Kormondy, E.J. 1965. Readings in Ecology.
Prentice-Hall, Inc. NJ. 219 pp.

EARLY NATURAL HISTORY

In the present day, the term "natural history" has become opprobrious among ecologists in connoting anecdotal, unsystematic, and casual investigation. Indeed, much natural history observation and writing is of this sort, and is not likely to make any very fundamental contribution. There is, however, a different kind of natural history—that which provided the beginning of a tradition leading to modern ecology and which, in many respects, is a fundamental component of it. Among the salutary characteristics of this true naturalist tradition, as evidenced in the following selections, are careful attention to detail, precision of recording, recognition, and manipulation of variable influences, and awareness of the observations of others.

The period of the great naturalists, arbitrarily represented here from Theophrastus to Reáumur, is, in some respects, actually without termination. Excellent natural histories continue to appear in the twentieth century, but their audience and function would appear to have changed, at least in part. Serving always to inform, instruct, and often to persuade, these treatises were as much directed to students of science as to the literary public in a former day. Modern natural histories have too generalized and insufficiently critical an approach for scientific purposes, but do provide considerable motivation and enjoyable reading for scientist and nonscientist alike. There is a great tradition in such natural history exposition that is both illuminating and absorbing.

ENQUIRY INTO PLANTS

Theophrastus—c. 300 B.C.

Reprinted by permission of the publisher and the Loeb Classical Library from Theophrastus: Enquiry into plants, Volumes I and II, translated by Sir Arthur Hort. Cambridge, Mass., Harvard University Press, 1916.

Perhaps not so imaginative nor conceptually creative as Aristotle, his teacher and predecessor as head of the Lyceum, Theophrastus was a much more careful observer of nature. Most of his botanical writings were based on material brought to him by those who accompanied Alexander on his expeditions. The following selection, with its obvious anthropomorphisms, shows strong ecological orientation in its consideration of plant associations and the dynamic and causal relationships of plants with their environment.

OF THE IMPORTANCE OF POSITION AND CLIMATE

I. The differences between trees of the same kind have already been considered. Now all grow fairer and are more vigorous in their proper positions; for wild, no less than cultivated trees, have each their own positions: some love wet and marshy ground, as black poplar, abele, willow, and in general those that grow by rivers; some love exposed and sunny positions; some prefer a shady place. The fir is fairest and tallest in a sunny position, and does not grow at all in a shady one; the silver-fir on the contrary is fairest in a shady place, and not so vigorous in a sunny one.

Thus there is in Arcadia near the place called Krane a low-lying district sheltered from wind, into which they say that the sun never strikes; and in this district the silver-firs excel greatly in height and stoutness, though they have not such close grain nor such comely wood, but quite the reverse,—like the fir when it grows in a shady place. Wherefore men do not use these for expensive work, such as doors or other choice articles, but rather for ship-building and house-building. For excellent rafters beams and yard-arms are made from these, and also masts of great length which are not however equally strong; while masts made of trees grown in a sunny place are necessarily short but of closer grain and stronger than the others.

Yew *pados* and joint-fir rejoice exceedingly in shade. On mountain tops and in cold positions odorous cedar grows even to a height, while silver-fir and Phoenician cedar grow, but not to a height,—for instance on the top of Mount Cyllene; and holly also grows in high and very wintry positions. These trees then we may reckon as cold-loving; all others, one may say in general, prefer a sunny position. However this too depends partly on the soil appropriate to each tree; thus they say that in Crete on the mountains of Ida and on those called the White Mountains the cypress is found on the peaks whence the snow never disappears; for this is the principal tree both in the island generally and in the mountains.

Again, as has been said already, both of wild and of cultivated trees some belong more to the mountains, some to the plains. And on the mountains themselves in proportion to the height some grow fairer and more vigorous in the lower regions, some about the peaks. However it is true of all trees anywhere that with a north aspect the wood is closer and more

compact and better generally; and, generally speaking, more trees grow in positions facing the north. Again trees which are close together grow and increase more in height, and so become unbranched straight and erect, and the best oar-spars are made from these, while those that grow far apart are of greater bulk and denser habit; wherefore they grow less straight and with more branches, and in general have harder wood and a closer grain.

