III

SOME OTHER DEFINITIONS OF ANIMAL INDIVIDUALITY

From time to time various definitions of individuality have been given by zoologists. Most of them are framed with little reference to the philosophical idea of individuality, and the result has often been that the term individual as defined by them, though applicable to some reality of zoology, can no longer be used without absurdities in its more popular but more correct and more original sense.

One of the most widespread definitions considers the individual as "the total product of a single impregnated ovum" (8 *a*, p. 59), that is to say as the sum of the forms which appear between one sexual act and the next. This would make all the polyps in a colony of hydroids, all the separate polyps budded off by a fresh-water hydra, all the summer generations of the aphis, together constitute but a single individual. Of recent years it has not found so much favour, but Calkins (2) has urged that it should apply to protozoa, declaring that all the separate cells arising by continued division from a single parent between one sexual act (conjugation) and the next, should be considered as one individual, no less than the cells of a metazoan like man, which too arise by continued division from a single parent, the ovum, and remain connected to form his body.

Of the various facts which make the hypothesis untenable, the chief are concerned with the artificial or accidental

production of two or more co-existent organisms from a single ovum.

In most animals each single fertilized egg gives rise to a single embryo and this to a single adult organism: but in some, where this is the normal rule, more than one embryo may be accidentally or artificially formed from one egg, and in others this multiplicity is the usual course of events, even though most of their relations may grow up in the ordinary humdrum way—"one egg, one adult."

Aberrations may occur even in man: there can be very little doubt that identical twins[1] (to leave all double monsters out of account) arise from the two cells produced by the first division of a single fertilized ovum, which have accidentally been torn apart instead of staying united.

A very interesting variation on this is seen in the nine-banded armadillo (*Dasypus novem-cinctus*) which regularly produces "identical quadruplets" (14). Most mammals give birth to several young at one time, but usually each grows up from a separate and separately fertilized ovum and each is enclosed in its own set of embryonic membranes. The armadillo's brood, however, like the identical twins in man, has only a single chorionic membrane, and the four resemble each other minutely. Always of the same sex, their measurements are identical; even the number of plates in their armour is constant to less than 1 per cent., though the range of variation from brood to brood may be 5 per cent. and more.[2]

Then comes Experiment and confirms our conclusions of observation. The egg when it develops outside the body of its parent (the rule with most of the lower animals) is at the mercy of the experimenter. After it has divided into two halves, these two blastomeres (as the cells produced by the subdivision of the egg are called) can be separated either

mechanically or by chemical means. In the majority of animals where this is possible, the half-blastomere, that identical mass of substance which without man's intervention would have formed half the body of the adult, develops, owing to the mere accident of separation from its sister, into a whole body. Even with such a highly organized creature as the newt this has been accomplished.

The experiment may be carried still further. A whole jelly-fish (Liriope) may grow up from a quarter-blastomere, and in sea-urchins a single one of the first 8, 16, or even of the first 32 blastomeres will make a gallant attempt to develop into a normal whole; and, though it does not succeed, its death seems due to mere minuteness, lack of size, rather than to lack of that internal machinery which produces the complex adult from the simple egg.

These facts are a *reductio ad absurdum* of the theory. It is difficult to consider the two or more experimentally produced sea-urchins or newts as constituting a single individual; the four armadilloes with their one individuality raise more than a doubt; and with the occasional and accidental production of true twins in man comes finality. If anything is an individual on this earth, that surely is man; and yet we are asked to believe that though the most of us are true individuals, yet here and there some man who lives and moves and has his being like the rest is none, that he must make shift to share an individuality with another man simply because the couple happen to be descended from one fertilized egg instead of two. In himself a twin is like any other man; to say that one is an individual while the other is not, takes all meaning from the word.

The idea rests partly on a misapprehension of the sexual process, partly on realities which are of some zoological importance but have no true bearing on the idea of individuality.

