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* and **: See the Note to the Reader

ON PLANTS **

E. S. Forster

BOOK I

1 · Life is found in animals and plants; but while in animals it is clearly 815ª10
manifest, in plants it is hidden and not evident. For before we can assert the
presence of life in plants, a long inquiry must be held[1] as to whether plants possess a
soul and a distinguishing capacity for desire and pleasure and pain. Now Anaxago-
ras and Empedocles say that they are influenced by desire; they also assert that they 15
have sensation and sadness and pleasure. Anaxagoras declared that plants are
animals and feel joy and sadness, deducing this from the fall of their leaves; while
Empedocles held the opinion that sex has a place in their composition. Plato indeed 20
declares[2] that they feel desire only on account of their compelling need of
nutriment. If this be granted, it will follow that they also feel joy and sadness and
have sensation. I should also like to reach some conclusion as to whether they are
refreshed by sleep and wake up again, and also whether they breathe, and whether 25
they have sex and the mingling of the sexes or not. But the great diversity of opinion
on these subjects involves too long an inquiry, and the best course is to pass over
these topics and not to waste time on the unprofitable investigation of details. Some 30
have asserted that plants have souls, because they have seen that they are generated
and receive nutriment and grow, and have the bloom of youth and the dissolution of
old age—characteristics which nothing inanimate shares with plants; if plants
possess these characteristics, they believed them also to be affected by desire. 815ᵇ10

Let us first examine their obvious characteristics, and afterwards those which
are less evident. I say that whatsoever takes food desires food, and feels pleasure in
satiety and pain when it is hungry, and that these dispositions do not occur without
the accompaniment of sensation. The view of Plato, then, who held that plants have
sensation and desire was remarkable, but not unsound; but Anaxagoras and 15
Democritus and Empedocles declared that they possessed intellect and intelligence.
These views we must repudiate as unsound and pursue a sane statement of the case.
I assert, then, that plants have neither sensation nor desire; for desire can only 20

TEXT. J. Bussemaker, *Aristotelis Opera Omnia,* Vol. IV, Firmin-Didot, Paris, 1878
[1]Omitting *constaret enim.*
[2]See *Timaeus* 77AC.

proceed from sensation, and the end proposed by our volition changes in accordance with sensation. In plants we do not find sensation nor any organ of sensation, nor any semblance of it, nor any definite form or capacity to pursue objects, nor movement or means of approach to any object perceived, nor any sign whereby we may judge that they possess sense-perception corresponding to the signs by which we know that they receive nutriment and grow. Of this we can only be certain because nutrition and growth are parts of the soul, and when we find a plant to be possessed of such a nature, we perceive of necessity that some part of a soul is present in it which lacks sensation; but we ought not to allow that a plant is a thing possessed of sense, because while sensation is the cause of the glorification of life, nutrition is the cause of growth in the living thing.

These differences of opinion come into consideration in their own proper place. It is certainly difficult to find a state intermediate between life and the absence of life. Some, too, will urge that a plant, if it be alive, is therefore an animal; for it is difficult to assign any principle to the life of plants except that of the life of nutrition. But, when men deny that plants have life, they do so because plants do not possess sensation—for there are certain animals which lack foresight and intelligence. For nature, which destroys the life of the animal in death, preserves it in the continuation of its kind by generation, and it is wrong for us to suppose any intermediate state between the animate and the inanimate. We know that sea-shells are animals which lack foresight and intelligence and are at once plants and animals. The only reason, therefore, for their being called animals is that they have sensation; for genera give names and definitions to the species which fall under them, while the species give names to the individuals, and the genus ought to rest on a common cause present in the several individuals and not on several causes; but the nature of the cause, on which the genus is based, is not familiar to every one. Now there are animals which have no female sex, and some which do not procreate their kind, and some which lack the power of movement, and some in which the colour varies, and some which produce an offspring unlike themselves, and some which grow from the earth or from trees.

What, therefore, is the principle of life in animals? What is it that raises the noble animal, i.e. that which surrounds the heavens, the sun and the planets, from the sphere of perplexity and doubt? For the heavenly bodies feel no outside influence, and sensation is an effect produced on a sentient being. Now a plant has no movement of itself, for it is fixed in the earth, which is itself immovable. Whence, then, shall we infer any similarity which may enable us to attribute life to the plant? For there is no one thing which includes all of them. We therefore assert that sensation is common to all animal life, because sensation marks the distinction between life and death; but the heavens, which pursue a nobler and more sublime path than we do, are far removed from life and death. But it is fitting that animals should have[3] some common characteristic perfect in itself but less sublime, and this is the acquisition and deprivation of life. And one ought not to shrink from the use of these terms on the ground that there is no mean between the animate and the

[3]Reading *habeat*.

inanimate, between life and the deprivation of life; indeed, there is a mean between life and the inanimate, because the inanimate is that which has no soul nor any portion of it. But a plant is not one of those things which entirely lack a soul, because there is some portion of a soul in it; and it is not an animal, because there is no sensation in it, and things pass one by one gradually from life into non-life. We can 816b1
put the matter in a different way and say that a plant is animate. I cannot, however, assert that it is inanimate as long as it possesses soul and some form of sensation; for that which receives food is not entirely without soul. And every animal has soul, but 5
a plant is imperfect, and, whereas an animal has definite limbs, a plant is indefinite in form, and a plant derives its own particular nature from the motion which it possesses in itself. Someone might say that a plant has soul, because the soul is that which causes locomotion and desire to arise, and locomotion can only arise when 10
sensation is present. But the absorption of food is in accordance with a natural principle, and is common both to animals and plants, and no sensation at all will accompany the absorption of food; for everything that absorbs food employs two 15
qualities in feeding, namely, heat and cold, and an animal properly requires moist food and dry food, for coldness is always found in dry food; for neither of these two natures is ever unaccompanied by the other. And so food is continuously being sup- 20
plied to that which feeds on it till the time when it begins to decay, and animals and plants have to be provided with food similar in kind to themselves.

2 · Let us now investigate what we have already mentioned, namely, desire in plants, their movement, and their soul and its function. A plant has not 25
respiration, although Anaxagoras declared that it has; and we even find many animals which have not respiration. We can see by ocular demonstration that plants do not sleep and wake, for waking is due to an effect of sensation, and sleeping is an 30
enfeebled condition of sensation, and nothing of this kind is found in that which vegetates at all times in the same condition, and is itself naturally without sensation. When an animal takes food, a vapour rises from the food into its head and it falls asleep, and, when the vapour which rises to its head is consumed, it wakes up. In 35
some animals this vapour is plentiful and yet they sleep but little. Sleep is the suppression of motion and this involves the quiescence of the thing moved.

