

traction takes place, consequently the egg is not fertilized and a drone is always the result. The production of a queen bee is from an ordinary worker egg, the larva insect being fed by the workers upon a nitrogenous food, known as "royal jelly."

Some insects, such as aphides (plant lice), reproduce their species both by sexual fertilization and parthenogenetically. Throughout the summer there is a constant viviparous (born alive) production of parthenogenetic (without fertilization) females.

These have as a rule, no wings. But the reproduction of these insects is so rapid that the plants upon which they live would be destroyed if another of the species did not arise. Occasionally, therefore, females are produced, which having wings, fly away to live upon some other plant and to start a new colony.

The progeny of these colonial aphides in turn resemble their grandparent, rather than their parent, in the fact that wings are usually absent, though the preservation of the species is provided for by the occasional appearance of a winged individual. The phenomenon which I have just named—the likeness of the insect to its grandmother, and not to its mother—is called metagenesis, or the alteration of generations.

As yet no male has appeared upon the scene; but colder weather, or the scarcity of food, results in the birth of males which fertilize the females, and eggs are then laid. These eggs do not usually hatch until spring.

In concluding this subject, it is desirable to say that we know very little concerning the causation of sex; that high feeding has a decided tendency to produce females, and that poor feeding has a marked tendency to produce males, has been established beyond doubt. But there are other factors in the problem—factors of which we are at present ignorant. Any attempt to give a fuller explanation of the causation of sex would be purely speculative, and in my opinion, valueless, being unsupported by any scientific evidence.

Two Forces.

As the earth is kept in an orbit, which makes life possible by the balance of the antagonistic centripetal and centrifugal forces, so is that life evolved and maintained by the balance of the two conflicting forces of heredity and variation. Heredity, that is, the principle which makes offspring resemble their parental organisms, may be considered as the centripetal force which gives stability to species, while variation is like the centrifugal force which tends to make them develop into new forms, and prevents organic matter from remain-

ing ever consolidated in one uniform mass.

As regards heredity, the considerations which have been advanced in the early part of the references to sex will enable the reader to understand the principle upon which it is based. When a moneron, or living piece of pure protoplasm, or its successor, the nucleated cell, propagates itself by simple division into two parts, it is obvious that each half must, in its atomic constitution and motions, exactly resemble the original. If amoeba No. 1 divides into amoebae Nos. 2 and 3, both the latter two are exact facsimiles of No. 1 and of one another, and so are the progeny of Nos. 2 and 3 through any number of generations. They must remain identical repetitions of the parent form, unless some of them should happen to be modified by different actions of their surrounding environment, powerful enough to affect the original organization. The moot point as to whether amoebae continue to propagate indefinitely by subdivision, or whether at some period propagation ceases unless two individuals come together, is too technical for discussion in this place.

In propagation by germs or buds, the same thing must hold good as in propagation by fission, only, as the offspring carries with it, not the half, but only a small part of the parental organism, its impress will be less powerful, and the new organisms will more readily be affected by external influences. When we come to propagation by spores or single cells, and still more to sexual propagation by the union of the cells of two progenitors, it becomes more difficult to see how the type of the two parents, and of a long line of preceding ancestors, can be maintained so perfectly. Of the fact that it is maintained, there can be no doubt. Not only do species breed "true" and remain substantially the same for immense periods, but the character of individual parents and their ancestors repeat themselves, to a great extent, in their offspring. It is well known, of course, that the cross between the white and black varieties of the human species perpetuates itself to such an extent, that a single cross of black blood leaves traces for a great number of generations. In the Spanish-American states and the West Indies, where the distinction is closely observed, the term "octoroon" is commonly applied to creoles who have seven-eighths white to one-eighth black blood in their composition. In the case of what is called "atavism," which means recurrence to the character of ancestors more remote than the immediate parents, some very remarkable phenomena [may be ob-

served. Perhaps one of the most striking cases is that of Lambert the "porcupine man," mentioned by Darwin in "The Variation of Animals and Plants Under Domestication." This man's body was covered with warty projections which were periodically moulted. Some of his children, and also some of his grandchildren, presented the same remarkable characteristic which, however, had not been known to have been present in any of his ancestors.

Long Distance Transmission.

In breeding animals, it is not uncommon to find the peculiar features of generations of ancestors long since extinct, cropping up occasionally in individuals.

Horses, having stripes like those of the ass along the back and down the shoulders, occasionally appear, whose immediate ancestors for many generations back showed nothing of the sort; and even stripes across the legs like those of the zebra occur quite unexpectedly, and testify to the common descent of the various species of the horse tribe from a striped ancestor. How these ancestral peculiarities can be transmitted through many generations, each individual of which originated from a single microscopic cell which has been fertilized by another cell, is one of the greatest mysteries of nature. In a single microscopic cell there may be myriads of atoms circling around one another and forming infinitesimal solar systems, so to speak, of infinite complexity and variety. Darwin's "Provisional Theory of Pangenesis" supposes that some of the actual identical atoms which formed part of ancestral bodies are thus transmitted through their descendents for generation after generation, so that we are literally "flesh of the flesh" of the primæval creature who developed into man in the later tertiary or early glacial period. Darwin's hypothesis, however, has not met with any general acceptance. Haeckel has suggested the hypothesis that, not the identical atoms but their peculiar motions and mode of aggregation have been thus transmitted and he has named this mode of transmission the "Peregenesis of Plastids." There are any number of other guesses at the truth, the theory of physiological units of Mr. Spencer being the one which involves the hereditary nature of acquired characteristics, and the "continuity of the germ-plasm" being that of Weismann, who insists that such characteristics are never transmitted. It is sufficient to say here that a solution of the various problems of heredity is by no means impossible.

Variation.

The principle of variation is quite