. Argolis is a district in N.E. of Southern Greece.
[a] Aristotle, 8, 9, 10, 19 (2), 33, 63, 240, 242, 276, 277, 302 (2), 303 (2), 304. See Introduction.
[a] Artemidorus (of Parium), 22, 286 (2), 287. Not otherwise known.
[a] Asclepiodotus, 74, 77, 207, 246, 253. Not otherwise known.
Asia, 224, 233. Province on the W. coast of Asia Minor, or generic name for area E. and N.E. of Europe.
Astronomy (*Caelestia*), scope of, 51; of Egyptians, 274; of Chaldaeans, 275; of Greeks, 298.
Atabulus (Wind), 211.
Atalanta, 256. Small island between Euboea and mainland of Greece. The channel now bears the name Talanta, which is likewise that of a neighbouring town.
Athens, 211.
[a] Attalus, 94, 95. Stoic philosopher, one of Seneca's teachers.
Attalus, 288. King of Pergamus, 241-197 B.C.
Atlantic Ocean, 174, 175 (2).

Atlantic Ocean, growth of trade to ports on shores of, 175.
Atmosphere, friction of, produces fires, 9, 39; upper portion dry and hot, 39, 60, 65, 78; possesses unity or continuity, 52, 57; place of, in universe, 54; earthy elements of, 56, 60; tension of, 56; lowest portion dense and dark, 60, 184; and warmer than the rest, 183; distribution of temperature in, 60, 184; causes of movements of, 61; relation of, to the ether, 65, 66; adapted to transmit sound, 77; rarefied, kindles fire, 100, 205; by violent movement sets itself on fire, 102; proof that it is never absolutely motionless, 193; possesses a native capacity of movement, 197.
Atoms, the world a fortuitous concourse of, 7.
Augury, kinds of, 79, 80, 82.
Augustus, 9, 12, 42, 211, 290.
Auster (Wind), 210.
[a] Authorities (various, not specified by name, but spoken of as "certain," "some," etc.), 18, 31, 35, 57, 63, 67, 73, 75, 93, 101, 110, 116, 118, 119, 122, 135, 148 (2), 150, 182, 184, 186, 230, 233, 236, 238, 239, 242, 243, 244, 283.
Avarice, denounced, 207.

Bactra, 215. In Central Asia (Balkh).
[a] Balbillus, 171. Governor of Egypt in Nero's reign, 53.
Balkan Mountains; *see* Haemus.
Baths, heating of water of, 136; effect of Campanian earthquake on tiled floor of, 264.
Bathyllus, 307. A native of Alexandria, freedman at Rome during reign of Augustus; perfected a pantomimic or ballet dance.
Bear (Great), 208.
Belus, 151. Babylonian deity.
[a] Berosus, 151. Priest of Belus, about 250 B.C.
Black Sea; *see* Pontus.
Boeotia, 137. District in Central Greece.
Boreas (Wind), 208.
Bothynae (meteors), 37.
Breezes, morning, 195, 198.
Buris; *see* Helice.

[a] Caecina, 86, 94, 95, 100. A friend and correspondent of Cicero, about 48 B.C.
Caesar (Julius), 166, 213, 290.
Caius (Emperor Caligula), 163, 164.

Calabria, 211. District in extreme S.E. of Italy.
[a] Callimachus, 172. Grammarian and poet; chief librarian of Alexandrine library, 260-240 B.C.
[a] Callisthenes, 254 (6), 258, 276, 277. Relative and pupil of Aristotle, friend and victim of Alexander the Great.
Cambyses, 78. King of Persia, 529-522 B.C.
Campania, 221 (2), 224 (2), 225, 239, 257, 259 (adj.), 264, 265. District in Italy containing Capua, Naples, etc.
Cancer (sign of the Zodiac), 151.
Cannae, 209. In Apulia.
Cannon, ancient types of, 67.
Capitol, 91.
Cappadocia, 138. Centre of Asia Minor.
Capricorn (sign of the Zodiac), 151.
Caria, 132, 142 (adj.). S.W. of Asia Minor.
Carthage, 110, 166.
Caspian, 153.
Cassander, 122. Son of Antipater, regent of Macedonia; eventually king of Macedonia; died 297 B.C.
Castor and Pollux, 11. Constellation and sign of the Zodiac (Gemini).
Cataegis (Wind), 211.
Cataracts (Nile), 168.
Caucasus, 173.
Caves with noxious air, 134; felt to be warmer in winter than in summer, 176, 241.
Caÿstrus (or Caÿster), 173. River in W. of Asia Minor flowing into the sea near Ephesus.
Chalcis, 246, 257. Chief town of Euboea on Strait at narrowest point.
[a] Chaldaeans, 81, 275 (3), 302.
[a] Charimander (or Charmander), 276. Otherwise unknown.
Charms, laws against, 182.
Charybdis, 153. Whirlpool in Strait of Messina.
Chasmata (meteors), 38.
Chersonese (= peninsula), 142. Carian or Rhodian on S.W. of Asia Minor.
Chios, 175. Island and town (Scio) off coast of Asia Minor.
[a] Cicero, 100.
Ciconians, 133. Tribe in Thrace.
Circius (Wind), 211.
Claudius (Emperor), 290, 294, 304.
Cleonae, 181, 182. Town in Argolis.
Cleopatra, 172 (2). Antony's celebrated partner.
[a] Clidemus, 99. A philosopher anterior in date to Aristotle.