The most important and appropriate subject of inquiry which arises in this 817a1
science is that proposed by Empedocles, namely, whether female and male sex is found in plants, or whether there is a combination of the two sexes. Now we assert[4] that when the male generates it generates *in* another, and when the female generates it generates *from* another, and both are mutually separate. This is not 5
found to be the case in plants; for in a particular species the produce of the male plant will be rougher, harder, and stiffer, while the female will be weaker but more productive. We ought also to inquire whether the two kinds are found in combina- 10
tion in plants as Empedocles states that they are. But my opinion is that this is not the case, for things which mingle together ought first to be simple and separate, and so the male will be separate and the female separate; they afterwards mingle, and

[4]Omitting *sicut diximus*.

the mingling will only take place when it is produced by generation. A plant, therefore, would have been discovered before the mingling had taken place, and it ought therefore to be at the same time an active and a passive agent. The two sexes cannot be found combined in any plant; if this were so, a plant would be more perfect than an animal, because it would not require anything outside itself in order to generate; whereas the plant *does* require the right season of the year and sunshine and its natural temperature more than anything. Thus it requires them at the time when the tree sprouts, and while the nutritive principle in plants is derived from the earth, the principle which generates seeds is derived from the sun. Hence Anaxagoras said that the seeds of plants derive from the air, and others call[5] the earth the mother and the sun the father of plants. But we must suppose that the mingling of the male and the female in plants takes place in some other way, because the seed of a plant resembles the embryo in animals, being a mixture of the male and female elements. And just as in a single egg there exists the force to generate the chicken and the material of its nutriment up to the time when it reaches perfection and emerges from the egg, and the female lays the egg in a short space of time; so too with the plant. And Empedocles is right when he said the tall trees do not bear their young; for that which is born can only be born from a portion of the seed, and the rest of the seed becomes at first the nutriment of the root; and the plant begins to move as soon as it is born. This, then, is the opinion which we ought to hold about the mingling of the male and female in plants, similar to that which we hold about animals. This process is the cause of plants under a certain disposition of circumstances; for in the case of an animal when the sexes mingle the powers of the sexes mingle after they have separated, and a single offspring is produced from them both. But this is not the case with plants. And if nature has mingled the male and the female together, she has followed the right course; and in plants the only operation which we find is the generation of fruits; and an animal is only separated at the times when it is not having sexual intercourse, and this separation is due to its multifarious activities and intellectual pursuits.

But there are some who hold that the plant is complete and perfect because of its possession of these two powers, and because of the food which is adapted to feeding it, and the length of its existence and duration. When it bears leaves and fruit its life will continue and its youth return to it. No excrement will be produced from plants. A plant does not require sleep for many reasons, for it is placed and planted in the earth and attached to it and has no movement of itself; nor has it any definite bounds to its parts, nor does it possess sensation or voluntary motion, or a perfect soul; indeed it has only part of a soul. Plants are only created for the sake of animals, and animals are not created for the sake of plants. Some one will urge that a plant requires food which is easily obtained and poor, yet it needs it very regularly and continuously, and without interruption. If it were agreed that a plant has an advantage over an animal, it would follow that things which are inanimate were better and nobler than those which are animate; yet we see that the function of the animal is nobler and better than all those of the plant, and we find in the animal all

[5]Reading *dicunt alii* for *dicit lechineon.*

the virtues which are present in the plant and many others. Empedocles said that plants had their birth when the world was yet small and its perfection not attained, while animals were born after it was completed. But this account does not suit the facts, for the world is a whole, perpetual and eternal, and has never ceased to produce animals and plants and all their species. In every kind of plant there is 818ª1 natural heat and moisture, and, when these are consumed, the plant will become weak and grow old and decay and dry up. Some people call this corruption, others do not.

3 · Some trees contain a gummy substance, such as resin and almond-gum and myrrh, and frankincense, and gumarabic. Some trees have knots and veins and core and wood and bark and marrow within them; some trees consist almost wholly of bark. In some the fruit is underneath the bark, that is, between the bark and the wood. Some parts of the tree are simple, such as the moisture found in it and the knots and veins; other parts are compounded from these, such as the branches and twigs and the like. These are not all found in all plants; for some have composite and some simple parts, while others do not have them. Plants possess various other parts as well—roots, twigs, leaves, branches, flowers, catkins, tendrils, and bark surrounding the fruit.

Just as in the animal, so also in the plant there are homogeneous parts, and all the composite parts of a plant are like the members of an animal: the bark of a plant resembles the skin of an animal, while the root of a plant is like the mouth of an animal, and its fibres are like an animal's sinews, and so with its other parts. Any of these parts can be divided on one principle into similar parts, or a division can be made by dissimilar parts (just as mud can be divided in one way into earth only and in another into water; similarly the lungs and flesh can be divided up on one principle so that they are pieces of flesh, while on the other principle they can be divided into their elements or radical parts). But a hand cannot be divided up into another hand, nor a root into another root, nor leaves into other leaves; but these roots and leaves are themselves the result of composition. Some fruits are composed of few parts, some of many—olives, for example, which are made up of bark and flesh and a shell and a seed. Some fruits[6] have as many as three coverings. All seeds have two barks. We have now mentioned the parts of which individual plants consist. The aim of our discussion is to determine the parts of the plant and its coverings and its variations—this is very difficult—and in particular, to define its essential nature and its colour, and the period of its duration, and the effects which are produced upon it. Plants have not fixed habits of mind and the power of action 818ᵇ1 like that possessed by animals; and if we compare the parts of an animal with those of a plant, our discussion will be a long one, and we shall hardly avoid considerable differences of opinion in naming the parts of plants. For a part of a thing is of its own kind and of its own particular substance, and, when it is once produced, each kind will remain in its original condition, unless it departs from it owing to some long continued infirmity. Flowers, fruits, and leaves will, in some cases, be produced

[6]Reading *semen. et fructus quidam.*

annually, in others they are not, nor do they remain as the bark does . . .[7] This does not happen in plants; for various undetermined parts of plants are often shed (like hair in the case of man and claws in the case of animals), and in their stead other parts grow either where the lost parts were, or elsewhere in some other place. It is clear from this that it is not determined whether the parts of a plant are really parts or not. It is wrong for us to say that those things with which an animal grows and by which it reaches completion are not parts of it; but the leaves and everything that is found in a plant[8] are parts of that plant, although they are not determined and are gradually shed; for the antlers of a stag and the hair of certain animals, and the fur of certain of those which hibernate in hollows underground, fall off, and this process resembles the shedding of leaves.

We ought, therefore, to treat of the subjects which we mentioned first, and begin to name the parts which are peculiar to certain plants and those which are common to all, and their differences. Let us say, therefore, that there is a great diversity in the parts of plants in respect of number and fewness, largeness and smallness, and in respect of strength and weakness. The reason of this is that the moisture which is found in large trees, is in some trees, the fig, for example, like milk, in others it is like pitch, as in the pine, in others it is watery, like the liquid found in the vine, in others it is acrid, like that found in marjoram and in the herb called opigaidum. There are also plants which have their parts dry. Some plants have their parts well defined, and neither alike nor equal in size; others have parts which are similar to one another but not equal, in others they are equal but not
819*1 similar, and their position is not fixed. The differences of plants are recognized in their parts—differences in form and colour and sparseness and density and roughness and smoothness, and all their incidental differences in equality of size, numerical increase and decrease, largeness and smallness. Some plants, too, will not be uniform, but will show great variation, as we have already said.