Such trees exhibit nearly the same differences, whether the position be shady or sunny, windless or windy; for trees growing in a sunny or windy position are more branched shorter and less straight. Further that each tree seeks an appropriate position and climate is plain from the fact that some districts bear some trees but not others; (the latter do not grow there of their own accord, nor can they easily be made to grow), and that, even if they obtain a hold, they do not bear fruit—as was said of the date-palm, the sycamore, and others; for there are many trees which in many places either do not grow at all, or, if they do, do not thrive nor bear fruit, but are in general of inferior quality. And perhaps we should discuss this matter, so far as our enquiries go. . . .

OF DISEASES AND INJURIES DONE BY WEATHER CONDITIONS

. . . there are certain affections due to season or situation which are likely to destroy the plant, but which one would not call diseases: I mean such affections as freezing and what some call 'scorching.' Also there are winds which blow in particular districts that are likely to destroy or scorch; for instance the 'Olympian' wind of Chalcis in Euboea, when it blows cold a little before or after the winter solstice; for this wind scorches up the trees and makes them more dry and withered than they would become from the sun's heat even in a long period; wherefore its effect is called 'scorching.' In old times it occurred very frequently, and it recurred with great violence in the time of Archippus, after an interval of forty years.

The places which suffer most in this way are hollow places, valleys, the ground near rivers, and, in general, places which are least open to wind; the tree which suffers most is the fig, and next to that the olive. The wild olive, being stronger, suffered more than the cultivated tree, which was surprising. But the almonds were altogether unscathed, as also were the apples pears and pomegranates; wherefore this too was a surprising fact. The tree gets scorched by this wind right down to the trunk, and in general the upper are caught more and earlier than the lower parts. The effects are seen partly at the actual time of budding, but in the olive, because it is evergreen, they do not appear till later; those trees therefore which have shed their leaves come to life again, but those that have not done so are completely destroyed. In some places trees have been known, after being thus scorched and after their leaves have withered, to shoot again without shedding their leaves, and the leaves have come to life again. Indeed in some places, as at Philippi, this happens several times.

Trees which have been frost-bitten, when they are not completely destroyed, soon shoot again, so that the vine immediately bears fruit, for instance in Thessaly. In Pontus near Panticapaeum the frost-bite occurs in two ways, either just from cold, if the season is wintry, or from long spells of frost; in either case this generally occurs in the forty days after the winter solstice. The frosts occur in fine weather, but the cold spells, which cause the frost-bite, chiefly when in fine weather the 'flakes' fall; these are like filings, but broader, and can be seen as they fall, but when

they have fallen, they disappear—though in Thrace they freeze solid. . . .

OF THE EFFECTS OF CLIMATE, SOIL, AND MANURING

For growth and nourishment the climate is the most important factor, and in general the character of the season as a whole; for when rain, fair weather and storms occur opportunely, all crops bear well and are fruitful, even if they be in soil which is impregnated with salt or poor. Wherefore there is an apt proverbial saying that "it is the year which bears and not the field."

But the soil also makes much difference, according as it is fat or light, well watered or parched, and it also makes quite as much difference what sort of air and of winds prevails in that region; for some soils, though light and poor, produce a good crop because the land has a fair aspect in regard to sea breezes. But, as has been repeatedly said already, the same breeze has not this effect in all places; some places are suited by a west, some by a north, some by a south wind.

Again the working of the soil and above all that which is done before the sowing has an important effect; for when the soil is well worked it bears easily. Also dung is helpful by warming and ripening the soil, for manured land gets the start by as much as twenty days of that which has not been manured. However manure is not good for all crops; and further it is beneficial not only to corn and the like but to most other things, except fern, which they say it destroys if it is put on. (Fern is also destroyed if sheep lie on it, and, as some say, lucerne is destroyed by their dung and urine.). . .

HISTORY OF PLANTS

Linnaeus—1750

Reprinted from The Elements of Botany, Chapter XI, translated by Hugh Rose. Published by T. Cadell, 1775.

The renascence of the Greek spirit of inquiry in natural history writing reached its acme in the work of Gesner and Aldrovandi in the sixteenth century, and in Linnaeus, Reáumur, and Buffon in the eighteenth century. In addition to his significant contributions to taxonomy, Linnaeus' writings show considerable perceptions in ecological matters, notably regarding the phenology and geography of plants. Unlike the herbalists, he recognized the influence of environmental factors in promoting seasonal progression and plant distribution. This feature is evident in the following passage which is a portion of a chapter detailing what the Swedish botanist considered important for a complete understanding of plants.