Clouds, as sources of lightning and thunder, 10, 62, 63, 64, 75, 203; invisible when we are within them, 24; composition of, 24; compression of, causes thunder, 67; produce fire, 70, 74, 100; must be burst before they emit sound, 76, 98; not necessarily connected with wind, 195; as sources of wind, 203, 204.
Cloud-winds, 203.
Colours (in rainbow), origin of, 21, 25, 30, 31.
Comets, infrequency of, 272, 288, 301; what are they? 272; points of resemblance of, to planets, 273; resemblance to meteors, 275, 276; classes of, 276, 290; not due to wind, 278, 279-282; curved path of, 279; long visibility of, 282; distribution and shape of, 283; Greek classification of, 283; different from the planets, 284; examples of, 288, 290; vast orbits of, 290, 297, 302; vary in apparent size as they advance or retreat, 291; transparency of, 291, 300; Stoic opinions regarding, 291-294; directions of, 294, 303, 304; Seneca's opinion, 295, 305; form of, 300; portents from, 302.
[a] Conon, 274. Astronomer; born at Samos; lived at Alexandria about 250 B.C. Said to have been a friend of Archimedes.
Constellations, 301.
Contentment, duty of, 112.
Continuity or unity, defined, 53.
Corus (Wind), 210.
Corycian (Mt.), 122. The district round Corycus in Cilicia was famous for saffron.
Crassus, 215. Celebrated Roman, slain in battle in Mesopotamia, 53 B.C.
Crete, 123, 153 (adj.).
Crispus Passienus, 160. Stepfather of Nero. Consul in 42.
Crocodiles and dolphins, fight between, 171; chase of, 172.
Cutiliae, 139 (2). In the Sabine country, N.E. of Rome.
Cyclades, 147. Group of islands in Grecian Archipelago.
Cyclopes, 91. Jove's fabled armourers with workshops beneath Etna, Stromboli, etc.
Cyprus, 259.

Dacian, 5.
Danube, as a political boundary, 5, 233; alleged remarkable character of, 135; floods of, 146; contrasted with the Nile, 166; not swollen in winter, 173.
Darius, 254. King of Persia, 521-485 B.C.
Death, to be faced without fear, 103, 223, 226, 265-268;

equalises mankind, 223; the introduction to a better place than earth, 267.

Delos, 258, 259. Perhaps the most famous of "the isles of Greece."

Deluge, that is to destroy the earth, 143.

[a] Demetrius, 161. Cynic philosopher, contemporary of Seneca.

Demetrius (father and son), 288. Kings of Syria between 162 and 125 B.C.

[a] Democritus, 183 (2), 194, 249, 250, 276. The optimist or "laughing philosopher" of Abdera in Thrace; said to have lived 460-361 B.C.

[a] Diogenes (of Apollonia in Crete), 68, 176, 177. Pupil of Anaximenes, lived in fifth century B.C.

Dnieper (Borysthenes), 174.

Dog-star, 202.

Dolphins and crocodiles, fight between, 171.

Doris, translated "sea nymph" in the quotation from Virgil, 142.

Dowsers, 127.

Drops, globular form of, 178.

Drunkenness, 134, 188.

Earth, material of, formed from water, 120, 121.

Earth as a whole, place of the, in universe, 55; formed after the plan of our bodies, 126, 151, 242, 255; final destruction of, 143; itself the cause of earthquakes, 237; whether it or the universe revolves, 273.