4 · Some plants produce their fruit above their leaves, others beneath; in some plants the fruit is suspended from the stock of the tree, in others it grows from the root, as in the Egyptian trees which are called vargariaton; in some cases it grows in the middle of the plant. In some plants the leaves and knots are not separated; in others the leaves are equal in size and similar to one another, and some of those which have branches have branches equal in size. The following parts, which we will name, are found in all plants, and admit of growth and addition—namely, the root, the shoots, the stem, and the branches; these resemble the limbs of animals which include all the other limbs. The root acts as an intermediary between the plants and its food, and for that reason the Greeks call it the root and cause of life in plants, for it supplies the plant with the cause of life. The stem is the only part which grows out of the ground and forms and is like the stature of a tree. The suckers are the parts which sprout from the root of a tree, while the branches are

[7]The next sentence is unintelligible: *et corpus cadens aere abiciente ipsum propter causam.*
[8]Reading *illa.*

above the suckers. They are not found in all plants; and in some plants which have branches these are not permanent, but only last from year to year. There are plants which do not have branches or leaves, fungi, for example, and mushrooms. Branches are only found on trees. Bark and wood and the pith of a tree are produced from moisture; some call this pith the womb of the tree, others the viscera, others the heart. The knots and veins and flesh of the whole plant are made up from the four elements. Parts are often found which are adapted to reproduction, leaves, for example, and flowers and small twigs (which are flowers outside the plant); similarly with the fruit and leaves of a plant, and what is produced from the seed and the shell which surrounds it.

Of plants some are trees, some are midway between trees and herbs and are called bushes, some are herbs, and some are vegetables. Almost every plant falls under one of these names. A tree is a plant which has a stem growing from its root, from which stem numerous branches grow, olive-trees, for example, and fig-trees. A plant which is something between a tree and a small herb, and is called a bush, has many branches growing out of its roots, like the thorntree and bramble. Vegetables are plants which have a number of stems growing out of one root and a number of branches, rue, for example, and cabbage. Herbs are plants which have no stem, but their leaves grow out of their roots. Some plants are produced and dry up every year, wheat, for example, and vegetables. We can only indicate these various classes of plants by general inferences, and by giving examples and descriptions. Some plants verge towards two extremes, mallow, for example (since it is both a herb and a vegetable), and likewise beet. Some plants grow at first in the form of low bushes and afterwards become trees, as, for instance, the nut-tree, the chaste-tree, and the plant called 'goatberry'. Perhaps myrtles, apple-trees, and pear-trees fall also under this class, for all of them have a number of superfluous stems growing from their roots. It is worth while to specify these that they may serve for purposes of example and inference, but we must not investigate the definitions of every kind of plant.

Some plants are indoor plants, others garden plants, and others wild, in the same way as animals. I think, too, that all species of plants which are not cultivated become wild. Some plants produce fruit, others do not; some produce oil, others do not; some have leaves and not others; some plants shed their leaves, others do not; some have branches, others do not. Plants differ greatly in their large or small size, in beauty and ugliness, and in the excellence, or the contrary, of their fruits. Trees in a wild state bear more fruit than garden trees, but the fruit of the garden tree is better than that of the wild. Some plants grow in dry places, some in the sea, others in rivers. Plants which grow in the Red Sea will there reach a great size, whereas they are only small in other places. Some plants grow on the banks of rivers, others in standing water. Of plants which grow in dry places, some grow on mountains, others in the plain; some plants grow and flourish in the most arid districts, as, for example, in the land of the Ethiopians which is called Zara, and increase there better than anywhere else. Some plants live at high altitudes, some on moist ground, others in dry, others equally well in either, as, for instance, willow and tamarisk. A plant changes very much with a difference of locality, and such variations must be taken into consideration.

5 · A plant which is fixed in the ground does not like to be separated from it. Some places are better for certain plants than others; similarly some fruits are better in one place than in another. In some plants the leaves are rough, in others smooth; in some they are small, in others they are cleft as in the vine. Some trees have a single bark, as the fig, others have several layers of bark, as in the case of the pine; some are bark throughout, as, for example, the mediannus. Some plants have joints, reeds, for example; some have thorns, like the bramble. Some have no branches, others have a great number, like the sycamore. Other plants show various differences; for instance, suckers grow from some and not from others; this can only be due to a difference in the root. Some plants have a single root only, the squill for example; for it grows in a single shoot and spreads by expansion underground, and will increase as it grows more and more and approaches the sunlight, because the sun draws out its shoots.

Of the juices which are found in fruits, some are drinkable, as, for instance, the juice of grapes, pomegranates, mulberries, and myrtles. Some juices are oily, as in the olive and pine-nut; others are sweet like honey, as in the date and fig; others are hot and pungent, as in marjoram and mustard; others bitter, as in wormwood and centaury. Some fruits are made up of a fleshy and a bony substance and a seed, plums for example; others, cucumbers for instance, are made up of a fleshy substance and seeds, others of moisture and seeds like the pomegranate. Some have rind outside and flesh inside, others flesh outside and seed inside; in others one
820[b]1 comes immediately upon the seed with the envelope which encloses it, as in dates and almonds; in others this is not so. Fruits are edible or inedible accidentally, and some people can eat certain fruits while others cannot, and certain animals can eat certain fruits while others cannot. Some fruits, again, are in pods, like seeds; others in sheaths, like[9] weapons, wheat for example; others are enclosed in a fleshy substance, dates for instance; others in husks, acorns for example, and some in several husks, a cuticle and a shell, nuts for example. Some fruits mature quickly, like mulberries and cherries, others slowly, as do all or most wild fruits. Some plants produce their leaves and fruits quickly, others slowly—and of these some wait for the winter before coming to maturity. The colours of fruits and flowers vary very much. One plant is green throughout, another has a tendency to blackness, another to whiteness, another to redness. Also the conformation of the fruit, if it be wild, varies considerably; for all fruits are not angular, nor do they take the form of straight lines.

6 · In aromatic trees it is sometimes the root which is aromatic, sometimes the bark, sometimes the flower, and sometimes the wood; in other cases every part is aromatic, in the balsam for example.

