# VI

# THE RELATION OF INDIVIDUALITY TO MATTER; CONCLUSION

"Shall man into the mystery of breath,
From his quick-beating pulse a pathway spy?
Or learn the secret of the shrouded death,
By lifting up the lid of a white eye?"
MEREDITH.

A very striking experiment can be made on many of those free-living flatworms, the Planaria. If they are cut in two longitudinally, the halves will regenerate into perfect wholes, and this whether they are fed or not. If not fed they present us with a strange spectacle (Fig. 15). Without food, they cannot of course rebuild their missing block of buildings as we should, with new bricks: indeed, as energy has to be expended in the construction, some of the existing materials must be sacrificed as energy-producers, so that by the time the bit of worm-protoplasm has turned itself into a worm, it has actually decreased in bulk (Fig. 15). The half-worm has never ceased to exist as a half, but has somehow managed to become an ever smaller half while remodelling itself continually and at the same time handing over material for the building of what is missing. Finally the other half is completed—a whole worm has been made; up till now the old half had been decreasing rapidly in size, the new increasing almost as fast. From the

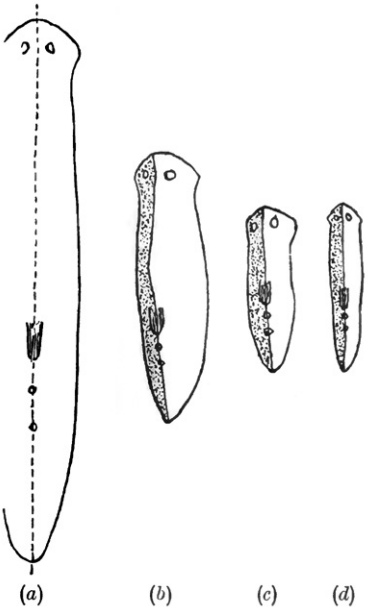


Figure 15
*Planaria lugubris*. Four stages in the regeneration of a whole from a longitudinal half. The dotted line in (*a*) marks the line of the cut. The stippled areas represent regenerated tissue. The figures are all drawn to scale. (After Morgan.) (Slightly magnified.)

time that a whole is formed, both halves behave alike, decreasing slowly together as a result of starvation.

This and many other similar facts tend to show that the relation of form, and so (since specific form or structure is only the visible machinery of a specific working) of individuality in living things to its physical basis of matter, is primitively a simple one, though one that is at variance with all our preconceived ideas. It seems to be this: any separate mass of one kind of protoplasm will be able to, or rather must, make itself into an individual with the form characteristic of the species. The

only provisions are that it is neither too large nor too small within certain defined limits and, of course, that the external conditions are favourable.

Facts suggesting this we have seen in Clavellina, in Stentor, and in Sycon:[1] indeed, as I have said, it really seems to be an original attribute of life, only more wonderful and startling than ordinary embryonic development because it is no regular part of the cycle of the species. Through its help the animal can extricate itself from positions in which it has never before been.

But, like most other primitive attributes of life, it has undergone considerable restrictions in the course of evolution. Animals, like men, cannot have their cakes and eat them. Three main factors have led to a restriction of this power of regeneration. The first is the formation of different substances for the performances of different functions, and their subsequent segregation into different regions of the body. These substances may get so specialized, so different from each other and from their common ancestor, that one cannot produce the other, and the presence of both is necessary in a mass of substance which is to give rise to a whole individual. In Stentor, for instance, although both nucleus and cytoplasm alike are living Stentor-protoplasm, yet a bit of one without the other will not regenerate. Here the two substances have been segregated by internal differentiation within the cell. Something similar occurs in Sycon, where the collar-cells by themselves cannot regenerate the other forms of tissue necessary to make a complete sponge; here aggregate differentiation has been at work, and whole cells and tissues are affected instead of parts of cells.

The second narrowing factor is harder to precise; but though we do not know its exact nature, we can often see it

at work. There are many animals, such as man himself, where regeneration is almost non-existent although in any given case all the necessary substances and kinds of tissue would appear to be present. Here the failure to regenerate seems to stand in some general relation with the degree of specialization of the tissues; most animals can regenerate more completely when young or embryonic than when they are grown up.

The third factor is more obvious: certain bits of organic machinery are of such a nature that it is physically impossible for the animal to live at all if they are seriously tampered with. It is just because our blood-circulation is so swift and efficient and our nervous system so splendidly centralized that damage to heart or brain means almost instant death to us while a brainless frog will live for long, and a heartless part of a worm not only live but regenerate. Thus here again sacrifice is at the root of progress, and only by surrendering its powers of regeneration and reconstitution has life been able to achieve high individualities with the materials allotted her.

But this original property of living matter is important to us in one way. We begin to realize what an influence the correlation of parts can exert—how one part can affect others by its mere presence or absence. In Stentor, each bit that if separated from the rest would grow into a perfect little whole, remains as a part as long as it is connected with the other parts. If it forms a part, it is because of its relation with other parts; if it forms a whole, it is because it is freed from that relation. Whatever it does, in fact, is due to the tendency of any separate mass of Stentor-protoplasm to form a whole Stentor.

Exactly similar is the behaviour of the blastomeres or separate cells of the segmenting egg (pp. 52–53) only here the subordination is in one way more startling, for each of them is a single cell and represents historically a whole individual.

Similarly in all animals where small fragments can reconstitute miniature wholes, the fate of any particular cell in a fragment is determined very largely by its position in the fragment, and would be different if the fragment were of a different size or shape.