Earth's interior, water supply in, 119, 206, 233, 234; cold temperature of, 119, 121; like surface above ground, 128, 206; blind animals in waters of, 129; origin of wind within, 206, 239, 243, 244, 254; landslips in, 238, 249, 251; store of vital air in, 244, 245.

Earthquakes, causes of, 51, 229, 230, 236, 249; effects of, 121, 221, 229, 257, 259, 262, 263; Campanian (of A.D. 63), 221, 257, 259, 262, 264; influence of, on the human mind, 222, 262; widespread destruction produced by, 223; not the work of angry gods, 228; Seneca's youthful work on, 230; water as the origin of, 231; fire as the origin of, 236, 238; air as the origin of, 239-248, 251, 255, 256, 264; mixed sources of, 249; varieties of movement in (*inclinatio*, *succussio*, *tremor*), 252; most frequent near the sea, 255; cause of local extent of, 257; features of the Campanian, 259-264; the first shock of, the most violent, 264.

Eclipses, 35, 274, 284, 293.

Egypt, 6, 167-177 (*passim*); great heat in, 173; said not to be visited by earthquakes, 258.

[a] Egyptians, ideas of, as to the elements, 125; astronomy of, 274.

Elements, interchangeability of, 120, 121, 245; four in number, 123; contrariety of, 301.

Eleusis, 306. In Attica, N.W. of Athens about 12 miles; scene of the great Eleusinian mysteries.

Elis, 114, 257. District in S.W. of Southern Greece.

Emanations, terrestrial, feed the sun and stars, 55, 198, 244; cause thunder, lightning, and commotion of the air, 63, 275; dry and moist, 63, 78.

[a] Empedocles, 136 (2). Philosopher of Agrigentum in Sicily, flourished about 444 B.C.

[a] Ephorus, 289 (3). Greek historian of some repute about 340 B.C.

[a] Epicurus, 250. Born 342, died 270 B.C.

[a] Epigenes, 274, 275, 276, 277, 278, 279, 280 (2), 283. A Greek astronomer of Byzantium of uncertain date.

Erasinus, 142. River of Argolis.

Etesian (Winds), 174 (4), 175, 201 (4), 202 (4), 212.

Ether, characters of the, 65; descent of force from the, 68.

Ethiopia, 6, 117, 167, 168, 172, 173, 212, 235. Term was applied very loosely to all the hinterland of Africa, only the Mediterranean coast and a portion of the Nile basin being known to the Greeks.

Etna, 77.

[a] Etruscans (or Tuscans), 79, 88, 92, 95 (sing.). Etruria lay immediately N. of the Tiber.

[a] Eudoxus, 274. Astronomer of Cnidus in Caria, pupil of Plato, flourished about 366 B.C.

Euphrates, 5, 215.

[a] Euripides, 173.

Euronotus (Wind), 210.

Europe, 173 (adj.), 233.

Eurus (Wind), 208, 209.

[a] Euthymenes (of Marseilles), 174, 175 (2). Geographer, probably about 150 B.C.

Evaporation from the earth, 198, 200, 240.

Expiation, the reason for, 83, 84.

Eyesight swifter than hearing, 64.

[a] Fabianus (Papirius), 144. Distinguished Stoic, one of Seneca's teachers.

Falernian (wine), 35. District famous for wine in N. of Campania.

Fate, unalterable, 83; nature of, 84, 91; uncertainty of visitations of, 225.
Favonius (Wind), 210.
Fear, how to be combated, 103, 225, 229, 265, 266, 267; arises from ignorance, 229; leads to loss of reason, 262.
Fidus Annaeus, 161. Apparently a gladiator of gigantic stature.
Fire, kindled in atmosphere, 39, 62, 64, 70, 100, 102; passes into air, 120; artificial modes of producing, by percussion or friction, 70; naturally rises, 71, 102; endowed with the power of producing some animals, 197; as the cause of earthquakes, 236, 238; produced in the earth's interior, 251; kindled by air, 251.
Fires, celestial, 8, 39, 294, 295, 296.
Fish in underground waters, 129, 132.
Flattery, counsel against, 159.
Floods, the earth to be finally destroyed by, 143, 144.
Fortune, vicissitudes of, 111.
Fountains, discharges from, 142.
Fucinus, 116. Large lake in Sabine country E. of Rome.