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The native places or stations of plants respect the country, climate, soil, and situation, nature of the ground, earth, and mould. The only true foundation of gardening, and the right cultivation of plants, depends on the knowledge of the native places of their production, from whence the rules

and principles of the art ought to be derived. Miller's Gardener's Dictionary lays down the particular culture of every plant; but this method of gardening through all the known species of plants would be too tedious, diffuse, and burdensome. From the natural place of their growth we know where to find the different species of plants for gardens, herbals of dried plants, medicinal and economic uses. The country respects the kingdom, provinces, districts; and, when the plants are very rare and scarce, the places of their growth ought to be most particularly mentioned. The climate respects the latitude, longitude, and altitude of the place, which last is its perpendicular height above the level of the sea. Vaillant was the first who introduced the climates in describing the native places of plants, and this he did with regard to the latitude only. But that the latitude alone is not sufficient, and much less the longitude, appears from this; that places very remote from each other, but under the same latitude, produce plants very different. Rome in Italy, Pekin in China, and New York in America, are situated nearly under the same degree of North latitude; Rome being 41:51, Pekin 39:55, and New York 41:0. In like manner Palestine and Florida on the North, and the Cape of Good Hope and Chile on the South, are nearly under the same latitudes; but those countries produce plants very different from one another. It is much more proper to observe the altitude of the place in describing the habitations of plants; thus the aquatic plants of India often agree with those of Europe, as the hooded milfoil, the sun-dew, the water-lily, the arrow-head, and *Aldrovanda*. The Alpine plants of Lapland, Greenland, Siberia, Switzerland, Wales, Scotland, the Pyrenean mountains, Olympus, Ararat, and Brazil, are often the same, though growing in places so remote from each other. Suppose a meadow a little higher than the sea, and full of such plants as commonly grow in meadows, and the adjacent ground a little higher still, and further from the sea; this last will produce other plants very different from the meadow; examples of which may be seen everywhere. In describing the habitations of plants, we ought always particularly to mention the soil, situation, nature of the ground, earth, mould, etc. in which they grow. This is very various, being either in the sea, on the sea shore, about fountains or springs, in rivers, or on the banks of rivers, in lakes, ditches, water-pits, ponds, pools, fens, marshes, bogs; on the tops of very high mountains, and in thick forests on their sides; on little hills, declivities, cliffs, rocks, stones, caverns, old high walls; groves, woods, hedges, and shady places; heaths, commons, fields, fallows, closes, plowed lands, gardens, dunghills, rubbish, meadows, pastures, loam, sand, gravel, clay, chalk or marl; or lastly, on the roots, trunks, and branches of trees or other plants. In this respect plants may be arranged into six general divisions, according to their places of growth above recited, viz. aquatic, Alpine, hilly, shady, campaign, and parasitic plants, each of which contains several subdivisions. We shall give examples of each in their order. . . . From what has been said it appears that the nature of any ground or soil may be readily known from the bare inspection of the plants that grow in the same. Thus, the *Potentilla argentea*, tormentil cinquefoil, indicates clay under the surface; *Melampyrum cristatum*, crested cow-wheat, grows only in hilly ground; *Melampyrum arvense*, purple cow-wheat, in plowed land; *Melampyrum nemorum*, wood cow-wheat, in groves or shady places; *Melampyrum pratense*, meadow cow-wheat, in meadow or pasture ground; *Melampyrum sylvaticum*, yellow cow-wheat, in woods;

Pedicularis sylvatica, common lousewort, in spungy [sic.] or spouty ground; *Aira cerulea*, purple hair-grass, in turfy ground.

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The time of the whole duration of plants, or the years of their age, the time of their germination, that is, their sprouting or springing out of the ground after sowing, the time of their foliation, or leafing, flowering, sleeping, watching, fruiting, and shedding their leaves, plainly indicates the climate, or points out to us how one climate differs from another. And first of germination, which is the time that seeds require to spring out of the ground, or to put forth their seminal leaves after sowing. And in this respect the seeds of plants differ amazingly, from one or two days to as many years. Thus, e.g., the millet and wheat come up in one or two days; the navew, rocket, blite, mustard, turnip, spinache, and kidney-bean, in three or four days; the dill, lettuce, cucumber, gourd, and cresses, in four or five days; the beet and radish in six days; barley in seven days; orrach in eight days; cabbage in ten; beans require from fifteen to twenty; the onion comes up in nineteen or twenty days; the hyssop in thirty days; parsley seed in forty days; smallage in forty or fifty days; the peach, almond, walnut, chestnut, and piony [sic], in one year; the cornel and hazle-nut in two years after sowing. The foliation or leafing of plants is the time of the spring or summer they unfold, expand, or put out their first leaves. . . .

