BIOLOGICAL CHARACTERS AND BIOLOGICAL PRODUCTS

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The word "Biology" comes from a Greek word meaning "Life," and the science of Biology is or should be a science of life. But what is life?

Under the head "Life" in the Encyclopedia Britannica, it is said that "the definition of life must really be a description of the essential characters of life". The article from which that quotation is taken is two pages long; yet there is in it not one word about any "character of life". We are told only about the structure in which life sometimes exists, but nothing about life itself. To meet this situation we must use some illustrations.

A cow will produce milk. That is, she can produce milk if she is alive, but not if she is dead. From this it is evident that the power of producing milk is a character of some form of life, and consequently it is a biological character. But the milk is not a character of life. It is a product of life, and consequently a biological product. There is a fundamental distinction between milk and the power of producing milk.

A cow can be regularly bred provided she is alive, but not if she is dead. From this we see that the power of reproduction is a characteristic of life. If a cow is regularly bred and regularly milked, she will produce a certain quantity of milk when she has her first calf, a greater quantity when she has her second calf, still more when she has her third calf, more yet when she has her fourth calf, and so on up to at least her tenth calf.

Here we see that one characteristic of life is the power of producing a product, and another characteristic of life is that the first characteristic is increased by its own activity. Stating the matter in other words, the development of powers by exercise is a biological character.

Power of producing milk is an inherited character, as is evident from the fact that it is found in a cow when she has her first calf, and power of producing milk is an acquired character, as is evident from the fact that it increases from year to year in cows which exert themselves in the production of milk. The inherited character and the acquired character are identical characters: and the fact that acquired characters are inherited is seen from the fact that the later calves of a cow inherit greater milk-producing power than do her earlier calves.

If you plant an acorn, it will grow. That is, it will grow if it is alive, but it will not grow if it is dead. Thus we see that the power of growth is a characteristic of life, and consequently it is a biological character. We also see that a physical body is not a biological character, and that is true even when that body is the germ plasm of a seed. The seed may be dead.

When an acorn grows it will become a tree, and in due time that tree will produce a thousand other acorns. In each of those thousand acorns there is just as much life as there was in the original acorn from which the tree grew. In other words, that tree gives forth a thousand times as much life as it inherited, and it still has more left on hand than it had in the first place. That extra life did not come from nowhere out of nothing. It was acquired by the tree in its process of living, and what those thousand acorns inherited was what the parent tree acquired. It is a characteristic of life that it can absorb powers from the inorganic world, and can transform those powers into new life which is inherited by offspring.

If you cut off the tail of a mouse, that tail will stay off, and that is true whether the mouse is alive or dead. Thus we see that the tailless condition is not a character of life, and consequently it is not a biological character. It is an effect produced by the non-biological environment.

Weismann cut off the tails of mice, and he then bred those mice. He cut the tails from the second generation of mice, and then bred those mice to get a third generation. He cut the tails from the third generation and then bred those mice to get a fourth generation, and so on for many generations. The last generation had just as good tails as the first. This is an illustration of the fact that non-biological things are not biologically inherited.

If you cut off the tail of a mouse, there will be produced a wound, and the wound will heal. That is, the wound will heal if the mouse is alive, but it will not heal if the mouse is dead. The healing of a wound depends upon the existence of life, and consequently the power of healing is a biological character. When Weismann cut off the tails of mice, the wounds healed. He then bred those mice and cut the tails from the second generation. Again the wounds healed, and he bred the second generation of mice to get the third, and so on for many generations.

Did those wounds heal more rapidly in the later generations than in the earlier ones? Unfortunately, Weismann did not tell us; yet that wound-healing was the only biological thing associated with that tail-cutting operation. The fact that the non-biological part of this tail-cutting experiment is cited at the present time as evidence against inheritance of biological things is itself evidence that real biological characters have not been given proper consideration. And the fact that biological characters have not been given proper consideration is the reason why the article on "life" previously referred to does not tell us anything about life.

When the germ of a mouse starts on its embryonic career it will produce a tail provided the germ is alive, but not if it is dead. We thus see that the production of a tail is dependent upon the existence of life, and the tail is a product and not a character of life. There is a distinction between a tail, and the power of producing a tail.

Biological characters are characteristics of life itself. Biological products are physical structures which are built by life. Another distinction between biological characters and biological products is that characters are inherited and products are not. A man does not inherit a Roman nose. He inherits a life which builds a nose in one generation in substantially the same form that it built it in previous generations. Or, if we wanted to be technically accurate, we would say that there is no such thing as inheritance. There is only a continuity of expanding and contracting life which repeats over and over the same things it did in previous generations.

Life has the power not only of building structures, but it has the power of tearing down a structure already built and rebuilding the material into a structure of a different form. A caterpillar will spin for itself a cocoon within which it is shut away from the environment. Here it will tear down the caterpillar structure and rebuild the material into a butterfly. The butterfly structure is very different from the caterpillar structure, but the same life is in both of them. A biological character is not determined by the structure in which it is found.

When the lens of the eye of a newt is torn out, the life in the newt rebuilds that lens from totally different tissue found in the edge of the iris. When Lewis cut the developing eye of a tadpole from connection with the brain and pushed it back under the skin to the region of the shoulder, the life in that tadpole used part of the skin as material out of which to build a lens for that eye.

If an egg is kept warm so that it does not have to radiate heat to the atmosphere, that egg will develop into a chick. That is, the egg will develop into a chick provided it is alive, but will not if it is dead. In this process the life within the egg tears down the structure within the shell, and rebuilds the material into a new structure in which there is a complicated series of organs formed of bones, muscles, skin, feathers, and so on.