Some trees come into existence by being planted, some from seeds, others spontaneously. Those which are planted are separated either from the root, the stem, the branches, or the seed, or else the whole is transplanted; some are slightly bruised before being planted. Some are planted in the earth again, others are

[9]Reading *ut tela*.

planted, that is, grafted, on other trees. It is better to graft on trees which are similar and have the same proportions; the best results are obtained in the grafting, for instance, of apple on pear, fig on fig, or vine on vine. Sometimes grafting of different species is resorted to, bay, for example, on wild plane, olive-trees on terebinth, mulberries on a number of different trees, and wild trees on garden trees. 821[a]1 Every plant does not produce a seed similar to that from which it is sprung; some produce a better seed, others a worse, and good trees sometimes grow from bad seeds, as in the case of bitter almonds and pomegranates. In some trees too, when they are weak, the seed fails, in the pine for example, and the palm. But a good plant is not likely to be produced from a bad seed, nor a bad tree from a good seed. This often occurs, however, among animals.

A tree which has hard bark and has become barren, if its root be split and a stone inserted in the cleft will become fruitful again. In palms too, if the leaves or pollen or bark of the male palm be applied to the leaves of the female palm so as to cohere,[10] its fruits will come to maturity quickly, and it will prevent their falling off. The male can be distinguished from the female palm, because it sprouts first and its leaves are small, and also because of its odour; sometimes all these conditions are present, sometimes only some of them. It will perhaps happen that the wind will bear the odour of the male to the female palm, and then the dates will come to maturity; the foliage of the male will also cohere to that of the female palm when they catch in one another. Wild fig-trees, too, spread along the ground and contribute to garden fig-trees; similarly wild olives contribute to olives, when they are planted together.

7 · Again, some plants change into other species, the nut-tree, for example, when it becomes old. It is also said that catmint changes into mint, and basil, if plucked up and planted by the Persian Gulf, will perhaps turn into thyme. Also wheat and flax change into tares. The poisonous nightshade which grows in Persia changes its nature if transplanted into Egypt and Jerusalem and becomes edible. Almond-trees and pomegranates change their condition for the better under cultivation. Pomegranates are improved by being manured with pigs' dung and watered with fresh cold water. Almond-trees with pegs driven into them exude gum for a long while. Many wild plants are thus artificially changed into garden plants. 821[b]1 Position and care, and, above all, the season of planting, contribute to this process. Some plants require some one to plant them, others do not. Most plants are planted in the spring, a few in the winter and autumn, very few in the summer after the rising of the dogstar; planting at this season takes place in few places—nowhere except in the Crimea. In Egypt planting only takes place once in the year.

Some trees produce leaves from their roots, some from their buds, some from the wood, others from every part. In some they are near the ground, in others far from it, in others they are neither high nor low; others produce a few leaves at various times. Some trees bear fruit once a year, others several times, and their fruit does not mature, but remains unripe. Certain trees are very fruitful over a long

[10]Reading *cohaereant*.

period, as, for instance, fig-trees. Some bear fruit one year and then recuperate for a year, as do olive-trees, although they produce a number of boughs which cover them. Some trees are more productive when they are young than when they are old; others, on the contrary, are more fertile when they are old, almond-trees, for example, and pear-trees and holm-oaks. Wild and garden plants can be distinguished by virtue of the male and female, each being recognizable by its peculiar characteristics; for the male is thicker and harder and has more branches and less moisture and a smaller fruit, and does not reach such maturity; the leaves, too, and likewise the suckers are different.

In considering this we should form some conjectures whereby we may know trees and their seeds apart, and similarly in the case of small herbs. We must consider what the ancients have said on these points, and examine the works written upon them. We shall only be able to take a brief survey and extract the essence of them. This means that we shall consider those plants which contain oil, those which produce seeds, and those which produce wine, and plants which have medicinal properties, and those which destroy life. All these particulars about trees and plants are well known. But in order to know their causes, we ought to inquire into their production, and discover why certain plants grow in certain places and not in others, and at certain seasons and not at others; we must examine their methods of planting, their roots, their differences of sap and odour and juice and gum, and the
822a1 excellence and defects of particular plants, and the fact that the fruits of some trees last but not those of others, and why some fruits putrefy quickly, others more slowly. We must inquire into the properties of all plants, and particularly those of their roots; and why some fruits grow soft while others do not; and why some arouse lust, others cause sleep, and others are fatal to life; and many other differences; and why the fruits of some produce milk, of others not.

BOOK II

1 · A plant has three powers, the first derived from the element of earth, the second from that of water, the third from that of fire. From the earth the plant derives its fixity, from water its solidity, and from fire the unity of its fixity. We see much the same thing in vessels of pottery, which contain three elements—clay, which is, as it were, the material of pottery; secondly, water, which binds the pottery together; and, thirdly, fire, which draws its parts together, until it completes the process of manufacture. The appearance, then, of complete unity is due to the fire; because rarity is present in pottery according to the composition of its parts, and, when the fire heats them, the moist matter is completed, and the parts of the clay will cohere together. Dryness will thus take the place of moisture, owing to the predominance of the fire and the process of concoction which takes place in all animals, plants, and metals. For concoction takes place where moisture and heat are present, when the struggle between them is allowed to run its course; and this is what will take place in the concoction of stone and metals. It is not so in animals and

plants; for their parts are not closely compacted, and so there is an escape of moisture from them. But in metals there is no such escape of moisture or sweating, because their parts have no rarity, and therefore they can give up nothing except parts of themselves to correspond to certain residues which are given off by animals and plants. This escape of moisture can only take place where rarity is present; and so where there is no rarity, nothing at all can be given off. Therefore that which cannot be increased is solid, because that which can increase requires space in which to dilate and grow; and therefore stones, salt, and earth are always the same, neither increasing nor growing. There is motion in plants in a secondary sense, and this is a form of attraction, namely, the force of the earthly element which attracts moisture; in this attraction there will be motion, and the moisture makes for a certain position, and the process of concoction is thus in a certain way completed. And so small plants usually come into being in the short space of a single day, unlike animals; for the nature of animals is in itself different; for no concoction will take place except by the use of material in the animal itself. But the material of which the plant is formed is near at hand, and therefore its generation is quick, and it grows and increases, because it is rare, more quickly than if it were dense. For that which is dense requires many powers on account of the diversity of its form and the extension of its parts in relation to one another. Consequently the generation of a plant is quicker on account of the similarity of its parts to one another, and the completion of its growth is speedier. Now the parts of plants are usually rare, because the heat draws the moisture into the extremities of the plant, and the material is distributed through all its parts, and that which is superfluous will flow away; just as in a bath the heat attracts the moisture and turns it into vapour which rises, and, when it is present in superfluity, it will turn into drops of water. Similarly in animals and plants, the superfluities ascend from the lower into the upper parts and then descend in their action from the upper to the lower parts.

We find the same phenomenon in streams which are generated underground and come forth from mountains, and whose material is rain. When the waters increase and are confined within the earth, an excess of vapour will be produced from them on account of their compression underground, and the vapour will break its way through the earth and fountains and streams will appear, which were formerly hidden.

