ARISTOTLE ON CAUSES AND LAWS IN THE WORLD OF LIVING BEINGS[1]

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Linnaeus and Cuvier have been my two gods,
... but they were mere schoolboys to old Aristotle.
Charles Darwin

ABSTRACT. *Aristotle's observations in the world of living beings do not have the character of natural laws, in today's sense of the word. They testify primarily about a high correlation between forms and functions of body organs and environmental conditions, and what will be confirmed in the New Age by the theory of evolution (Darwin). However, he formulates several general principles of inference we quote: (1) "Nature does nothing in vain" [Aristotle, 1943, II, 741b], (2) "Nature does nothing superfluous" [Aristotle, 1994 – 2003, II, 691b], (3) "Nature acts according to a goal" [Aristotle, 1965, II, 471b].*
As well as the principles he has named as: the principle of compensation and balance and the principle of economy. The first of them reads as follows: (4) "Everything needs something to counterbalance it, in order to achieve a balance and the mean" [Aristotle, 1994 – 2009, II, 7, 652b], and the second one as: (5) "When nature has the aim to create something, it strives to 'consume' the minimum of material in that way". He, of course, has in mind four causes of all that exists in the inanimate and living nature, namely: material, formal, efficient and final cause, whereby, in the organic world, a particular importance he attributes to the last of them.
Aristotle, therefore, made plenty of observations about the adaptability of species to the environmental conditions, but did not derive conclusions about the disappearance of those forms of living beings with which it was not the case. Namely, both plant and animal species, according to him, nature has built up such as they are, once and forever.

Contents

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1. About four causes in nature etc.

When Aristotle describes carefully his observations in the world of living beings, he does not try to formulate the laws of nature, in the modern sense of the word. What he notes are different observations in many species, in character "external" ones, between certain organs and their functions, that occur in many cases, or frequently. In this sense, he speaks about the principles, rules, etc., which haven't the character of biological laws, whose validity would concern all biological individuals in the broadest sense of the word. (Such is in character, for example, the current law of evolution, whose validity do not meet the exceptions.) It is important to make sure as well that Aristotle excludes the presence of supernatural forces in the explanation of biological phenomena, like God, etc.

According to him, the emergence of each thing (being) in nature is owed to mutual relations of quadruple causes, what he illustrates in the example of a sculptor and his work. A sculptor, say, decides to carry out the figure of God Hermes. He chooses first a valid piece of marble on which he will accomplish his work and the appropriate tools afterward: a hammer, a chisel etc. for the same reason. The result would be the figure of Hermes, carved in marble. Here each of four moments is for him a "natural cause", which is differently appointed, and so in that sense, he speaks about a material cause (*causa materialis*), a formal cause (*causa formalis*), an efficient cause (*causa efficiens*) and a final cause (*causa finalis*). In the mentioned example, his material cause would be a piece of marble, a formal cause – the idea in the mind of the sculptor, an efficient cause – the associated tools and a final one – that which Hermes' figure would serve, as accomplished one.

We identify these four causes also when the matter is of formation of living beings. In fact, in the *Generation of Animals*, Aristotle finds that two and two of them are very close so that it is possible do not distinguish them. It would be the case with material and efficient cause, on one hand, and formal and final cause, on the other, or in his words:

> As we know, there are four basic causes: (1) 'that for the sake of which' the thing exists, considered as its 'end'; (2) the logos of the thing's essence (really these first two should be taken as being almost one and the same); (3) the matter of the thing, and (4) that from which comes the principle of the thing's movement. [Aristotle, 1943, I, 1, 715a]

Besides it, in the world of living beings, Aristotle attributes a particular meaning – to the final cause. In this regard, he notes that certain specific features of living beings, such as hair color, a color of the eye, of the voice in men are owed only to a material cause, not serving a specific goal. And when he speaks about the fetus, he denies Democritus theory, according to which its development depends on the mechanical movement of the uterus and the way of mother's breathing. And all that for the sake of an end towards which it tends, as well as of necessities ruling in nature – such as humidity and heat necessary for its development. It shows that nature of Aristotle is an ordered whole, where the same causes lead to the same results, etc.,

what helps him, by presenting his observations in the world of living beings, to formulate more rules, whose validity is sufficiently general.

Such rule is, say, according to him, that of an ordinary relation between the number of teeth and the length of life in animals. In the sense that animals having more teeth live longer, or if they are more densely spaced than those where the case is reversed. Or that the length of life depends on the presence or absence of bile in the liver and the like. But if on the basis of these conclusions are only external observations, when the matter is of blood and its properties, Aristotle will find – something that is more founded – if the animal's blood is rarer, its intelligence is bigger and the sensuality more developed, bearing in mind that blood is a substance that feeds the organs of the body. As he will conclude, say, from the form (size) of heart about the character of an individual, finding that those animals whose heart is, as an organ, big, are shy and lazy etc.