Until very recent times the sexual process, the so-called "act of fertilization," was looked on as something which had to be repeated at regular intervals to keep the race going. Somehow it communicated to the organism a mysterious force, which sooner or later dying down must be renewed by repetition of the act.

This is by no means a true view of sexuality. To start with, one large group of organisms, the Bacteria, seem not to possess it at all, while here and there in higher groups it has been lost; the American water-weed (Elodea) for instance, that pest which at one time choked half the waterways of England, started its career in this country by being accidentally imported with American timber, and in all its subsequent development has never been known to form seed.

Lower down, near its first appearance, it is not connected with reproduction at all, as in the Ciliates among the protozoa. Hereto it is not a necessary part of the life-history; Woodruff (20) has recently shown that these animals, which reproduce by fission, may be bred through an indefinite number of generations without conjugation. Enriques, on the other hand (7), has shown that a ciliate which has just conjugated, or in other words received a part of the nucleus of another and joined it with its own, may, before dividing at all, and with this very nucleus just formed by sexual fusion, immediately repeat the process. These observations show that the sexual act stood originally in no relation to the life of the cell, or of the multicellular organism, or of the race, so that any conclusions with regard to individuality based on the periodical recurrence of sexual fusion cannot be fundamentally true.

But though the theory cannot be upheld in its entirety, yet some of the facts upon which it is founded are of considerable interest not only generally but also in reference to individuality.

To start with, the upholders of this theory, such as Professor T. H. Huxley (8 *a*), base themselves largely upon the facts of metamorphosis, that sudden change, from the grub to the fly, from the tadpole to the frog, that occurs at a definite point in the life of so many animals. What is perhaps the most remarkable example of metamorphosis, that of the Pilidium into the Nemertine, he does not mention, since it was only established some three years later, but as it illustrates his contentions better than any of his own examples, it may be given here.

Many of the nemertines—salt-water worms with long cord-like bodies—lay eggs each of which develops into a transparent free-swimming creature, very unlike its parent, and called Pilidium from its resemblance to a little hat (Fig. 5). The hat is provided with ear-flaps, and between the flaps there is a mouth leading up into a capacious stomach.

That is its structure when young: at the close of its life, however it is seen to contain a darker something within itself, and this something on closer inspection turns out to be a young nemertine worm, wriggling actively inside a hollow sac which intervenes between it and the tissues of the Pilidium. This is strange; but stranger still, the young worm contains within itself the stomach that was the Pilidium's, so that when the Pilidium feeds, the food passes through its mouth into the stomach which is now the worm's.

The origin of the worm is equally curious: at a certain stage in the growth of the Pilidium, five little pockets appear on its outer surface, arranged in a ring a little above the brim of the hat. The pockets deepen, and their outer openings get narrower and narrower, at length becoming quite "sewn up," so that there are now five closed bags under the skin. These bags flatten and then extend round the stomach of the Pilidium in every direction, laterally as well as up and down; they thus