Gaetulicus, 163. Cn. Cornelius Lentulus G., put to death by Caligula 39.
Galatia, 138.
Gallic, 6.
Gallio, 161, 202. See Introduction.
Gaul, 117, 122 (pl.), 211.
Geography (*Terrena*), scope of, 51, 52.
Germanicus, 9. Nero Claudius Drusus, brother of the Emperor Tiberius, died 10 B.C.
Germans, 233.
Germany, 5, 117, 166.
Gibraltar, 175.
Glass, globe of, filled with water magnifies objects, 29; cause of iridescence in, 30.
God, nature of, 3, 4, 7, 8, 91, 305; sends portents, 80; unchangeable, 84; to Him everything is present, 84; His design in creating the winds, 213, 216.
Gods, dread of infernal, 208; do not disturb heaven or earth, 228; not to be feared, 266.
Gold, lust for, denounced, 5, 208, 215
Greece, 215, 274 (2), 298.
Greek, 58, 95, 210, 255.
[a] Greeks, 12, 13, 15, 34, 39, 40, 140, 169, 198, 203, 205, 209 (2), 210, 211, 240, 255, 283.

Gusts of wind, origin of, 203.
Gylippus, 12. Spartan commander against Athenians at Syracuse, 414 B.C.

Haemus (Balkan Mountains), 122.
Hail, 177, 181; falls more in summer than winter, 179; prognostications of, 181.
Halos (crowns), round sun and moon, 12, 14, 34, 41.
Hannibal, 110, 209. Famous Carthaginian general in Second Punic War, 219-201 B.C.
Happiness, how to be gained, 5, 266.
Heavenly bodies, influence of, on rivers, 141; on weather, 275; apparent retrogression of some, 299.
Heavens, extent of the, 7; contemplation of the starry, 271; divisions of the, 210; supposed by Artemidorus to be a solid vault, 286.
Helice and Buris (or Bura), 254, 257, 259, 267, 276, 277, 289. Towns in Achaia swallowed by earthquake 373 B.C
Heracleotic (mouth of the Nile), 171. Most westerly and largest, not far from Alexandria.
[a] Heraclitus, 100. Ancient representative of pessimism, "the weeping philosopher," of Ephesus, toward end of sixth century B.C.
Herculaneum, 221 (2), 259.
[a] Homer, 258.
Horizon, 211.
Hostius Quadra, 42. Unknown save for Seneca's unfortunate mention of him.
Hydissus, 132. Orthography of this Carian town is uncertain; Gercke reads Idumus.
Hydraulic organs, 56.

Iapygian (Wind), 211.
Ice, 140.
India, 7, 212, 215.
Intermittent action, 128.
Iron, discovery of, 45; money made of, 46.
Islands, floating, 139.
Ister (or Hister), a name of the Danube, *which see.*
Italy, 110, 117, 133, 212, 261, 262 (adj.), 263.

Junior; *see* Lucilius, 168.
Jupiter (Jove), temple of, in African desert (Ammon), 78;

his thunderbolts, 88, 89, 91, 92; affords lessons to earthly rulers, 90; other names for, 91, 92.
Jupiter, the planet, 284, 299.

Lacedaemonians, 189. Lacedaemon, or Sparta, was in Laconia, the district in the S.E. of Southern Greece.
Ladon, 257. River in Arcadia, tributary of Alpheus.
Laelius, 268. Friend of the younger Scipio Africanus, consul 140 B.C. Chief interlocutor in Cicero's Dialogue on Friendship.
Lakes, with dense water, 138, 139; underground, 154; wide extent of some, 233.
Land and sea breezes, 198.
Landslips, 238, 249, 251; effects of, 253.
Latin, 210 (2).
Leo (sign of the Zodiac), 301.
Lepidus, 166 (3). Formed with Augustus and Antony the Second Triumvirate after Caesar's assassination in 44 B.C.
Libonotus (Wind), 210.
Libyan (Wind), 210.
Life, the proper conduct in, 112, 159, 266; uncertainty of, 226; to be carried in our hand if we desire to live happy and without fear, 266.
Lightning, 62, 66, 69, 86, 87, 100; effects of, 78, 87, 88, 96; portents indicated by, 79, 81, 82, 86, 92, 94, 95, 215; possible pestilential power in, 97; cause of zigzag course of, 102; moral lessons to be derived from a consideration of, 104; safe retreats from, 223; blinding effects of, 292; connected with the planets, 275.
[a] Livy (Titus Livius), 209, 213. Roman historian, 59 B.C.–17.
Lower Sea; *see* Propontis.
Lucilius Junior, 1, 103, 109, 114, 142, 159 (2), 161, 162, 163, 217, 221, 265, 267, 268. See Introduction.
Luxury, introduction of, 45, 46; growth of, 47, 188; illustrations of, 129, 187; denunciation of, 130, 187, 306.
Lycia, 140. District S.W. of Asia Minor.
Lycus, 142. River, probably of Phrygia in Asia Minor, flowing into the Maeander.
Lydia, 139. District in W. of Asia Minor.
Lyncestis, 134.

