NOTES

CHAPTER I

1. There may appear to be a vicious circle in the use of the word individual before we know its definition; in reality there is not. The word individual has not been manufactured to label a theoretical concept, but to denote something existing. It was originally applied to human beings, and a special word had to be used for them because it was felt that they differed in certain important ways from mere *things*. Certain other objects (all of them organic, but together making only a portion of the whole organic world) are immediately recognized as possessing similar attributes, and it is obvious that they too must be Individuals, although equally obvious that we have only used, without defining, the category "Individual."

2. See pp. 65–68 for some further treatment of the value of size.

3. That is, of course, supposing the external world and the properties of matter allowed it to exist at all when in such small masses: e.g. Lillie has proved that there is a minimum size (determined no doubt chiefly by surface-tension) below which pieces of Stentor (a ciliated Infusorium) cannot regenerate. See pp. 36–37.

4. For a case of heterogeneous physical *structures* which cannot exist simultaneously, see pp. 82–83, 86. There the structures must alternate with each other in cyclical change; here, the memory obviates the necessity for that. Though two states of consciousness cannot actually co-exist at one moment of time, for all practical purposes memory permits it, as when we say that a man can attend to his profession and write a book upon some other subject "both at once," or as when a chess-player plays a dozen games "simultaneously."

5. For a fuller treatment of both these conceptions, see an article on "The Meaning of Death" in the *Cornhill Magazine* for April 1911.

6. As examples will serve, the hollow trunks of aged trees, the brittleness of old bones, and the decay of teeth.

7. It is to be noted that no actual impossibility stands in the way of the individual's continuance, but only great practical difficulties. Bergson somewhere makes the illuminating remark that the whole of Evolution might have realized itself in a single individual. This, with our knowledge of the potential immortality of many kinds of functioning protoplasm (see Metschnikoff on the age of trees, their propagation by cuttings, etc.) on the one hand, and of the facts of embryology, more especially the striking changes that take place at metamorphosis, on the other, we shall not readily be prepared to deny; but Life, gifted with reproductive powers has found it come cheaper and easier to choose Death for each single individual and think rather of the persistence of the race than to expend ever-increasing energy on patching up the defects that are bound to appear in the individual with age. (See *Conhill*, 1911, loc. cit.)

8. It would be more accurate to say *at least one* individual: often two or more distinct and unlike individuals are employed in each cycle of working; see p. 16.

CHAPTER II

1. Those which do not serve this end (with the exception of some which appear to be "accidental" by-products due to the interaction of the purposeful factors) are of course destined to help in reproduction.

2. Or at least without adding more than a very small amount. Normal growth may go on, but the re-modelling goes on still faster. That growth and reorganization are not necessarily connected is shown by the strange facts narrated on pp. 111–112.

3. The animal kingdom is divided into the two primary subkingdoms Protozoa or single-celled animals, and Metazoa or many-celled animals.

4. *Almost* universal, for it will be seen later that mental powers have made possible such organisms as an ant-colony, which is not a solid whole, single and defined in space; and growth and mobility may be in abeyance for long periods, though always present in some stage of an organism's life.

5. Though, as in commerce, one organism's manufactured article is another's raw material; take as an example the quadruple chain of nitrogen-fixing bacterium, clover, ox, and man.

6. Some biologists wish to restrict the term cell to protoplasmic units with a formed nucleus. The nucleus, however, has certainly arisen by internal differentiation (pp. 45–46), so that the lowest non-nucleated moneron, the complex protozoan, and the specialized metazoan tissue-cell are all *homologous*, and some word is required which will cover them all. Whether a mass of protoplasm is nucleated or not is of importance, but it is of still more importance to know whether it has arisen by a series of divisions from a primary unit of life, and so whether it is itself a primary unit of life, and so whether it is itself a primary unit. Such units we shall here call cells.

7. It will be objected that the change in surface-tension permitting binary fission is adaptive or purposeful. This is quite true, but the adaptation is concerned only with the race; it is the first step towards a species-individuality. The cells within the species, however, remain unaffected.

