

The Eighth Article brings to view the results of the *studies in the growth of plants* by that wonderful observer of nature, CHARLES DARWIN.

The Reviewer agrees with Mr. Darwin as to the real action of plants in growing, but decisively differs with him in his surreptitious attempt at obliterating the distinction between plant action and animal action. Mr. Darwin insinuates analo-

gies tending to identify plant life with animal intelligence. The Reviewer first states the true nature of plant movement, showing that it is all mechanical; being, in fact, caused by the incoming of new force and substance in the process of growth. Plants, Mr. Darwin shows, "circumnutate," that is, nod about, and with the tip of their radicle adapt themselves to conditions of warmth, light, and softness of adjacent substance. The Reviewer replies:

But animals do not circumnutate. Their movements are of a strikingly different character from the nodding and staggering gyration which is here pointed to as the primary process in the plant. The stems, roots, and leaves are thrust out in consequence of the interstitial deposit of new material in the growing textures, and the extending shoots assume a spiral form of advance because the thrust is exerted more on one side than on the other. The onward projection is thus essentially a process of growth from the addition of substance, and all the irregularities in the halting progress are immediately ascribed to a purely physical cause, the swelling or increased turgidity of the tissue at the point where the sidelong thrust occurs. The only circumstance that at all warrants the assumption of a resemblance in the strongly contrasted processes is the fact, which Dr. Darwin has brought prominently into notice, that the mechanical impulse of the disturbing influence originates not at the spot upon which the effect of that impact is transmitted by an intermediate agency seated in the organization of the plant. He is obviously aware that this is the strong point of the argument for resemblance which he suggests, as in one notable paragraph he says, "But the most striking resemblance is the localization of sensitiveness, and the transmission of an influence from the excited part to another, which consequently moves." The effect here alluded to is, no doubt, very remarkable, and well deserving of the further examination which it will assuredly receive at the hands of physiologists. But it can hardly be conceived to be strong enough to support any comprehensive hypothesis of the identity of vegetable and animal movements. Dr. Darwin himself says, "Plants do not, of course, possess nerves or a central nervous system." But he then deprecatingly and somewhat significantly adds, "And we may infer that with animals such structures serve only for the more perfect transmission of impressions, and for the more complete inter-communication of the several parts."—Pp. 258, 259.

The line between intelligence and volitional action in the animal, on one side, and the merely mechanical action under growth forces in the plant, is drawn by the Reviewer at length

and with great clearness and beauty. For this purpose he selects the lowest known form of animal life, the *Amœba*.

The creature is found most commonly in the slime which collects upon submerged or floating objects. It is apparently destitute even of a skin, and it has no internal organ of any kind. It is simply a small mass of animated jelly, possessing the power of streaming half coherently about under some mysterious and apparently spontaneously exerted impulse. When first placed upon the glass slide of a microscope, it presents the aspect of a small, round, transparent mass; but finger-like processes soon begin to be pushed out from the pulp in various directions, somewhat after the manner of the horns of a snail. Some one of these having at last fixed itself to the glass, the rest of the mobile jelly rolls over the attached part, and then begins to push out other processes. The amœba, in reality, travels along the glass in this grotesque shambling way. By the mere flow of its half-coherent living substance, it not only changes its form, but shifts its position. If, during its Protean shambling progress, it comes in contact with any fragmentary morsel suitable to be turned to account as food, it spreads itself over the fragment until it envelops it within its own substance, and in that way extemporizes a digestive cavity or stomach, where the morsel soon gets dissolved and converted into living protoplasm. Indigestible matters, which cannot be so turned to account, are dismissed by a reversal of the process; the fluent jelly loosening its grasp, rolling itself off, and so leaving them behind as it moves away in some other direction.

This microscopic changeling of Ehrenberg is an object of the very deepest interest to physiologists, because it is a typical specimen of the raw material of animal life presented to observation in its simplest and least-disguised form. Although a mere lump of animated jelly, without any trace of specialized organization, it yet manages to perform several of the most important operations of animal life, accomplishing, in its organless state, results which, in the more highly endowed animals, are performed only through the instrumentality of an elaborately complex and diversified apparatus. It extemporizes, in the rudest, but nevertheless most effective way, actions which are essential to its lowly form of existence. Its fluent pulp serves it in the place of limbs. It turns its own flesh into a stomach, and secretes a digesting juice round its entangled prey. It assimilates and appropriates food, and turns it into mobile living substance like itself. It consumes its own pulp by the wasting efforts of its movements. It reproduces living lumps like itself by breaking up into fragments, and above all *it breathes*, not through the specialized appendage of lungs, but throughout its entire gelatinous mass. The air permeates its naked or skinless pulp, and oxygen is appropriated and carbonic acid generated and expelled. It is oxidized, or burned, so to speak, and its

powers of shambling movement, of digesting food, of elaborating secretions, and of performing other allied operations, are as essentially a result of that combustive oxidation as the flame of a candle is the result of the burning of its stearine or wax. This process of oxidation, or faculty of breathing, indeed, constitutes its claim to the distinction of being "animated." The word simply implies that it possesses *anima*, or breath. This, then, is radically the difference to which it is our purpose to draw attention. Plants move because they grow. The circumnutations which Dr. Darwin discovers at the bottom of the movements of the plant, is an effect of growth. It is due to the elaboration and building up. Wherever it is manifesting itself, carbon is in process of being fixed, and oxygen in the process of emancipation and discharge. But the animal protoplasm—the basement of animated flesh—moves because it is in process of combustive destruction, which is the exact opposite of elaborating construction. Heat is appropriated in the case of the vegetable movement, and rendered latent as one of the constituents of the accumulating structure, and as an implement of cohesion. The sunshine is actually put to the work of holding together the constituent elements of the molecules of the enlarging mass. Heat is set free, in the case of the animal movement, as a supply of energy or power capable of doing work, and in the breathing animal, as a result of the dissolution and destruction of the cohesive integrity of previously built-up molecules.—Pp. 259, 260.