2 · We have set forth the causes which produce springs and rivers in the book on *Meteorology*. An earthquake frequently discloses springs and rivers which had not before been visible, when the earth is rent by vapour. We also often find that springs and rivers are submerged when an earthquake takes place. But this does not happen in the case of plants, because air is present in the rarity of their parts. This is indicated by the fact that an earthquake never takes place in sandy localities, but only where the ground is hard, that is in districts of water and mountains. Earthquakes occur similarly in these districts, because water and stone are solid, and it is the nature of warm, dry air to ascend. When, therefore, the particles of air become massed together, they gain force and thrust up the ground and the vapour

makes its way out; whereas, if the ground were rare, the vapour would make its way out gradually from the first. But the ground being solid, it does not make its way out gradually, but its parts collect, and it is then strong enough to rend the earth. This, then, is the cause of earthquakes in solid bodies; there will, therefore, be nothing to correspond to an earthquake in the parts of plants and animals, though it will occur in other things—often, for example, in pottery and glass, and in some cases in minerals. Any body which has considerable rarity tends to rise upwards, for the air supports it. This we often see when we throw a gold coin or some other heavy substance into the water and it immediately sinks; whereas if we throw in a piece of wood, which has rarity in it, it does not sink. A gold coin sinks not because of its leaf-like form nor on account of its weight, but because it is solid. That which has rarity can never altogether sink. Ebony and similar substances sink because there is very little rarity in them, and therefore there will not be air present to support them; and so they sink, because their parts are practically solid. Oil and leaves always float on the surface of water. We will now prove this. We know that heat and moisture are present in these substances; and it is characteristic of moisture to cohere with particles of water, while it is characteristic of heat that it causes things to rise and makes its way towards the particles of air; and it is the habit of water to raise objects to its surface, and of air to rise upwards; and water does not rise above its surface, because the whole surface of the water is one and the same, and consequently the air rises with the oil above the water. Some stones too float on
823[b]1 water, because rarity is present in them and is greater in quantity than the matter of which they are formed, and consequently[11] the space occupied by air will be greater than that occupied by the earthly element. It is the nature of water to take up a position above the earth, and of air to rise above water; the material, therefore, which composes the stone, which is of the element of earth, sinks in the water, while the element of air enclosed in the stone rises above the water. Each element therefore attracts its like in a contrary direction to the element with which it is combined. If, then, one element is equal to the other, half the stone will be submerged and half will project above the surface; but if the air is present in greater quantity, the stone will float above the water. The weight of trees is made up in the same way. (These stones are due to a violent collision of waves, and are originally foam which forms an oily milk; when the wave is dashed against the sand, the sand will collect the oily foam, and the dryness of the sea will dry it up together with the superfluous salt, and the particles of sand will collect, and thus in the long process of time stones will be formed.)

The presence of sand under the sea is explained by the fact that earth always has a fresh flavour, and when water stands it will be prevented from undergoing any change, and will form an enclosed mass of water in the place where it is, and the air will not draw it up; the particles of earth, therefore, gain the upper hand and become salty, and gradually acquire heat. (Now soil is found in its natural state in fresh running water, because there the water is sweet and light.) And because the dryness of the earth gains the upper hand in the water, it changes it into an earthy

[11]Reading *ideo* for *idem*.

nature, or something like it, and makes both the earth and water crisp; and this process of drying goes on as long as the earth remains in its place and there is water still left, and it splits up the soil into small particles; and for this reason the earth near the sea is always sandy. The same thing happens on plains which have nothing to protect them from the sun, and which are far from fresh water; the sun has dried up the particles of fresh moisture and that which is of the nature of earth has remained; and because the sun shines continually upon an exposed place of this kind, the parts of the soil become separated and sand is thus formed. A further sign of this is that if we dig deep down in a desert, we shall find natural soil. Natural soil, therefore, will be the basis of sand, and will only become sand accidentally and under certain circumstances, namely, when the sun's rays dwell on it for a long time and it is far removed from fresh water. The saltness of the sea is to be accounted for in a similar way; for the basis of all water is fresh water, and saltness is accidental, occurring only under the circumstances which we have mentioned. The fact that the earth is below the sea and the sea naturally and necessarily above the earth is a self-evident proof of this. Some, however, have held that the common element is that which is present in the greatest quantity, and that there is a greater quantity of water in the sea than elsewhere, and that, therefore, sea-water is the element present in all water. But water naturally has its position above the earth and is lighter than it; for we have already shown that water is at a higher elevation than the earth according to the altitude at which the mass of water stands. Let us take two vessels of the same size and place fresh water in one and salt water in the other; then let us take an egg and place it in the fresh water; it will sink, whereas, if we place it in the salt water, it will float. It therefore rises above the particles of salt water because these particles do not let it sink,[12] as do those of fresh water, but they can uphold the weight, which therefore does not sink. So in the Dead Sea no animal can sink, nor is any animal life produced in it, because dryness predominates in it and it is like the form of earth. It is clear, therefore, that dense water finds a lower level than water which is not dense; for the dense is of the nature of earth, the rare of the nature of air; therefore, fresh water stands at a higher elevation than any other water, and is therefore further removed from earth. Now we already know that the water which is furthest removed from earth is the natural water, and we have shown that fresh water is higher in position than all other kinds of water; as this sign shows, then, it certainly and necessarily is the natural water. Salt water is also produced in pools, because fresh water becomes salt. The saltness, therefore, of the earth prevails over that saltiness, and the air will remain enclosed, and the mass of water will not therefore be fresh. Saltness may also be produced from water by being given off from it like sweat.

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3 · So too in the case of plants: their species will be formed, not from a simple element, but by a process of composition, just as saltness and the substance of sand are formed from the water of the sea. For vapours which rise, when they become solidified, will be able to conceive these plants, and the air will descend and bedew

[12]Reading *mergunt*.

the ground, and from it will come forth the form of their seeds through the powerful influence of the stars. But plants must necessarily have some material, and this material is water. There are, however, different kinds of water, and water only rises if it is fresh, and salt water is heavier than fresh; and so that which rises above water is rarer than water. When, therefore, the air draws it up, it will become rarefied and rise still higher; and this is why fountains and streams are formed in mountains. Similarly phlegm and blood rise to the brain, and all foods also rise; so too all water rises. Even salt water rises in that part of it which heat dries out into the element of air, and, because air is always higher than water, that which rises above salt water is fresh. We often find the same thing taking place in baths. When heat takes hold of salt water, its parts will be rarefied, and vapour will rise in a contrary direction to the depth of the bath, and the particles of salt and the natural moisture become separated, for the latter is of the nature of air and follows the vapour; and cloud after cloud of vapour rises upwards, and when they reach the roof they press upon it. The vapour will thus collect and become condensed, and will turn into drops of fresh water dripping down, and so in salt baths the vapour will always be fresh.