This "tendency towards wholeness" thus manifests itself across cell-boundaries as easily as through the more continuous substance of a single cell. More than this, it often seems to disregard them altogether. Many facts of embryology, as when form appears first and cells only later, lead us inevitably to a standpoint resembling that of Whitman (19), when he says of normal development:—"the plastic forces heed no cell-boundaries, but mould the germ-mass regardless of the way it is cut up into cells." Such considerations have led him and several others to throw up the cell-theory altogether, saying that the cells of a metazoan are not homologous with free-living protozoan individuals, but are merely convenient bricks, so to speak, or centres of local government, produced by the forces of life after the form of the creature had been established. But such a conclusion cannot be justified. We must carefully distinguish between what exists to-day, whether in adult body or developing embryo of a metazoan, and what we believe to have happened in the past.

Volvox and Haplozoon, whose cells we can with no shadow of doubt affirm to be homologous with free-living Protozoa, show that it is possible for a higher individual to be evolved from a collection of lower ones. If we refuse to the Metazoa an ancestor formed thus by aggregate differentiation, we are landed in far more and far worse difficulties than any we escape from. Whitman is right in drawing attention to the remarkable fact that the so-called Kupffer's vesicle of embryonic Teleost fish is non-cellular, a mere thin sheet of protoplasm which is

not even nucleated, whereas it is certainly homologous with a structure of other vertebrates which is composed of very definite cells, but to reject the cell-theory altogether on this account is not warranted. Rather should we in such facts see examples of the extreme lengths to which the degradation of the individuality of the parts can go—a degradation which we found to be everywhere (except in man's societies) a necessary accompaniment of the formation of a higher individual from an aggregate. Here the cells have become degraded to the level of mere bricks, with even less share in determining the form of the whole than real bricks have in determining the form of a house. But how different is the structure of our Sponge or of Volvox—and they deserve equal consideration with the fish. It is better to believe in the historical individuality of the cells and to wonder at the idea of the whole's form that can thus penetrate the substance and absorb the individualities of its parts, robbing them of all their ancestral freedom, as the universal mind (some would believe) absorbs and loses in itself our souls at death. But here we have come down to the bed-rock questions of biology—the old problems of ordered growth and purposeful working, which are still shrouded in their dense cloud of ancient mystery.

Yet though, like enquirers who try to push far after knowledge in any direction, we are at length brought face to face with the unknown and perhaps unknowable, we have made some solid progress. Without discovering the origin or the inner being of individuality, we have been able to see it made objective in the various streams and masses of protoplasm which we call animals and plants and to trace an upward progress in its course, at the same time getting light on many related problems of biology. We have seen the totality of living things as a continuous slowly-advancing sheet of protoplasm, out of

which nature has been ceaselessly trying to carve systems complete and harmonious in themselves, isolable from all other things, and independent. But she has never been completely successful: the systems are never quite cut off, for each must take its origin in one or more pieces of a previous system; they are never completely harmonious, as Metschnikoff's long list of the "disharmonies" in man will show; and they are never completely independent. These very incompletenesses, due to the limitations of the material stuff with which life has to work have proved the foundations of fresh advance. It is just because every system is bound to be in some degree dependent, that a number of systems can adjust their various ways of dependence to each other, till a condition of minimum wasted and maximum interdependence is gradually set up, and a new system, better equipped than any and all of the earlier ones, is made.

These systems are individuals, and it thus comes about that individuals exist in grade upon grade, any one in any grade being able to combine with others like itself or with others unlike itself to form the beginnings of a new system, a new individual. Moreover, within each grade there may exist individuals of every degree of perfection. At the bottom, a Gonium-colony is but a possibility of an individual; the individual formed by the inter-relation in food-matters of plants and animals is so vague as scarce to deserve the name. At the top, Man astounds by his harmonies, his purposeful completeness, and power over nature; but none are perfect. Thus we must not expect any hard-and fast rule; there are many grades, many degrees, and many kinds of individuality, and each individual must be judged on its merits, as something really new.

Finally we have learnt to appreciate the historical point of view, and through it to be brought to admire the seemingly

infinite changeableness of life. On the one hand we have seen many structures and many habits of animals that can only be made fully intelligible through their history. Each new species must go through its period of storm and stress while striving to come into harmony with its environment;

> "And 'mid this tumult Kubla heard from far Ancestral voices!"

—the forms and patterns of its forefathers rise up and will not be denied, forcing themselves into the altered mould, and thereby often taking on new and unfamiliar shapes.

The ancestral plan may persist in spite of present uselessness, like the elaborate arrangement of the lines of hair on the body and limbs of man; or it may take on some new use, like our Eustachian tube, in fish-like ancestors a gill-slit. It is by this incorporation of the old in the new that we can trace such adventurous histories as that of the cell-individual.

But this persistence is not absolute: with necessity and long lapse of time life seems able to cast away every vestige of the old forms, as when gills are replaced by lungs in air-breathing vertebrates, or when a metazoan structure, once cellular, builds itself without cells.

All roads lead to Rome: and even animal individuality throws a ray on human problems. The ideals of active harmony and mutual aid as the best means to power and progress; the hope that springs from life's power of transforming the old or of casting it from her in favour of new; and the spur to effort in the knowledge that she does nothing lightly or without long struggle: these cannot but help to support and direct those men upon whom devolves the task of moulding and inspiring that unwieldiest individual—formless and blind to-day, but huge with possibility—the State.