The watching or vigils of plants are the precise times of the day that their flowers open and shut. Such flowers as observe a determinate time of opening and shutting are called solar; and are of three sorts, viz., 1. Meteorical, which observe the hour of expanding with less accuracy, but open sooner or later according to the degree of shade, moisture, dryness, greater or lesser pressure of the atmosphere. 2. Tropical, are those which open in the morning and shut up before night, but the time of their opening is sooner or later as the days increase or decrease; therefore they observe the Turkish or unequal hours. 3. The third sort of solar flowers is called the Equinoxial. These open precisely at a certain hour of the day, and generally shut up every day at a determinate hour, and therefore observe European or equal hours. . . .

Of the sleep of plants (as we may call it) in the night, we have spoken somewhat in chapter V, sect. 133. This sleep of plants is a certain position or situation of their leaves very different from that they have by day, and takes place almost in every species of plants. . . .

Now this nocturnal change in the position of the leaves of plants, which we call sleep, may be ascribed by some, partly to the darkness, and partly to the cool air, of the night. But that these are not the sole cause of this phenomenon appears from hence, that the same plants, though placed in a stove, where the degree of heat is the same both day and night, do not withstanding at their usual hours in the evening contract their leaves, and go to sleep, and open or expand them again very early in the morning; and, which is very remarkable, that they observe the same vicissitudes of contracting and expanding their leaves, whether the window shutters of the stove are shut or open. Let it be observed, that as animals while young and tender sleep most, so also do plants in their young state, but when grown up they indulge less in this respect.

The next thing to be observed, is the time that that plants ripen their fruits and seeds. Common barley sown in Lapland May 31, 1732, was cut July 28, consequently ripened in 58 days. The same sort of barley sown at Upsala

Mar. 6, 1750, was cut Aug. 4, and ripened in 151 days. And we find that at Upsala the medium is 110 days, in Scania 90 days, and in Lapland 60 days. For as eggs require a fixed time for the exclusion of the young, so the barley does in different provinces to ripen the seed, as appears by the above examples. And thus should observations be made on other plants as to the time of ripening their seeds.

Defoliation is the time of autumn, when trees shed their leaves, and thereby point out the progress of autumn, and the approach of the ensuing winter. The ash is among the first that sheds, and the last that puts out its leaves. The first fall of the leaves of trees with us is about the autumnal equinox. We ought carefully to observe also the first blowing of the meadow saffron. . . .

Botanists, having been hitherto taken up in acquiring the knowledge of plants, and confounded, or as it were overwhelmed, with the prodigious number and vast variety which nature everywhere presented to their view, have not been at leisure to make a regular course of observations in the manner of astronomers, although, in my opinion, such observations would have been of far greater utility to the public. Calendars of *Flora* should be made out in every province yearly, according to the time of plants coming into leaf, flower, fruit, and shedding their leaves; observing also the climate, that the difference of one country from another might from thence appear. The time also of solar flowers opening and shutting should be made out in every climate, that anyone, without the help of a clock, or seeing the sun, might know the time of the day. Maps of the plants also should be formed, which would point out everywhere the country, climate, and soil. Such observations would be highly useful in discovering more clearly the nature of the earth in general. The progress of the year from the putting out to the fall of the leaves of trees would show the climate, and also the greatest heat and cold of the place. In our botanic thermometer the freezing point is 0, and that of boiling water 100. The autumnal plants are those of Virginia, which flower kindly with us in Sept. and Oct. but rarely produce ripe seeds. The winter plants are those of the Cape of Good Hope, that flower with a gentle heat in the middle of winter, which is midsummer time in their native places. The spring or vernal plants are all those called the Alpine, which produce their flowers and fruit very early. The plants which flower twice a year, to wit, in spring and autumn, are all the Indian ones between the Tropics. The cold plants, such as the Alpine, etc., will scarcely bear the heat of 30 degrees on our thermometer. The temperate plants, such as those of Spain, Italy, etc. will scarce bear the cold of 8 degrees. The warm plants will bear the heat of 40 degrees, but the cold of 10 degrees will kill them. The cold plants placed in a stove, at first grow very luxuriant, but in a short time grow weak and die. The warm plants in a cold situation do first cease to grow, then lose their leaves, and produce neither flowers nor fruit. . . .