Macedonia, 138, 207, 224, 303.
Magnesia, 122. Town of Lydia.
Mankind, compared to ants, 6; early ages of, 45, 46; final

destruction of, 147, 152; re-creation of, after the deluge, 155; world not made only for, 305.
Marmora or Marmara (Sea of); *see* Propontis.
Mars, the planet, 10, 275, 284.
Marseilles, 174.
Marshes, 233; of the Nile, 236.
Magalenopolis (or Megalepolis or Megalopolis), 257. Town in Arcadia.
Melas, 137. River of Boeotia in Central Greece.
Memphis, 170. Great Egyptian city a little above Cairo.
[a] Menander, 165. Athenian comic poet, 342-291 B.C.
Mercury, the planet, 284.
Messalina, 163. Third wife of Emperor Claudius; put to death by Narcissus, 48.
Messana (Messina), 142.
Metalliferous veins, 126.
Metals, melted by lightning, 78, 96; denunciation of the search for the precious, 207, 215.
Meteorology (*Sublimia*), scope of, 51.
Meteors, 8-11, 37, 38, 40, 275, 276, 292, 293, 296.
[a] Metrodorus (of Chios), 248 (2). Philosopher who flourished about 330 B.C. "Sceptic." Disciple of Democritus, perhaps.
Milky Way, 289.
Mind, the human, its nature and seat unknown, 297.
Mines, water in, 154; ancient, explored by Philip of Macedon, 207.
Mirrors, 22, 23, 24, 27, 41, 42, 44, 45, 47.
Mock-suns, 35.
Moon, eclipse of, 298; varying colour of, 300.
Moral reflections, Seneca's, 1-8, 42, 44-47, 102-105, 109-114, 130-132, 143-156, 159-166, 186-190, 207, 213-217, 222-229, 254, 265-268.
Mountains, insignificance of height of, compared with the whole mass of the earth, 184.
Mushrooms, 189.
Mylae, 142. Town on N. coast of Sicily, near Messina.
Myndus, 274, 290. Town in Caria.

Naples, partly damaged by earthquake of A.D. 63, 221.
Narcissus, 164. Freedman of Claudius, put to death by Agrippina, 54.
Natural Philosophy, 3, 8.
Nature, influence of, 3; origin of, 7; as a synonym for God, 92; advantage of the study of, 113, 265; finds no task hard, 144, 154; inadequate conceptions of, 228; study

of, the highest pursuit, 230; power of variation in, 301; inexhaustibility of, 306; still most imperfectly known, 306.
Naval wars denounced, 213.
Nebaioth, 208. An Arabian people, put for East in general. Latin form is Nabataei.
Neptune (Earthshaker), 255.
[a] Nero Caesar, 25, 235, 290, 294; probably referred to, though not named, 90 (last two sentences).
Nicopolis, 259. City in W. of Greece at entrance to Ambracian Gulf. The word means "city of victory," something like our oft-recurrent "Victoria."
Nile, unusual character of, 114, 135, 166; physiological effect of water of, 140; rise of, 141, 167, 169, 172; course of, 168, 170, 233; cataracts of, 168; mode of descent of, 169; delta of, 170, 171; canalisation of, 170; deposit of, 170, 258; inundation of, 171; supposed underground supply of, 235; Nero's expedition to the, 235; transport of sediment by, 258.
Nonacris, 137. Town in Arcadia.
Notus (Wind), 209.
Nuceria, 221. Town in Campania.

Ocean, 6 (2), 112, 119, 135, 143, 153, 155, 231, 254 (2), 266.
[a] Oenopides (of Chios), 175. Mathematician and astronomer, probably contemporary of Anaxagoras, fifth century B.C.
Olympic, 142 (2). Olympia was in Elis.
Olympus, 257. High mountain in Thessaly, Northern Greece.
Omens, arranged by Providence, 80; from lightning, 82.
Organs (hydraulic), 56.
Ossa, 257. Mountain in Thessaly, Northern Greece.
Ostia, 41. Town at mouth of Tiber; port of Rome.
[a] Ovid, 114, 133, 148, 165, 168. Latin poet, 43 B.C.–18.