Aristotle finds a connection also between the way the animals move and species they belong to. According to him, all bloodless animals have more than four points of support in moving, and warm–blooded animals – maximum four. Or that the number of legs in animals is always even and that quadrupeds perform their steps "diagonally". When observing birds, he will find that those of them having long necks have such legs as well (except palmipeds), or that there is no bird with a feathered tail, not having a lot of feathers on wings too etc.

When it is about the animal world, as the most general laws that apply without exception, Aristotle carries out the fact that each animal – even the smallest one – feeds, as it is proper to each of animals to reside solely, or mainly, in one of four proto–elements: earth, water, fire or air. For example, to birds in the air, to fish in the water, and to all other animals – on land. It is of an importance also his observation that a minor change in a "small" organ of the body, can lead to essential changes in the function of the whole organism. Like resizing an embryo, which can cause the sex change, or small changes of an organ in a castrated male, which can bring to gender reassignment of an animal. In this way, even the smallest part of an organism is the holder of the principle of a species, that plays a crucial role in its functioning.

In the words of Aristotle:

> But if in the sanguinea it is the parts concerned in copulation that differs primarily in their forms, we must observe that a small change in a first principle is often attended by changes in other things depending on it. This is plain in the case of castrated animals, for, though only the generative part is disabled, yet pretty well the whole form of the animal changes in consequence so much that it seems to be female or not far short of it, and thus it is clear then an animal is not male or female in virtue of an isolated part or an isolated faculty. [Aristotle, 1943, I, 2, 716b]

Let us mention a general principle also, recognized by Aristotle in leaving and in inanimate nature, that is the principle of order and beauty. Namely, we see the harmony of celestial bodies, of them as non–created ones, but also a harmonious

performing of functions of organs in the body, according to the aim it is proper to it. And when it is about the beauty, each body, as a rule, is "double" one, Aristotle says, because almost all of its organs are symmetrical – what indicates a particular balance in the body.

2. "Nature does nothing in vain", "Nature does nothing superfluous", and "Nature acts according to a goal"

"Nature does nothing in vain" is one of the major principles, which helps Aristotle not only to explain the structure of organs and the way of life of living beings, but also the origin of species. Nature clearly knows what it wants and persistently tries to achieve it. In that way it confirms its ingenuity: as an artist, it outlines the shape of a human fetus and, step by step, it forms each organ of the body. Not making, therefore, anything in vain – so, for example, nature did not "earmark" eyelids to fishes, since the aquatic environment, according to him, has no impurities such as air environment

Aristotle says about it:

> Fishes, however, have eyes of a fluid consistency. For animals that move much about have to use their vision at considerable distances. If now they live on land, the air in which they move is transparent enough. But the water in which fishes live is a hindrance to sharp sight, though it has this advantage over the air, that it does not contain so many objects to knock against the eyes. The risk of collision being thus small, nature, who makes nothing in vain, has given no eyelids to fishes, while to counterbalance the opacity of the water she has made their eyes of fluid consistency. [Aristotle, 1994 – 2009, II, 13, 658a]

But as nature does not anything superfluous or vain, it does not anything that is sooner or later, equally striving – of more possibilities – to achieve the one which is the most optimal. An example for it Aristotle finds in man, to which nature has implanted hair on the anterior of the body, because his vital organs are on that side. Differently than in animals quadrupeds, whose hairs are thick on the back, and rare on the stomach, just because those organs are, in a way, protected.

Or, in his words:

> The reason for this is that hair is intended to serve as a protection to its possessor. Now, in quadrupeds, owing to their inclined attitude, the under or anterior surface does not require so much protection as the back, and is therefore left comparatively bald, in spite of its being the nobler of the two sides. But in man, owing to his upright attitude, the anterior and posterior surfaces of the body are on an equality as regards need of protection. Nature, therefore, has assigned the protective covering to the nobler of the two surfaces; for invariably she brings about the best arrangement of such as are possible. [Aristotle, 1994 – 2009, II, 14, 658a]

3. The principle of compensation and balance

The other two general principles in nature help Aristotle to explain the morphology of living beings and species. They are *the principle of compensation and balance* and *the principle of economy*. The first of them he describes by the words: "Everything needs something to counterbalance it, in order to achieve a balance and the mean". [Aristotle, 1994 – 2009, II, 7, 652b]. In other words, nature seeks to preserve the proportion of all things, namely, so that a surplus on one side would not prove fatal for it, it allotted the opposite side to it, to compensate that surplus. Something similar had in mind Heraclitus when he says: "All things are exchanged for Fire, and Fire for all things, even as wares for gold, and gold for wares". [Heraclitus, frg. 90]. It is interesting that Aristotle explains the role of the brain by means of this principle, that is, this area of the body, in the skull, which is cold, has the role to make cool another area, the area of heart which is warm. (He, therefore, did not know what exactly serves the brain, the most complex organ of human body).