THE NATURAL HISTORY OF ANTS

René Antoine Ferchault de Réaumur—c. 1742

Reprinted by permission of the publisher from The Natural History of Ants, an unpublished manuscript translated by William Morton Wheeler. New York, Alfred A. Knopf, pp. 161–168, 1926.

Although best known for his Mémoires pour servir à l'Histoire des Insectes, *Réaumur dealt quite competently with industrial arts and physics as well, making substantial contributions to these fields. This less well known discourse on ants, presumed by Wheeler to have been written as part of the uncompleted* Memoires, *provides an excellent example of naturalistic writing. Disregarding the diffuseness of Réaumur's style, which Wheeler suggests is "due to a desire for completeness of description," the thoroughness and perspicacity evidenced in this selection were characteristic of the great naturalists. It was this tradition which was carried on in the nineteenth century by Charles Darwin, Alfred Wallace, and Henry Bates.*

Are there then in a formicary two kinds of females, winged and wingless? No, there is only one kind; both of them are the same individuals seen at different seasons. There constantly happens to the winged ants what happens to no other known animal of the class of those that bear wings: they lose theirs. . . .

. . . When we follow the ants through their various stages we see that those that are born without wings pass their lives without having them, whereas those that are to be winged have wings from the moment of their birth, like the other flies and the butterflies; that is, after the transformation which enables us to recognize them as ants. . . .

Now if we observe a formicary at certain seasons we find in it certain very large ants which we might regard as having lost their wings, and which are actually such individuals. We find also others quite as large that still possess wings. Both kinds are females, though their number is always far inferior to that of the wingless ants of medium size, which are the ones that carry on most of the work. We also find some very small wingless females and finally some winged individuals as small as the latter. If the female ants have need of males—for this is a question we may ask, since we know that plant-lice are fecund without copulation—it is natural to suspect that the small winged ants are the males. The great disproportion in size by no means conflicts with this presumption, since the general rule among insects requires that the males should be smaller than the females. . . .

Perhaps I should have learned nothing from the first chance opportunity of seeing two ants mating, if I had been less familiar with the ways of these small insects. Being on the road to Poitou and finding myself on the levée of the Loire, very near Tours, on one of the first days of the month of September, 1731, I descended from my berlin, enticed to stroll about by the beauty of the spot and the mild temperature of the air, which was the more agreeable because the earlier hours of the day had been warm. The sun was within about an bour of setting. During my stroll I noticed a lot of small mounds of sandy and earthy particles rising above the openings that led the ants to their subterranean abode. Many of them were at that time out of doors; they

were red, or rather reddish, of medium size. I stopped to examine several of these earthen monticules and noticed on each among the wingless ants a number of winged ones of two very different sizes. Some of them had abdomens no larger than those of the wingless ants, and to judge from unaided vision one of tbe larger winged individuals must have weighed more than two or three times as much as one of the smaller. Over the beautiful levée, where I was enjoying my walk, there appeared in the air in places not very far apart small clouds of large flies which flew about in circling paths. They might have been taken for gnats or craneflies or may-flies. Often the small cloud hung in the air at a height within reach of the hand. I used one of mine to capture some of these flies and succeeded repeatedly in doing so. All I secured were without difficulty recognized for what they were, for they were winged ants like those I had found at every step on the small mounds of earth. But I observed—and the observation was as important as it was easy to make—that I almost invariably captured them in pairs. Not only did I almost always find in my hand one large and one small ant, but most frequently I took them copulating and held them for some time before they separated. The small ant was resting on the large one just as among common flies the male while mating rests on the female. The posterior end of the small ant was curved downward so as to apply itself to that of the female and it adhered so firmly that force was necessary to separate the pair. The abdomen of this small male was scarcely half as long as that of the large female, so that it could cover only the posterior portion of the latter's abdomen. I compressed the abdomen of some of the large ants and caused clusters of eggs to exude.