Parhelia, 35.
Pamphylia, 211. District on S. of Asia Minor.
[a] Panaetius, 304. Stoic philosopher of Rhodes, friend of Laelius and the younger Scipio Africanus; died 111 B.C.
Paphos, 259. Town on W. of Cyprus.
Parium, 22. Town in Mysia on N.W. of Asia Minor.
Parthians, 5, 215.
Paterculus, 303. His consulship is said to have been in the year 60.
Patras, 257. Town at entrance of Gulf of Corinth.
Paulus, 9. L. Aemilius P., consul 181 and 168 B.C.

Peacock, analogy from colours of, 25.
Peloponnesian (War), 256, 258. Lasted 431-404 B.C. between Athens and Sparta.
Peneüs, 138, 257. Great river draining the plain of Thessaly and flowing through vale of Tempe between Olympus and Ossa; now called Salambria.
Perseus, 9. Last king of Macedonia, 178-168 B.C.
Persia, 208, 215.
Persians, 254.
Pestilential vapours emitted from the ground, 260, 261.
Pharos, 258. Island off Alexandria with famous lighthouse, united to mainland by Alexander the Great.
Phasis, 174. River of Colchis at E. of Black Sea.
Philae, 168 (3), 169. Island in the Nile, just below First Cataract. Seneca seems to confuse it with the so-called island of Meroë, at the junction of the Blue Nile and Atbara.
Philip, 110, 207 (2). Father of Alexander the Great; king of Macedonia 359-336 B.C.
Philosophers, debt due to the early, 230; credulous folk, 258; severe criticisms of, 125, 175, 288, 289.
Philosophy, divisions of, 3; pleasures of, 4, 5; benefits conferred by, 97; delivers its votaries from fear, 225; rewards of, 229; decadence of, 307, 308.
[a] Pindar, 258. Greek poet, 522-442 B.C.
Pithitae, or pithiae (meteors), 38, 40.
Plancus, 160. L. Munatius P., a prominent actor in the civil wars, 48-31 B.C.
Planets, colours of, 10; enumerated, 275; fixed number of, 284; orbits of, 285; motions of, 288; possibly greater number of, 297; conspicuous movements of, 298.
[a] Plato, 216.
Pollux, 11; *see* Castor.
Pompeii, 221, 259 (2).
Pompey, 166 (3). Defeated by Caesar 48 B.C., and assassinated shortly after.
Pontus (district in N.E. of Asia Minor), 141.
Pontus (Black Sea), 153, 176, 180 (?).
Portents from meteors, 9, 228, 259; lightning, 79, 86, 93, 94, 95, 215; eclipses, 228; comets, 272, 290, 302.
[a] Posidonius, 26, 27, 73, 74, 98 (2), 177, 246, 252, 256, 292, 293. A very distinguished Stoic philosopher, president of that school. Instructor for a time and friend of Cicero. Prosecuted physical investigations with great success. Native of Syria. Lived 135-51 B.C.

Posterity, great increase of knowledge to be attained by, 298.
Predestination, 85.
Prognostications; *see* Portents.
Propontis (Sea of Marmora), 153, 176 (Lower Sea).
Providence, 92, 213.
Puteoli, 133. On coast of Campania.
Pylades, 307. A Cilician; a dancer like Bathyllus.
Pyrenees, 5.
[a] Pyrrho, 307. Founder of the sect of the Sceptics, native of Elis; flourished about fourth century B.C.
[a] Pythagoras, 307. Flourished in second half of sixth century B.C.
Pyx, trial of, 180.

Rain, Seneca's observation on descent of, into soil, 117; share of, in final destruction of the world, 143, 144, 149; seasonal variations of, 179; supposed to be influenced by incantations, 182.
Rainbow, 16-33.
Rainless countries, 167, 173.
Red Sea, 112, 153, 168.
Regulus, 221. Consul 63.
Reverence, duty of, 304.
Rhaetian, 35. The reference is to wine grown in the N. of Italy (Cisalpine Gaul).
Rhine, 146 (2), 173, 233.
Rhodians, 142. Island of Rhodes was at S.W. of Asia Minor.
Rhone, 146, 173.
Rivers as political boundaries, 5, 233; sources of supply of, 116; underground, 132, 141, 206, 207, 233, 235; summer rise of, 141, 173.
Roman, 5, 12, 46, 110, 113, 166.
Rome, 110, 166, 182, 209, 307.
Roots, disruptive force of, 57.
Rulers, counsel to, 90.