Plants ought not to grow in salt water, on account of its low temperature and dryness. This is because a plant needs two things—its proper material and a position suitable to its nature; when these two conditions are present a plant will grow. Now we find that snow is the substance furthest removed from an equable temperature, and its most striking characteristic is the impossibility of its existing in a temperate
825a1 region. We do not, therefore, find plants growing in snow; yet we often find plants appearing in the snow, and animals of all kinds, especially worms (for they are bred in the snow), and mullein and all bitter herbs. But it is not the snow which causes this to be so; but a certain characteristic of snow is active. The reason is that snow falls like smoke, and the wind congeals it and the air binds it together. There is therefore rarity amongst its parts, and air will be retained in it and will grow hot, and foul water flows from it, which had before enclosed the air; and when the air is present in considerable quantities and the sun shines upon it, the air which is enclosed in the snow will burst its way out, and a foul moisture will appear and will be solidified by the heat of the sun. But if the place is covered up, plants will grow in it, but without leaves, because it is cut off from the equable temperature of the earth which is congenial to it. This is the reason why there are numerous flowers and leaves on small plants in places where the air and water are temperate, and few flowers and leaves on a plant which occurs in the snow. So too in very salty and dry places plants do not usually appear, because these places are far from being temperate; and the ground is impoverished, because heat and moisture, which are the characteristics of fresh water, are absent. So the soil that is fresh is the mountain soil, and there plants grow quickly.

But in warm places, because there the water is fresh and the heat plentiful, the process of concoction proceeds for two reasons, partly as a result of the position and the air which is found there, and partly because there is a concoction of the air owing to the heat of the sun there. On mountains, because they attract moisture and the clearness of the air assists the process, concoction proceeds apace; and therefore plants are generally found on mountains. In deserts the saltness gains the upper

hand, as we have already shown, and rarities resembling one another are left between the particles of sand; the sun has therefore no power to produce or perpetuate any continuous plant life; and so in deserts separate species of plants will not occur, but species similar to one another.

4 · Plants which grow on the surface of the water will only do so when there is density in the water; the reason of this is that, when heat touches water which has no current to move it, something of the nature of a cloud comes over it and retains a little of the air, and the moisture putrefies and the heat draws it up, and it spreads over the face of the water. Such a plant has no root, because roots will only attach themselves to the hard particles of the earth, and the particles of water are loose and scattered. The heat then comes forth with the putrefaction which takes place on the surface of the water. Such a plant has no leaves because it is produced under conditions which are far from temperate, and its parts are not compact, because the parts of water are not compact. It is for this reason too that such plants grow like threads.[13] It is because the parts of earth are compact that the plants too which grow in the earth are compact. Sometimes putrefactions are set up in damp, smoky ground, and hold the air—the sun causing them to appear when rain and winds are frequent—and the dryness of the earth will make their roots dry up and solidify, and thus fungi and mushrooms and the like will be produced. In places that are exceedingly warm, because the heat concocts the water in the interior of the earth and the sun holds the heat, a vapour is formed and a plant is thus produced. This process takes place in all warm places, and the formation of the plant is thus completed. A cold locality causes a similar but contrary process; the cold air forces the heat downwards and its particles collect together, and the ground undergoes concoction with the moisture present in it; the ground is then cleft open and a plant emerges from it. Where the ground is fresh, water is generally not far away. When, therefore, the air which is enclosed in the earth is stirred into motion, the moisture of the water will remain behind, and the air will solidify inside the water and a plant is produced, such as the water-lily and various kinds of small plants; these plants grow straight up and do not expand, because their roots are above the earth. In places too where there is warm water running, plants often grow, because the heat of the water attracts the vapours which are retained in the earth, and draws the cold moisture upwards, and air is solidified from the moisture, which it concocts owing to the heat of the water, and a plant appears, but only after a long lapse of time. Small plants too appear in sulphurous places: and when the wind blows violently upon the brimstone, it will recoil back again, and the air which is in it will be stirred up, and the place will become hot, and fire will be produced from it, and will continue to be produced from it, because it exists deep down in the brimstone, which is due to impurities deposited by the air; the fire attracts the air when the sulphur putrefies, and a plant will be produced from it. Such a plant, as we have shown before, will not generally have many leaves, because it is produced under conditions which are far from equable.

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[13] Reading *fila*.

Edible products will grow from plants in positions which are warm even, and elevated, especially in the third and fourth zones; and products almost edible grow in cold and high districts. Many species are produced in cold, high positions owing to the attraction of the moisture and the temperate conditions which prevail in the warmth of the sun on spring days. Similarly natural soil readily produces plants which are full of oil; such soil, as we have already seen, is found where there is fresh water.

5 · A plant which grows upon solid rock takes a long time to grow; for the air which is enclosed in the stone strives to rise, and when it cannot find a way, owing to the resistance of the stone, it retreats back again and becomes heated, and attracts the residuum of the moisture in the stone upwards, and with this moisture a vapour comes forth accompanied by a resolution of small particles of the stone; and because the sun often acts upon the stone, it assists the moisture in the process of concoction, and as a result a plant is produced. Such plants do not generally grow to any height, unless they are near some soil or moisture. The rest of the plant requires soil, water, and air. If you look at the matter, you will see that if a plant faces the east, it will grow quickly, and slowly if it faces the west. A plant, when water is the predominant element in it, will retain the air and will not allow it to rise, and thus the plant is not nourished. Similarly, when dryness predominates, the natural heat will be diverted into the extremities of the plant and will block up the ducts through which the flow of water passed, and the plant does not receive nourishment.

6 · Every plant needs four things (just as an animal needs four things), namely, a definite seed, a suitable position, and a suitable supply of water and air. When these four conditions are fulfilled, a plant will grow and increase; but if they are lacking, the plant will be correspondingly weakened. A plant which is used for medicinal purposes will be more serviceable and suitable for such purposes if it grows on high mountains; its fruit, however, will be harder to concoct and will contain less nourishment. Places which are secluded from the sun's rays will not produce much plant life (just as they will not produce much animal life), because the sun makes the day long according to the duration of its absence, and it is the sun which draws out the moisture; and so plants which grow in sunless places will not have the strength to produce leaves and fruit. As for plants which grow in watery places, when the water is still, a foulness is formed, and there will be no power in the air to rarefy the particles of water, and the air will be imprisoned inside the earth, and this will prevent the thick matter in the water from rising; then the wind will invade[14] the spot and the earth will be cleft open, and the air which is enclosed will retreat into the earth, and the wind will solidify the moisture, and from this condition of moisture marsh plants will spring. Usually such plants do not differ from one another in form on account of the constant presence of water and its thick consistency and the heat of the sun overhead. The plants which grow in damp places will appear like patches of verdure on the surface of the earth. In such a place there

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[14]Reading *inundabit*.

is, in my opinion, little rarity, and when the sun falls upon it, it will stir up the moisture and the spot will grow warm through the resulting motion and the heat which is enclosed within the earth; and so there is nothing to cause the upward growth of the plant, while the moisture helps its expansion; and so it spreads over the earth in a sheet of verdure and produces no leaves. A kind of plant also grows which appears above the surface of the water and is smaller in quantity than that just mentioned, because it is like the nature of earth, and it neither grows upwards nor expands. Often, too, one plant grows out of another plant of a different form from itself, without any root, and spreads all over the plant. For when a plant which has numerous thorns and contains an oily juice moves, its parts will open and the sun will cause its putrefactions to turn into vapour, and the putrefied place of its own accord will produce a plant, and the wind and a moderate heat assist, and the plant grows in the form of threads and extends over the original plant. This is a peculiarity of very thorny plants, dodder and the like. 827ª1

There is also a class of plant which has neither root nor leaves, and another which has a stalk, but no fruit or leaves, the tamarisk, for example.[15]

All herbs and all things that grow above or in earth have their origin in one of five ways, namely, either from seed, or from putrefaction, or from the moisture of water, or from being planted, or from growing as parasites on other plants. These are the five causes of plants.