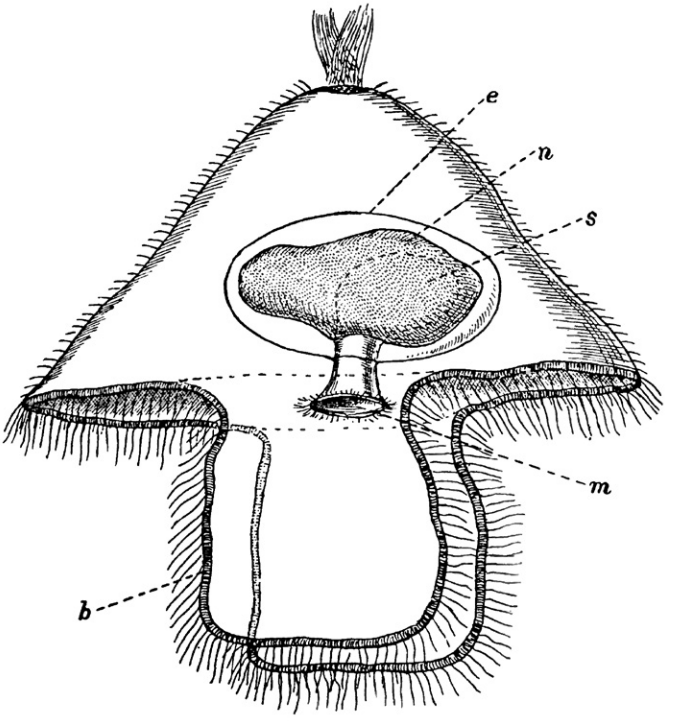

Figure 5
Diagram of a Pilidium with young Nemertine enclosed. *b*, band of special long cilia; *e*, envelope enclosing the worm; *m*, mouth; *n*, the young worm; *s*, stomach. (Magnified.)

meet each other, and the walls which are in contact then disappear, so that all their separate cavities join up into one. There is now beneath the skin an outer shell, then a cavity, and then an inner shell which surrounds the Pilidium's stomach. This inner of the two shells or sacs becomes thickened, undergoes various transformations and at last gives rise to the body wall and many other organs of the young worm, while the outer sac is merely a temporary protective envelope. The worm at

length wriggles so violently as to break through this envelope and the skin of the Pilidium, meanwhile tearing the gullet where it passes from the body of the Pilidium into its own. The worm goes on its way rejoicing, and grows up into an adult nemertine; while the Pilidium still swims about, though stomachless, for a time, but perishes at the last.

A perfect gradation in abruptness of metamorphosis can be traced up to this extreme condition. Often, as in man, development proceeds gradually—a slow transition through continual change. In others, as in the frog, there is one period when a sudden alteration of habit and structure takes place; the tadpole, we say, undergoes a metamorphosis and is made a frog. But though there is radical rearrangement, nothing is discarded. In the butterfly there is a more violent metamorphosis, and also a part of the earlier form, its outer skin, is discarded during the change. Finally in the Pilidium not merely the skin but nearly the whole of the larva is rejected at the metamorphosis.

From this, Prof. Huxley then says, it is but one step for the larva to keep all its essential organs when it parted company with the adult form; the one would be formed by the other after the fashion of bud, and from this on to the establishment of colonies like those of the hydroid polyps would be but one step more. Then we should have a perfect transition: the animal as it develops is represented first by a succession of forms, each one turning into the one that comes after, but then first a part and finally a whole of one of the forms comes to have a separate existence in space simultaneously with one of the later forms. So, he argues, since the tadpole and the frog can rightly be called mere forms or phases of the same individual, then the Pilidium and the Nemertine, and then all the polyps in the hydroid colony,[3] are but such forms too.

As a matter of fact, this gradation does not seem to exist in nature; but even if it did it would not be convincing. It is often forgotten that the most perfect quantitative gradation from one condition to another is no guarantee that the two conditions shall not be qualitatively different. To take the simplest example, when the chemical substance denoted by the symbol H_2O is heated, a definite addition to the rate of motion of its molecules is made for each degree of temperature through which it is heated. This quantitative addition, however, has a qualitative result: with continued heating the substance passes from the solid state into the liquid, and from that into the gaseous, turning from ice to water, from water to steam. There is a similar gradual transition in life from the mere aggregate to the higher-grade individual (Chap. IV).

Here, however, there seems to be no such series. All goes well up to the Pilidium, but then comes the gap. There is no case known, where two *complete* individuals are formed as the result of metamorphosis. In reality, the detachment of the Pilidium skin from the young worm is not an attempt at reproduction at all, but is due to something very different. This something is the incompleteness of adaptability in protoplasm, and since the subject will concern us again later (p. 100 *et seqq*.) it may be investigated here.