Sacrifice cannot alter fate, 84; to keep off hail, 181.
St. Elmo's Fire, 11, 37.
[a] Sallust, 279. Roman historian, 86-34 B.C.
Sarmatian, 5, 233 (pl.). Roughly speaking, the S. part of Russia.
Saturn, the planet, 275 (2), 284, 303.
Scipio, 46 (2). The elder Sc. Africanus, victor of Hannibal at Zama, 202 B.C.
Scironian (Wind), 211.

Scylla, 153; *see* Charybdis.
Scythia, 180, 208. Term used very loosely of region in Central and Northern Asia, but at times extending to Europe, as far west as the Danube. Sarmatia of one age was part of Scythia of another.
Sea, unity of the, 125; coeval with the world, 135; throws ashore ill-smelling deposits, 142; share of, in final destruction of the earth, 143, 150; current of, from Black Sea, 176; subterranean, 234.
Sea and land breezes, 198.
Seafaring, condemned, 216.
Sea-water, purged of its salt within the earth, 116.
Sejanus, 9. Notorious instrument of Tiberius; put to death 31.
Sela (gleams in the sky), 39.
Self, bondage of slavery to, 113.
Septemtrio (Wind), 210.
[a] Sextii, 307. Father and son in the time of Augustus and Nero respectively; taught a combination of Stoic and Pythagorean doctrines.
Sheep, destruction of, during Campanian earthquake of A.D. 63, 259.
Sicily and Sicilian, 114, 138, 142 (2), 153, 159, 166 (2), 235, 262, 263.
Sidon, 256.
Snow, melting in Ethiopia erroneously supposed to be the cause of the annual rise of the Nile, 173; supplies some European rivers, 173; on European mountains, 173; origin of, 178, 179, 182, 186; said to feel colder to the feet when dry and hard than when slushy and half melted, 180; artificial use of, 187.
[a] Sophocles, 172.
Soul, divine origin of, 6; to be rescued from error and fear of death, 103.
Sound less rapid than light, 64.
Spain and Spanish, 6, 7, 110, 263.
Springs, 118, 121, 127, 136, 142.
Squalls, origin of, 204; short duration of, 281.
Stabiae, 221. Small town on coast of Campania.
Stars, fed by emanations from the earth, 55, 198, 244; influence of, in human affairs, 81; nature of, 273; transits of, 284; supposed small size of, 288; place of, in sky, 297; varying colours of, 300.
Stars, falling, 10, 11, 37, 99, 296.
Statonia, 139. Town in Etruria, about 15 miles from the coast.

Stoics, 32, 40, 58, 66, 95, 119, 124, 135, 151, 180, 181 (2), 210, 251, 291, 292, 293, 295 (my school).
[a] Strato, 240. Succeeded Theophrastus as head of the Peripatetic school in 288 B.C. Native of Lampsacus in Mysia on the Hellespont.
Streaks in the sky, 33.
Strymon, 5. River of Thrace and Macedonia (Struma). The text of the passage is very doubtful.
Styx, 137. River in Arcadia.
Submergence of Helice and Buris, 254, 257, 259, 267, 276, 289; of Atalanta, 256; of Sidon, 256; of other cities and nations, 267.
Subsolane (Wind), 209.
Sudd, 236 n.
Sulphur, baneful effects of, in water, 134; supposed to warm water, 136; exists in large quantity underground, 206.
"Sulphur smell" produced by lightning, 69, 97.
Sun, size of, 20, 288; eclipse of, 35, 274, 284, 293; draws his sustenance from the earth, 55, 198, 244; movements of, 271; among the constellations, 301.
Superstition, 271.
Surrentum, 221. Town on promontory in Campania.
Syracuse, 12, 142.
Syria, 138, 288.