In all of these cases biological characters build structures, and these structures are biological products. But no structure can produce life. Life is not a function of structure, as is sometimes stated. If it were, then there could be no such thing as a dead animal because it is impossible to separate a function from the thing of which it is a function. Life is a distinct entity just as heat, light and electricity are distinct entities.

A horse can be trained and raced provided he is alive, but not if he is dead. This means that the power of racing is a biological character. When a horse is trained and raced he will gain in racing power just as a cow will gain in milk-producing power when regularly milked. By the records we learn that if the horse is trained and raced year by year he will continue to gain in this biological character up to at least seventeen years of age. We also learn by the records that under continued training a horse may develop a racing power beyond any possible inheritance. That is always the case when a horse becomes a champion, at either trotting or running.

When a horse which has been trained and raced is permitted to stand idly in stall or paddock for some years, he gradually loses his racing powers. This biological character gradually dissipates. But as a character cannot be separated from the thing of which it is a character, the thing which really dissipates is life itself. It is a characteristic of life that it adds to itself by its own activity, and correlatively, it is another characteristic of life that it dissipates and becomes less by inactivity.

During the middle part of the last century there was established a doctrine of energy, and certain laws of thermodynamics. There are two laws of thermodynamics, the second of which is stated in such technical language that it is not generally understood. These laws are limited to the relationship of heat to force and motion, but for our purpose we will broaden them out to cover all forms of energy. Energy, by the way, is defined as stored work, and all forms of energy are measured in terms of work.

The first law of energy is known as the Conservation of Energy. This is a simple statement which means that no matter what may be done, or how many times energy may be transformed or shifted about, no new energy can be brought into existence, and none of that in existence can be destroyed. No one has yet made a perpetual motion machine, or found anything else to cast doubt on this statement.

The second law of energy is more complex, but may be set forth in simple language under three heads.

(a). For energy to perform work, it must exist at a high potential, and must run down to a lower potential. Examples: If a spring is the instrument thru which energy operates, the spring must be wound up, and the tighter it is wound the more work can be performed. If water is the instrument, then the water must be raised to an elevated position from which it can run down, and the greater the elevation the more work can be performed. If a gas, such as air or steam, is the instrument, then the gas must be under pressure, and the greater the pressure the more work can be performed when it expands to a lower pressure.

(b). Energy left to itself always dissipates. This is known as the Dissipation of Energy. Examples: When an object is heated to a high temperature and permitted to stand, the heat will gradually radiate away. If a storage battery is charged and permitted to stand, the charge leaks away.

(c). Energy can be raised from a lower to a higher potential only by the performance of work. This is a logical consequence of (b), and can be illustrated in many ways. It requires work to wind a spring, to elevate water, to compress a gas, and so on.

For convenience we may make a third law out of the statement that all forms of energy may be transformed into each other, either directly or indirectly. We transform heat into motion, motion into electricity, electricity into light, light into chemical action, chemical action into heat, and so on.

When put to the test, it is found that biological characters in general, and even life itself, respond perfectly to all three of these laws, and to all of the sections of the second law. This means that life itself is a form of energy, and that the laws of energy are the most fundamental of biological principles. A few illustrations will serve our purpose.

When you wind up a spring you store work (energy) in that spring, and the energy thus put into the spring is identical with the energy we know in mechanics. It can be used to perform the same kind of work as if it came from a steam engine. This energy stored in the spring is not newly created energy. It came out of your muscles, and was part of the store of energy you had there.

If you work hard at winding springs without rest, you will become fatigued, and fatigue is simply a signal that the energy supply in your muscles is becoming depleted. If you work hard enough and long enough without rest, you will cause your own death from no other cause than the abstraction of energy. If abstracting energy is abstracting life, that fact shows that life is a form of energy.

The racing power of a race horse is the power of moving a physical body from one place to another, and that is the same power we know in mechanics. When a race horse stands idle for a considerable time, his racing power declines as the result of that idleness, and this decline is in accordance with section (b) of the second law.

When a horse is trained, he is worked until his energy supply is partly, but not injuriously, depleted, and he is then permitted to rest until his energy supply is restored. He is again worked and again rested, and so on. Under this system, the energy potential in his muscles is gradually increased, that is, more energy is stored in the same weight or bulk of substance. This is in accordance with section (c) of the second law.

You have mental energy stored in your brain cells, and that mental energy enables you to think. You also have muscular energy stored in your legs, and that muscular energy serves you for locomotion. It is clear that mental energy and muscular energy are not the same. But if you run a foot race until you are tired all over, you are in no condition to think clearly. The mental energy stored in your brain cells has been transformed into muscular eneregy and has been expended thru your legs. This is in accordance with what we have called the third law, and shows that while mental energy and muscular energy are of different species, they are of the same genus.

A man is useful in this world for what he does, and not for what he looks like, how tall he is or how much he weighs. This means that the essence of value in a man or any other living thing is in the biological characters, and not in the biological products. It is common to think of biological structures as being the real things, and energy or life as being a tool which structures use, but that is an erroneous view to take.

Physiologists and biologists in general claim that their conceptions are fundamentally mechanistic, but to be mechanistic they must accord with the principles of mechanics. In mechanics, the motive power is the essential thing, and is recognized as being the same no matter what form it may take. Given the power, the same work may be accomplished with any one of a great variety of tools, all of which are structures.

The same is true in the biological field. Given the necessary life, the same work may be performed by animals of widely different structures, or even by plants. If a tree is alive, it will raise tons of water for hundreds of feet by structures very different from those found in a pumping station, or in animals which also raise water to elevated positions. It will not do to ascribe these forces to the environment. There is nothing in the environment which will cause sap to flow upward in a tree if the tree is dead.