The whole *raison d'être* of a metamorphosis is the restriction of the animal to one environment in one period of its life, to another and a wholly different environment in another period. Different environments require different structures; and the metamorphosis is the time when the old structures are destroyed. When the tadpole, for instance, suffers a land-change, gills and tail must vanish. They do not, like the skeleton of the gills, become converted, after considerable

remodelling, into structures of the adult, nor like the caterpillar's outer skin, are they bodily cast off: they are absorbed, they shrink and their contents are drawn into the body of the young frog for future use, as the yolk-sac and its contents are drawn into the body of the unhatched chick.

The tadpole is so well adapted to the water, the frog so well adapted to the land, that certain organs can not be used, however remodelled, for life on both. They cease to exist as such; it is only the materials of which they are composed, not the living organs themselves, which the animal uses for its further development.

There is a wide possibility of change inherent in all living substance, but after a certain specialization of cell or organ is reached, it becomes impossible to remodel it to perform another totally different function. I say *impossible*: it would perhaps be safer to say that the difficulty of remodelling becomes so great that the simplest way, and so the least wasteful of energy for the organism, is to destroy the old structure, degrading it to the level of mere food-material, and then to build up the new from its very beginnings.

An extraordinary example of this is found in the development of the higher insects. Practically every organ of the body in a larval form like the caterpillar becomes broken down, chiefly by the action of phagocytes, into lumps and masses of dead proteid substances.

A boy known by repute to the writer once expressed surprise that there were any organs inside caterpillars: "I thought," said he, "that they were all just skin and squash." This would be a very accurate description of their condition during the metamorphosis, were it not that embedded in the squash at intervals there lie little patches of living tissue. These

so-called *imaginal discs* are formed of unspecialized cells; they grow, unite with each other, and develop gradually into the structures of the perfect insect.

In the Pilidium, it seems, the young worm finds that less energy is wasted in feeding on its own account than in attacking the larval tissues and converting them into readily assimilable food-stuffs. That part of the individual, therefore, which has been so specialized for a free-swimming life as to defy remodelling for worm-purpose, is discarded altogether instead of being absorbed.[4]

As with cells and organs, so with human beings: it is rare that the skilled workman can change his trade. When he is too specialized it may be easier to give him notice and train a new apprentice than to go through the pain and grief of the change from fixed habits.

The remains of the Pilidium then represent merely a part of the Nemertine individual which is discarded as being no longer useful: the history of the process shows that it has nothing to do with ordinary asexual reproduction such as the budding of polyps in a hydroid colony, and so, even were the detached larval part to regenerate a new stomach and become a separate self-supporting organism (as is not unthinkable) we should not be able to draw any conclusions applicable to colonies produced by ordinary fission or budding.

There is another reality on which, unconsciously the theory is based. In all Metazoa there is, before and during the sexual process, a shuffling and recombination of the chromosomes of the nucleus—those bodies which taken together appear to determine the characteristics of the offspring, or at least those which mark it off from others of the same species,—whether it shall be tall or short, fair or dark, chubby or lanky, tip-tilted or Roman-nosed. More, it was supposed

that this rearrangement only took place during sexual fusion, and instances were adduced of many vegetable "sports," or mutations as they are now often called, so many of which have been enumerated by De Vries. A plant will often appear showing a mutation in all its parts, so that the change inducing the mutation must certainly have affected the single sexually-produced cell from which the whole plant has sprung. Once formed, mutations will persist in cuttings or slips of the parent plant, but will usually be lost when the sexual chromosome-shuffling is allowed to take place and offspring are raised from seed. In such cases then, all the plants that have arisen thus asexually by grafts or slips, from actively growing parts of the one original parent, all possess, in the mutation, a common character separating them from other plants of the same species, and this common difference persists as long as sexual fusion does not take place between bits of their protoplasm.

Phrases such as "he has a marked individuality," or "he is very individual" lead people to suppose erroneously that one of the chief characters of an individual is its difference from all others. Then, seeking for some clue to guide them through the mazes of animal individuality, they seize upon this and say that because one stream of protoplasm exhibits constant differences from other streams, it is therefore an individual. It then appears that in many cases these differences only persist from one sexual act to the next: therefore, say they, the sum of the forms between two sexual acts must constitute an individual.