7 · Trees have three different methods of production; they produce their fruit either before their leaves, or at the same time as their leaves, or else after their leaves have grown. We have already described these three methods. A plant which produces its fruit before its leaves contains a considerable amount of oily juice, and when the heat which is natural to the plant has concocted the juice, its maturity will quickly follow, and the juice will acquire force and boil up within the branches of the plant and will prevent the moisture from rising; the result is that the fruit appears before the leaves. But in plants which produce their leaves more quickly than their fruits, the effects of the moisture are various. When the heat of the sun begins to disperse the particles of water, the sun attracts the particles of this moisture upwards, and the process of ripening will be delayed, because the concoction of the fruit will only take place through coagulation, and so the leaves come before the fruit. A plant which produces its leaves and fruit simultaneously has much moisture, and frequently also contains an oily juice. When the heat has concocted the moisture, it will, as a result, rise upward, carrying the juice with it, and the air and sun will draw it out, and the oily juice which forms the fruit will come out, while the moisture will produce the leaves, leaves and fruit coming forth together. The wise men of old used to assert that all leaves were really fruits, but so much moisture was present, because the fruit did not mature or solidify owing to the presence of heat above and the sudden attraction exerted by the sun, and consequently the moisture on which the process of concoction had had no effect changed into leaves; the leaves, they said, are simply intended to attract the

[15]This sentence occurs in the MSS after 'have grown', in line 10.

moisture and serve as a protection to the fruit from the violence of the sun. The leaves ought therefore, they said, to be equally regarded as fruit. But the truth is that the moisture rises above them and the leaves are converted into real fruits, as we have already said. The same theory applies to olives, which often fail to produce
827b1 fruit; for when nature brings about concoction of moisture, some of the thin moisture, which has not matured, will rise first, and this will produce leaves and its concoction will produce flowers, and when in the second year the process of concoction is completed, the fruit will grow and will eventually use up all the
5 available material according to the space which it has in it.

Thorns are not characteristic of plants or natural to them. My opinion is that there is rarity present in a plant, and concoction will take place at the beginning of its existence, and moisture and cold rise upwards, and they are accompanied by a
10 slight concoction; this circulates where there is rarity, and the sun causes it to solidify, and thus the thorns will be produced. Their form is pyramidal; for they begin by being thin at the point and gradually grow thicker, because when the air is withdrawn from the plant its parts increase, and the material expands. The same is
15 true of any plant or tree which is pyramidal at the top.

8 · Greenness must be the most common characteristic of plant life; for we see that trees are white internally and green externally. The reason is that the
20 material which supplies their nutriment is more readily accessible: it follows therefore that there is greenness in all plants, because their material is absorbed and rarefies the wood of the tree, and the heat causes a slight concoction, and the moisture remains in the tree and appears externally: consequently there will be greenness. This is also the case with the leaves, unless the concoction in them is
25 unusually powerful; and leaves are in respect of strength midway between bark and wood. But greenness does not persist, nor indeed come into existence without the presence of moisture, and is of the element of earth, and is the intermediate colour between that of earth and water. This is indicated by the fact that when the bark of
30 trees dries up it turns black, and the wood inside the tree becomes white, and the green, which comes between these two colours, is the colour presented by the outward appearance of the plant.

The shapes of plants fall under three classes. Some spread upwards, others downwards, while others are intermediate. The upward extension is due to the fact
35 that the nutritive material makes its appearance in the marrow of the plant, and the heat draws it up, and the air, which is present in the rarities of the plant, compresses it, and it assumes a pyramidal form, just as fire assumes a pyramidal form in bodies in which it is present and rises upwards. Downward extension is due to the blocking of ducts in the plant, and, when the material is concocted, the water, which contains
828a1 the marrow of the plant, will thicken, and the rarefied portion proceeds on its upward course, while the water returns to its former position in the lower portion of the plant, and by its weight presses the plant downwards. In the plants which are intermediate between the two classes already mentioned, the moisture is rarefied and the natural state of the plant is very nearly a temperate condition during the

process of concoction, and the ducts are open through the middle of the plant, and the nutritive material spreads upwards and downwards. There is a double process of concoction; the first takes place below the plant, while the second takes place in the marrow which comes out of the earth and is in the middle of the plant; afterwards the nutritive materials make their appearance fully matured and are distributed through the plant, and do not undergo a third concoction. In animals there is a third process of concoction; this is due simply to the diversity of their limbs and to the distinctness of their parts from one another. Plants, on the other hand, are more homogeneous and repeat the same members over and over again, and the nutritive material generally has a downward tendency. The shapes of plants will depend on the quantity of the seed, while the flower and fruit is dependent on the water and nutritive material. In all animals the first process of maturation and concoction takes place within the animal; there is no exception to this rule. But in plants the first concoction and maturation takes place in the nutritive material. Every tree continues to grow up, until its growth is completed and it dies. The reason is that, while in any animal its height is much the same as its width, in a plant it is far from being so, because water and fire, the elements which compose it, rise quickly, and therefore the plant grows. Variety in the branches of a plant is due to excessive rarity, and, when the moisture is intercepted there, the process of nature will cause it to grow hot and will hasten the concoction, and thus boughs will form and leaves will appear, as we have already said.

9 · The shedding of leaves from trees will be due to the tendency to fall, induced by quickly formed rarity. When the moisture is concocted with the nutritive material, it will assume a pyramidal form, and therefore the ducts within will be wide and will afterwards become narrow and pyramidal; when the nutritive material makes its appearance already concocted and formed, it will close up the extremities of the ducts above, and the leaves will have no nutritive material, and therefore dry up. When the contrary process to the one we have described takes place, the leaves do not fall from the trees. When coldness dominates in the plant, it will affect its colour owing to the secretion of heat in the middle of the plant and the presence of cold outside in its extremities; the result is that the leaves are blue-grey 828^{b}1
and do not fall, as in the olive, and myrtle, and similar trees. When trees or plants exercise a violent force of attraction, fruit will be produced once a year; when they do not exercise such a force, nature will employ the process of concoction on successive occasions and at each concoction they produce fruit, and so some plants bear fruit several times in the year. Plants which are of the nature of water bear fruit with difficulty on account of the predominance of moisture in them, and the wideness of their ducts and the tendency of their roots to fall off; when the heat is intense, the concoction will be quick and will be rarefied owing to the water and will not solidify; this we find to be the case in all small herbs and in some vegetables.