He says about it:

> For nutrition and the imparting of motion are offices of the soul, and it is by the heat that these are most readily effected. To say then that the soul is fire is much the same thing as to confound the auger or the saw with the carpenter or his craft, simply because the work is wrought by the two in conjunction. So far then this much is plain, that all animals must necessarily have a certain amount of heat. But as all influences require to be counterbalanced, so that they may be reduced to moderation and brought to the mean (for in the mean, and not in either extreme lies the true and rational position), nature has contrived the brain as a counterpoise to the region of the heart with its contained heat, and has given it to animals to moderate the latter, combining in it the properties of earth and water. [Aristotle, 1994 – 2009, II, 7, 652b]

Aristotle finds afterward that the developing of some organs in living beings is "followed" also by the said law of balance, in this sense, say, that each particular development of an organ or a function, takes place at the expense of other organs, or other function of the organism. It would be the case with the developing of horns in mammals, which, according to him, is connected with the lack of teeth in the upper jaw of the animal. Because the nutrients needed to both organs, go this time to one of them, and so, in that way, nature takes something of one side, to give it to another. Or, say, bears have a thick fur, precisely because their tail is short, just as in animals whose feet are separated, this shortfall is "compensated" by the development of horns on their head.

Many other examples too go in the favor of the validity of this rule, according to Aristotle.

For example, the animals which have tusks, like elephants, do not have horns, or those having a strong jaw, have no fangs, nor horns. In the same sense, nature has "rewarded" wading birds with long legs and long beaks, but, in turn, it has significantly weakened their ability to fly. These birds also do not have long feathers

on the tail, for the same reasons of saving material of the body, and so long as they fly, they stretch out the leg backward to compensate this deficiency. Let us mention, on this occasion, birds of prey, whose wings are disproportionately higher than rest of the body, and which were developed to serve precisely what is essential for their survival – feeding.

After, the principle of compensation, or balance, not only explains the place and the morphology of organs, but also the function they perform in the body. An example for that Aristotle finds in women by which the monthly duty cycle is absent at the time of pregnancy, because both processes use the same food in the basis, and which is now drawn by nature on the side of the infant.

Various examples of other type go in favor of a particular biological balance, which is recognized if one compares the size of an organism of an individual of a species and the number of offspring it leaves. Namely, this relationship is inversely proportional. That is perceived in mouse, insects, fishes ... which multiply almost without ceasing and whose offspring are numerous, while their organisms are relatively small. Similarly, in hens, the case is such that the smaller of them lay more eggs than the bigger ones etc., what Aristotle explains again in terms of balance: the lack of physical material on one side is compensated by the abundance of samples of the same species (by a surplus of breeding material) on the other.

And this phenomenon is evident, of course, in the world of plants too.

4. The principle of economy

The principle of economy in nature is in that when it has to create something, it strives to "consume" a minimum of material in that way. According to this principle, say, the long bones of vertebrates are thick but hollow and not all filled.

Trying to explain the other phenomena in the animal world by the application of the principle of economy, Aristotle mentions the mouth, as an organ, whose primary function the food intake, is "supplemented" by multiple other functions, such as: chew food (in some species), breathing, creating voices (speech). Also, the nostrils in animals have a dual function: as an organ of smell, and as an organ of breathing. Let us mention several other organs with more than one function. The tongue is an organ of taste, but it takes part in the creation of voices. In elephants the trunk has a role to grab and carry everything in its domain, just as it is the organ of breathing. The role of the kidneys is twofold as well. And at the same time, to man's hands belong various features which are difficult to be named all. However, nature, he notes, do not do it at all costs and in all cases, but only where it is most appropriate.

Finally, as the confirmation of an universal validity of the principle of economy in nature, Aristotle states that only those animals possess particular organs, which are capable of using them. This is the case with organs of attack and defense: the teeth fangs, horns, claws ... we meet only where they are properly used, that is, in the beasts, oxen, raptors, as follows. Or, in turn, the bent claws, in birds, raptors, and the interdigital webbing on the feet in geese and others. It would be always, therefore, so the animals possess only those organs that correspond to the highest degree of a

function they serve, performing this function in the most appropriate way and in the best conditions.