In order, therefore, to see ants copulating it is not necessary to know the place in which they hide during the act. Since I first took in the air the pairs of red ants of which I have just spoken, it has been easy for me to secure copulating ants of nearly all the species of this country. The fine days of summer and autumn, those especially tbat are bright and sunny, and during which various kinds of flies form small swarms in the air, are also the days on which the winged ants take flight. But they are not always congregated in the air in a kind of vortex; more frequently they are found dispersed, though occasionally they are present in the air in such great numbers as to be visible far and wide over very great areas. Even when they are flying and are difficult to observe near at hand, they can be distinguished nevertheless, at least during copulation, from several flies that differ but little from them in size and shape. This is indicated by a peculiarity that has never deceived me. When what looks like a fly about the size of an ant, with a posterior enlargement from which something seems to be dangling, is seen in the air, it is almost certain that what is taken to be a single fly is really a pair of ants. If the fly that seems to have this kind of tassel at its hind end passes within reach of the hand and is successfully captured it will be found that the hand holds two insects, a large winged female and another very small but also winged individual, whose posterior end is hooked to that of the former.

It is therefore in mid-air that the nuptials must be celebrated of those ants that pass the greater portion of their lives underground and the remainder of their lives crawling on its surface or at most on walls, plants or trees. I have sometimes stood near a formicary, part of whose inhabitants were winged, at about two or three o'clock in the afternoon while it was still being warmed by the sun's rays.

Then the winged individuals of the two different sizes issued from the earth, betook themselves, so to speak, to the roof of their abode and there, after being thoroughly warmed, strolled about in various directions, without, so far as I could see, any teasing of the large by the small winged individuals; that is, without any tender preludes to mating. Then one by one both the large and the small ones took flight. Soon the surrounding air was seen to be filled with them, and the large ones were seen each to have a small one dangling from its posterior end. Not only, therefore, do they remain aloft while they are copulating, but they actually begin the act in the air. Usually the female does not long remain alone. I have reason to believe this because along with the female and attached male which I expected to capture, and which I captured without their separating from each other, I have sometimes secured at the same time two or three additional males which, jealous of the good fortune of the first, apparently wished to supplant him, or were, perhaps, waiting till he left vacant the place that was the object of their desires.

Furthermore, I have always seen the ants return one by one to their formicary as they left it. Thus it is in the air that mating begins and continues. Then it is the task of the female to support the male, contrary to what is found in the flies called demoiselles, among which the male carries the female. Nature seems to have varied her combinations in all possible ways. The female ant flies in divers directions without being abandoned by her male, and sometimes carries him out of sight. Since it is impossible to follow continuously with the eyes even those that fly lowest, and since others crossing them cause them to be lost to view, I have never been able to ascertain how long the flight and the mating may continue. I have seen some that alighted very near the formicary before separating.

It has therefore been established that the wings are necessary to the ants, both male and female, in order that they may mate, and it would seem that these organs have been given them solely for this purpose. At least it is certain that the females do not long retain their wings after they have been fecundated. The males also shed theirs, but it would seem that they retain them much longer. Their wings are not useless, except on occasions when they fly through the air without succeeding in encountering females of their own formicary; for all appearances indicate that mating occurs only among ants born together, that is, among those of the some formicary. . . .

THE PHYSICAL AND CHEMICAL ENVIRONMENT

The various physical and chemical forces impinging upon an organism can be analyzed quite apart from any consideration of the organism. This was as obvious a truth in a period when earth, air, fire, and water were considered to be the major environmental principles as it is today when sundry physical and chemical phenomena are acknowledged to be of significance. Concomitant with this recognition of a wider diversity of environmental agents has been the development of increasingly complex and sophisticated methodology and instrumentation to aid in their analysis.

Environmental analysis without consideration of the organism is relatively meaningless for the ecologist. Life is a unit of interaction, and ecology is concerned essentially with those interactions which occur at the individual, population, and community levels of organization.

Interaction may take the form of the environment regulating the organism—its distribution in time and space, its physiognomy and phenology, among other peculiarities; it may involve compensatory and behavioral adaptations on the part of organisms; it may consist of regulation and modification of the abiotic environment by organisms through the release of excrements and as agents of decomposition. This section deals with the analysis of environmental factors and certain aspects of their regulatory effect on organisms; the converse situation of organisms regulating environment is treated in the section on ecosystems. In reality, all the readings represent some aspect of organism-environment interaction.