A grey colour will occur where the ground is exceedingly hot; here there will be little moisture and the ducts will become narrow, and when nature wishes to bring about concoction it will not have sufficient moisture to supply the nutritive material

and the ducts will become narrow. The process of concoction therefore will be reversed and the heat will cause it to continue, and the plant will be seen to have a colour intermediate between white and black. When this happens it will have black wood or anything like it between white and ebony, that is, any of the whole range of colours from that of ebony to that of elm;[16] and so such wood sinks in water because its parts are compact and the ducts in it are narrow, and no air enters into them. When white wood sinks the reason will be the narrowness of the ducts and the presence of superfluous moisture, which blocks up the ducts so that the air does not enter; consequently it sinks. Every flower is composed only of rarefied material when concoction first begins; and so the flower generally precedes the fruit in plants. We have already shown why it is that plants produce their leaves before their fruits. In the case of plants which have slender parts the colour of the flower will resemble a bright blue; when the parts are not closely compressed, it will tend to whiteness; under medium conditions it will be a blue-grey. The absence of flowers in certain plants is usually due to the solidity of their parts or their rarity or their roughness or thickness. The palm and similar trees therefore have no flowers.

829*1 A plant which has thick bark expands owing to the pressure of moisture and the impelling force of heat; we see this in the pine and palm. A plant which gives forth a milky juice will have such juice within it; there will be powerful heat within and an oily substance will be present there. When the heat begins to cause concoction, the oily substance will be turned into moisture, and the heat will solidify it to a slight extent, and local warmth will be caused, and an oily liquid will be produced similar to milk, and vapour will rise from the moisture which attracts the milky substance into the extremities of the plant, and the moisture will retain the heat which appears. The milky substance will not be solidified, because it is the function of heat to solidify it and any milk requires a great deal of solidification. If there is cold present in the tree, the milky substance will solidify when it has left its original position in the tree, and the result will be the formation of gum. Gum comes out warm from the tree by distillation, and, when it comes into contact with the air, it will solidify. Some gums flow in temperate places, and these will be of the consistency of water; others flow out and solidify as hard as stone or shell. Gum which flows drop by drop keeps its form, as in the tree which is known as *aletafur*. The gum which changes into a stony substance will be very cold on its first appearance, and its appearance will be caused by heat, and when it has flowed out it will turn to stone; it will occur where the soil is very hot. Some trees undergo a change in the winter and will become sometimes green and sometimes blue-grey, and neither their leaves nor their fruits decay; for trees in which this occurs have a great quantity of heat and rarefied water in their lower reservoirs. Thus as the year goes on this water will retain its heat on account of the coldness of the air; and because the heat goes out to the cold, it carries the moisture out with it, and the moisture tinctures it with the colour of heat, and therefore the colour is seen in the appearance of the tree. Consequently cold and heat are converted into activity, and the moisture retains heat, and therefore another colour makes its appearance.

[16]Reading *ulmum*.

10 · Fruit will be bitter because the heat and moisture have not completed the process of concoction (cold and dryness hindering the completion of this process), and so fruit turns bitter. This is indicated by the fact that what is bitter, when put into fire, becomes sweet. Trees which grow in sour water produce sweet 829ᵇ1
fruit, because the sourness assisted by the heat of the sun attracts that which is of its own quality, namely, cold and dryness. Sweet liquids therefore make their appearance inside the tree, and the innermost part of the tree becomes hot when the sun shines continuously above it, and the flavour of the fruit will be successively 5
sour, and then, when the process of concoction has taken place, the sourness will be gradually dissolved until it disappears, and sweetness will make its appearance. Consequently the fruit will be sweet, while the leaves and extremities of the tree will be acid. When the maturation is complete, the fruit will be bitter: this is due to a superfluity of heat with very little moisture. The moisture is used up and the fruit 10
makes the heat rise, and so the fruit will be bitter, and the stones in the fruit will be pyramidal in form on account of the upward attraction of the heat and the downward attraction of the cold and moisture which are of the same nature as sour 15
water; and the moisture remains in the trunk of the tree, which consequently thickens, while its extremities are thin. If trees are planted in temperate soil, they reach maturity quickly before the days of spring, because, when the heat is almost temperate and the moisture has made its appearance and the air is clear, the fruit 20
will not require much heat during the process of concoction. Consequently maturity comes quickly and takes place before the days of spring. Bitterness or harshness of flavour is prevalent in all trees when they are first planted. The reason is that when 25
the moisture is in their extremities and has concocted the parts that are in the middle of the tree, from which the material of the fruit comes, the dryness comes forth and follows the moisture, and the first concoction will be sour or bitter or harsh. The reason is that the concoction takes place in the heat and moisture, and 30
when moisture or dryness prevails over the heat, the fruit so produced will not at first have undergone proper concoction, and consequently the production of fruit is at first without sweetness.

The fruit of the bennut-tree when it first appears is sweet, but subsequently becomes harsh in flavour and finally bitter. The reason for this is that the tree has 35
excessive rarity in it, and at the time of concoction, when the ducts are wide, the heat will follow the moisture and will cause the fruit to mature; consequently the fruit will be sweet at first. Subsequently the heat attracts the dryness which resembles its own nature, and will cause the ducts to contract, and cold and dryness 40
will prevail over heat and moisture; the fruit, therefore, will change to a harsh flavour. Next, the sun with its heat will prevail through the attraction of 830ᵃ1
superfluous[17] moisture in the seed, which is present at the first appearance of the tree, and the cold will prevail over the dryness; the fruit will therefore become exceedingly harsh in flavour. Next, the natural heat will rise upwards, and the heat 830ᵇ1
of the sun outside will assist it; therefore the heat and dryness will prevail, and the fruit will become bitter.

[17]Reading *superfluae*.

INDEXES

REFERENCES give Bekker page-, column-, and approximate line-numbers: these numbers are to be found in the margins of the present translation. References of the form "*CA n*" give section-numbers in the *Constitution of Athens*. References to the fragments are all of the form "p. *n*" and give page-numbers of the present translation.

The Index of Names is largely confined to writers or thinkers mentioned by Aristotle. It does not include historical figures who occur mainly in the *Politics*. A few historical figures—and also a few geographical locations—are given in the General Index.

For reasons of space, the General Index is highly selective, both in its headings and (for all but the major items) in the passages it cites. Entries are not analytical. The reader who requires more detailed information must consult Bonitz's *Index Aristotelicus* (Greek) or Organ's *Index to Aristotle* (English)—or else turn to the indexes in the several volumes of the original Oxford translation.

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