8. There is in many protozoa a form of circulation known as cyclosis, in which the whole inner part of the cell is constantly revolving. This certainly performs the same general functions for the organism as does a blood-system, but to have the *whole* of one's inside always in motion would render difficult the development of other systems; thus a huge single cell with cyclosis would have overcome the difficulty of metabolism, but would be at a disadvantage in other ways when compared with a multicellular organism of the same size.

9. In the vegetable kingdom, things are somewhat different, and the largest plants, the great forest trees, are individuals of a grade higher again than the second.

CHAPTER III

1. It is well known that there are two kinds of twins: *identical twins*, always of the same sex and almost indistinguishable from each other, and *ordinary twins*, which may be of opposite sexes, do not resemble each other more closely than brothers of different ages, and like them arise from the fertilization of two separate ova by two separate spermatozoa.

2. It is an interesting fact that the four twins fall naturally into two pairs, the resemblance between the members of which is still more close than that between the four taken together. This taken together with the fact that the members of the pairs are always adjacent seems to show that the fertilized egg divided into two halves, *A* and *B*, which did not remain united. Then *A* divided into *a*1 and *a*2, *B* into *b*1 and *b*2, and these again parted company. These four cells gave rise to four separate embryos, *a*1 and *a*2 forming one pair, *b*1 and *b*2 the other. Thus one pair is descended from *A*, the other from *B*, and the closer resemblance of the members of a pair is explained by closer blood-relationship.

3. The examples actually used by him are the Salpae and the Aphides.

4. In one species of Pilidium (*P. recurvatum* Fewkes), however, the young worm does actually absorb the remains of the larva. It is interesting to note that a precisely similar series can be traced in the metamorphosis of echinoderms. In the sea-cucumbers the process is almost entirely one of remodelling, in sea-urchins and most starfish the young imago is formed apparently as a "bud" and the rest of the larva is absorbed later, while in some starfish (*vide* J. Müller) the larva and the imago part company.

5. As a matter of fact there are animals, such as the sea-urchins, where death results from division of the body and yet is certainly not caused by any dislocation of nervous centres, for the sea-urchins have a very feeble and very decentralized nervous system.

CHAPTER IV

1. I am aware that botanists distinguish between *cells*, which have one nucleus, and *coenocytes*, or masses of protoplasm with many

nuclei, such as are found in Caulerpa and other Siphoneae. However, I am using the word cell in a wide sense, a sense dictated by the historical or evolutionary point of view, to denote a discrete mass of protoplasm isolated by natural causes, and if this definition be allowed, then Caulerpa is simply a single cell which has found out the way to become large. The number of nuclei in a cell is often quite unimportant: in the Protozoa one form may have a single nucleus, while a close relation has several.

2. But not unique—e.g. in some colonial Ascidians, the germ-cells of the bud are formed from blood-corpuscles of the parent.

3. This has been done on various sponges, including Sycon, a not very distant relation of Clathrina: see Huxley (9)

4. Some species of Gonium, such as that represented in Fig. 7, are even simpler, being formed of but four cells.

5. Though these connections have not been described for other members of the family, it is possible that they have been overlooked.

6. To mention two examples, there is the strobila with its ephyrae, and the Syllids producing their special (epitokous) male and female forms by division.

CHAPTER V

1. It is interesting to note that in the Polyzoa, another group of colonial animals there has been a different kind of division of labour. The ordinary animals both feed and reproduce the colony, and defence is undertaken by much modified persons called Avicularia (from their resemblance to birds' heads with snapping beaks). Here the differentiation is between most of the somatic and all the germinal functions on one side, and a single somatic function on the other. In some forms there are no Avicularia, the colonies then consisting of only one kind of person.

2. A metaphorical effort, as when a carnivorous species acquires new powers of speed to run down its prey, or an actual effort, as when the members of that species make use of those powers.

3. See Dobell (5) for facts and references.

CHAPTER VI

1. pp. 35–37 and 71, respectively.

APPENDIX B

1. It is more than probable that Sponges have an ancestry quite separate from the rest of the Metazoa: if so, then the common ancestor of Sponges employed, though quite independently, the same method as the ancestor of the Metazoa proper.