Here's a quotation to illustrate it:

> The Good Fliers have big strong wings, e.g. the birds which have crooked talons and feed on raw meat: these must be good fliers owing to their habits of life, and so they have an abundance of feathers and big wings. But there are other sorts of birds which are good fliers beside these: birds safety lies in their speed of flight; and migrants. Some birds are poor fliers: heavy birds, which spend their time on the ground and feed on fruits; or birds that live on and around the water. [Aristotle, 1994 – 2009, IV, 12, 694b]

When it is about the organs and their functions, and having in view the rational power of the human race, Aristotle states as a principle that such a being is more intelligent which can use multiple tools. Thus he concludes that man has developed his hands because he is reasonable being and because he has used this natural power to assign various functions to that organ. In contrast to Anaxagoras, who spoke that man is more intelligent than other animals precisely because he has hands. Or else, what the Sophists say of human being that it is born naked and barefoot, that it begins to walk with difficulty, etc., and is therefore not adapted to its environment.

Aristotle says about it:

> Now it is the opinion of Anaxagoras that the possession of these hands is the cause of man being of all animals the most intelligent. But it is more rational to suppose that his endowment with hands is the consequence rather than the cause of his superior intelligence. For the hands are instruments or organs, and the invariable plan of nature in distributing the organs is to give each to such animal as can make use of it; nature acting in this matter as any prudent man would do. For it is a better plan to take a person who is already a flute–player and give him a flute than to take one who possesses a flute and teach him the art of flute–playing. [Aristotle, 1994 – 2009, IV, 10, 687a]

Aristotle finds that the advantage of human being in this regard is still multiple, because what animals bring as protection in their coming to the world, it stays forever, as the only thing they have, while the man is able to find out, directly or indirectly, the most diverse means to protect himself from unfavorable conditions of environment. Because his hand itself, or indirectly, can achieve the effect of claws at prey, of horns in animals that have horns and the like.

Epilogue

Aristotle, therefore, in speaking about the phenomena of living beings has reliably bowed, first, to laws “shared” by the uncreated world, as well as the created and changeable one, such as the quadruple causes of all that exists, or the principle in nature that the same causes lead always to the same results. According to him, there

is no principal difference in development between the animate and the inanimate world, what would be a valid basis in the science the universe to be interpreted on the basis of itself, beyond of supernatural, the divine and similar elements in its development. He also did not find that the most diverse animal species owe their existence, say, to some chaotic state of the universe at the beginning, to a case, but that everything or being is created "for something", as well as it persists for the sake of something. It is a teaching of purposefulness that exists in nature. According to him, species became "from nature", from the beginning such as they are, made as we have seen "by a plan": to be adapted to the environment in which they live, to "follow" the optimal ratio between the organs and their functions, that is, do not exist those which serve no purpose, nor those which are a surplus etc.

Although it could be differently objected to his observations and conclusions, it falls into eyes already at first glance the main terms of the relationship of species and the environment, of organ forms and functions they perform in the organism and the like. But this terminology is largely the one that will bring, more than two millennia later, say, the theory of evolution of Charles Darwin (1859). In fact, Darwin drew, as it is known, from the adaptability of individuals to the environmental conditions, the far-reaching conclusions about the origin of species, that is, that all species have evolved from the same initial forms, but only those have survived that were fit to the environmental conditions (the mechanism of natural selection). On that path, the path of evolution, he speaks about the so-called mutations, as on those morphological changings within a species, that will lead over time to a new species, since they would be transmitted through inheritance.

Aristotle, as we have said, made many observations about the highest "harmony" among nature, on the one hand, and the morphological and functional characteristics of biological species, on the other. But he did not make conclusions about the former life forms that are not preserved during their development. Although his researches were in favor of the validity of (a part) of Darwin's theory – that, precisely, about a mutual correlation between the survival of the species and environmental conditions.

In addition, now we know that hereditary characteristics and their changes (mutations) are related to the gene (1953), what, again, is closely to Aristotle's intuition, to his "idea", which is potentially contained in each thing or being, and which seeks and finds a way to actualize itself in the matter. Just as the basic characteristics of a (further) being are contained in the genes. And what tells about the extent in which the natural–scientific observations of Aristotle in biology could be compared to the contemporary teaching about living organisms and species. Since Aristotle did not possess knowledge about the structure of matter on its micro level: he didn't know what are atoms, cells, etc., nor ways of reproduction of living organisms, and the like.

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