Tempe, 137. Vale or gorge in Thessaly; *see* Peneüs.
Temperature of atmosphere, 60, 183, 184; of various waters, 136.
Tension, effects of, 56, 58.
Tentyra, 172. Island in the Nile (Denderah), not far from Thebes.
[a] Thales, 124, 125, 174, 233. Of Miletus; may be considered the father of Greek philosophy, 636-546 B.C.
Thebes, 257. Capital of Boeotia. There was a more ancient city of the same name in Upper Egypt on whose site are the modern Luxor, Karnak, etc.
[a] Theophrastus 122 (3), 129, 138, 139, 141, 172, 240, 303. Of Lesbos, favourite pupil and successor of Aristotle, head of Peripatetic school, 322-287 B.C.
Therasia and There (Thera), 252. Small volcanic islands in the group called Sporades, S. of Cyclades.
Thessaly, 137, 257.
Thrace and Thracians, 5, 161, 173, 254.
[a] Thucydides, 256, 258.
Thunderings, 62, 67; different kinds of, 75; causes of, 98.

Tiberius Caesar, 41.
Tigris, 142, 235.
Time, wasting influence of, 238, 253; fleetingness of, 268.
Trade to Atlantic ports, 175.
Transmutation of the elements, 120, 121.
Troglodytes, 173. Cave-dwellers, specially applied to tribes on W. of Red Sea.
Tuscans; *see* Etruscans.
Tyre and Tyrian, 27, 224, 225.

Unity or continuity, defined, 53.
Universe, defined, 54; impetuous whirl of, 273; ceaseless revolution of, 281, 294, 299; a harmony of discords, 301.

Vacuum, non-existent in nature, 128.
Vadimonian (Lake), 139. In Etruria, not far from the Tiber, the Lago di Bassano, now dried up.
[a] Vagellius, 227. Name unknown, probably corrupt.
Valerius Asiaticus, 74. Consul, for the second time, in 46.
[a] Varro, 209 (2). Famous grammarian, antiquarian, etc., 116-28 B.C.
Venus, the planet, 284.
Vice, conquest of, leads to highest happiness, 5; continued progress of, 46, 187, 306, 307.
[a] Virgil, 28, 35, 114, 142, 165, 209, 241, 253, 258.
Virginius, 221. Consul 63.
Vitellius, 160. Name doubtful; may refer to father of Emperor Vitellius, who flourished under Caligula and Claudius, being consul in 34.
Volcanic eruptions, 73, 74, 77, 252.
Vopiscus, 303. Consul 60.
Vultur, 209. Mountain on borders of Apulia.
Vulturnus (Wind), 209.

Wars, denunciation of, 213, 214.
Water, forms of, 114, 115, 233; transformed into air, 120; formed from earth, 120; as one of the four elements, 124; Thales' opinions on, 124, 231; underground sources of, 126, 233, 234, 235; various tastes of, 133; petrifying powers of, 133; varying temperatures of, 136; artificial heating of, 136; baneful kinds of, 137; dyeing properties of some kinds of, 137; varying densities of, 138; supposed physiological effects of some, 140; in mines, 154; produces animal and plant life, 197; as the cause of earthquakes, 231, 233, 234.

Watergalls and sun-dogs, 33.
Weather indications, 11, 14, 15, 28, 37, 39, 75, 181, 275, 302, 303.
Wells and their water-supply, 118, 123, 128; warm winter temperature of, 176, 241.
Whirlwinds, 204, 275, 276, 278, 279, 280, 281, 282.
Will, freedom of the, 85, 86.
Wind, definition of, 193; Democritus' view of origin of, 194; origin of, 196, 200, 203, 204; within the earth, 205, 206, 239, 243, 244; number and names of the winds, 208-212; teleological design of, 212, 216; misuse of, by man, 216; beneficial influences of, 216; disruptive energy of, 252.
Winds, 208-211. The following are specified: Africus, Aquilo, Argestes, Atabulus, Auster, Ἀφηλιώτης (= Subsolane), Boreas, Cataegis, Circius, Corus, Etesian, Euronotus, Eurus, Favonius, Iapygian, Καικίας, Libonotus, Libyan, Notus, Scironian, Septemtrio, Subsolane, Thracias, Vulturnus, Zephyrus.
Wine, frozen by lightning, 79, 97.
World, revolution of, 20.

[a] Zeno, 291. Native of Cyprus, founder of the Stoic philosophy, lived between middle of fourth and third centuries B.C.
Zephyrus (Wind), 208.
Zodiac, 285, 291, 296.

THE END

Printed by R. & R. Clark, Limited, *Edinburgh.*

PLEASE DO NOT REMOVE
CARDS OR SLIPS FROM THIS POCKET

UNIVERSITY OF TORONTO LIBRARY

Q
151
S4

Seneca, Lucius Annaeus
Physical science in the time of Nero

Physical &
Applied Sci.