However, even apart from the initial flaw, that mere difference constitutes individuality, the chain of argument will not hold, for it is found that not all mutations are similar to those we have described: permanent and considerable changes may take place at any time during the life-cycle, and not in

the sexual act alone. The so-called *bud-sports* of many plants are of this nature: from a single bud on a normal tree grows out a shoot displaying some new peculiarity, some mutation which it can transmit to its descendant shoots. A race of trees with the new character can thus be raised by grafting, and not only this, but some bud-sports breed true to seed. Thus nectarines have repeatedly arisen from peaches, not only from peach-seed, but also from peach-buds, and in both cases may subsequently grow true to seed (4, p. 360).

One last partial justification of the theory is left: often when more than a single individual life (in our sense) intervenes between one sexual act and the next, it happens that these several individuals are different from each other but appear in a regular cycle, as in the liver-fluke (p. 16). When this is so, the forms that intervene between two sexual acts do in point of fact together constitute an individuality, one of the type that we have called species-individualities. But this coincidence of sexual act and beginning of a new individuality is only an accident, philosophically speaking, as our previous discussion of the sexual process will easily prove (p. 54).

Thus, though we may note as an interesting fact that the sexual process has at various times and in various ways become connected with one or another form of individuality, yet we must recognize that this connection is not obligatory, that in origin the two are entirely distinct, and that therefore the one cannot possibly be used as the basis for the definition of the other.

Another and a very different view is taken by Le Dantec (11), who, sticking to etymology, gives the following definition:* "l'individu vivant est donc un corps qui ne peut être

* "The living individual is thus a body that cannot be divided without at least one of the resulting parts of the division dying."

divisé sans que l'une au moins des parties résultant de la division perde la vie." This happens, he says, only when there exists a nervous system, and one where the nervous elements are concentrated at certain points to form centres of control and co-ordination, a process which as its climax produces the brains of the higher insects and mammals.[5] Each nervous centre constitutes then in some way the nucleus of an individuality and only animals with highly-centralized nervous systems can properly be called individuals.

The real error of this view lies far back in its premises. The definition contains an error of logic. You may correctly insist on etymology and say that an individual is something which cannot be divided without losing its essential quality: but when you say that the essential quality is life, you are not talking sense. The essential quality of an individual is not life but *individuality*. As a matter of fact, an individual as defined in this book cannot be cut in two without its individuality being either lost or impaired (p. 36); and though the loss may be only temporary it is none the less real.

Le Dantec's idea, however, is not merely based on error. The centralized nervous system does form the nucleus, not of any individuality it is true, but of that special kind of individuality, a personality.

However, since not *all* brains, but only those whose mechanism allows some conscious reason and memory, are the structural tokens of a personality, and since it is beyond our present power to discriminate between conscious and non-conscious brains from mere appearance, this structural criterion breaks down in practice and we are driven to accept behaviour as the only accessible touchstone for personality.

The same is true of individuality. An individual is not an individual because it arises from the sexual fusion of two cells, nor yet because it possesses a certain aggregate of white fibres

and grey cells called a nervous centre. Even were it a fact that on this earth these two properties were always associated with individuals, they would still not afford the proper basis for a philosophic definition of an individual. They would be mere accidents of the individual, which would still owe its individuality not to them, but to the particular way in which it *works*.

The essential thing about an organism is its actual working, the way it directs the current of energy by which it is continually traversed, and causes it to act on the external world. The main errors of materialism on the one hand and of teleology on the other have resulted from thinking either of substance and structure alone, the mere tools by which the working is carried on, or only of the apparent purpose for which it seems to exist, and not merely of the working itself. Only on this basis can a definition of individuality be attempted, and it is by neglecting this basis that many have been led to false conclusions.