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CILIA.

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Anyone who has watched the minute organisms, seen in a drop of pond-water under the microscope, must have been struck by the extremely active motions of many of them. Simple in structure, and destitute of limbs, they rush across at a furious rate, or glide smoothly and swiftly in serpentine fashion, or spin round and round in endless gyrations. How are these astonishing movements produced? They are due to cilia, the simplest and most insignificant of all organs of locomotion. These organs are widespread in the animal kingdom, though, curiously enough the Arthropods, that large class of animals embracing crustaceans, insects, spiders, centipedes, etc., do not possess them, so far as naturalists have been able to ascertain. As a rule they are very small and abundantly scattered, but they may be few and of considerable length, when they are then distinguished as flagella, not cilia. A flagellum and a cilium are, however, structurally and functionally the same. Flagella occur in plants as well as in animals, and the spores of some algae are so active, when swimming about, that they may be readily mistaken for minute infusorian animalculæ. Certain bacilli, too, possess one or more flagella, and like the Monads, the lowliest of all animal organisms, are able to progress with considerable speed. *Noctiluca* is a remarkable flagellate animal, like a small particle of jelly. It swims through the water by means of its lashing flagellum, and it often occurs in such countless myriads at the surface of the sea, that being phosphorescent and able to admit light, the waves are brilliantly illuminated over considerable areas. In contrast to *Noctiluca*, we find that in *Paramæcium*, the commonest of ciliated infusorians, minute cilia occur thickly all over the surface of the body,

and extend even into the funnel-shaped mouth. *Noctiluca* is a good example of a flagellate creature. *Paramœcium* is a type of a ciliated animalcule. In the latter the cilia serve not only to drive the creature about, they carry food into its mouth. They perform this latter function also in the bell shaped *Vorticella*, and in *Stentor*, the trumpet animalcule. These microscopic animals are rooted by a stalk, and the circle of cilia, around the mouth-opening, sweeps in floating particles of food. When *Vorticella* becomes detached the cilia, at once, carry it swiftly about from point to point. Cilia, again, are chiefly food-carriers in those lowly animal forms, the sponges. The substance of a sponge is traversed by channels provided with waving cilia. While carrying in food and aiding nutrition the cilia assist in respiration by maintaining a constant circulation of water. Nutrition and respiration are also accomplished in aquatic mollusca by means of cilia. The river mussels, for example, inhale constant streams of water. These streams are produced by the countless cilia, with which the gills are covered. If a fragment of a gill be torn off the cilia immediately carry it through the water most vigorously. The intestine in these molluscs is also ciliated, and in the pond snails the tentacles and various parts of the body are richly so. Again, among the zoophytes cilia though present are of inferior importance. They stud the crown of tentacles and line the digestive tract, just as they do in certain worms, notably the tube-building species. In such marine annelids as *Terebella*, the gills, cirri, and tentacles, which form a crown around the head of the animal, are ciliated and it has been observed that, when the tube is being built, particles of sand and mud are driven along the tentacles to the protrusible proboscis by means of these cilia. The branchial cilia aid in respiration.

While some worms are non-ciliated, others are so abundantly clothed with them, that the surface of the body exhibits a constant shimmering appearance. Certain ciliated patches subserve sensory functions, such as smell, etc., but the excretory or "segmental" organs, characteristic of the Vermes, always possess a ciliated canal for ensuring the outflow of waste products. The digestive tube also in these creatures is observed to be lined with cilia, in most cases.

Important, however, as cilia are, in adult stages of the animals referred to, they are not of inferior importance to the newly hatched young. Sponges, starfishes, zoophytes, jellyfish, worms, etc., pass through a ciliated larval condition, with rare exceptions, and the cilia as in the active Infusorians aid in progressive locomotion.

It might appear that in the highest animals, provided with special limbs for locomotion and with complicated respiratory and digestive organs, there is no necessity for cilia. It is not so. They are often of importance in the Vertebrates, although sometimes they may be found to persist, when the necessity for them has apparently gone. Thus Amphioxus, the lowest of fishes, possesses a ciliated skin, in the young condition. Larval lampreys, too, exhibit delicate hairs upon the external integument, a remnant no doubt of the ciliated condition, though the hairs are now rigid. The usefulness of such cilia and bristles is difficult to discover. Similarly, the cilia which line the gullet in newly-hatched fishes, such as the haddock, have no doubt merely an ancestral meaning. No food passes down the gullet, for the creature is mouthless and subsists by absorbing the contents of the yolk-sac. The cilia soon disappear, though in many Vertebrates, such as the the frog, the mouth, throat, air-passages, stomach, etc., are ciliated through life. Nor are they absent from the highest animals, but even in man, they occur in the nasal passages, the respiratory tubes, certain auditory canals, the secretory ducts in the tongue and many organs, the ovarian passages, and other cavities ; but their use now appears mainly to be the expulsion of matters hurtful to the sensitive epithelial surfaces referred to. The central canal in the human spinal cord is lined by ciliated cells in childhood, but these cells are obliterated later. We thus see how important is the part played by these minute and insignificant organs. They are efficient for locomotion, they aid in securing food, they assist in excretion, they act protectively by driving hurtful matters away.

It remains to briefly describe cilia and their mode of action. A cilium is simply a thread-like continuation of the protoplasmic cell to which it is attached. Its base, under the highest microscopic powers, differs optically from the tip ; but practically the cilium is merely a

thread of undifferentiated protoplasm. From the surface of a cell there may project one to fifty cilia. This surface may appear like a hyaline layer, but it is a false appearance, and is due to the swollen bases of the cilia. Each cilium, indeed, is enlarged at its base, but narrows immediately above. This narrow neck is succeeded by a swollen portion which gradually becomes attenuated towards the tip. They vary in length, those 1-3000th of an inch long being of medium size, some are shorter, others longer. Vigorous lashing movements are characteristic of cilia. The movements are too rapid to be distinctly seen, the vibrations being usually 700 to 800 per minute.

If a fragment of the ciliated lining, say the mucous membrane from the roof of a frog's mouth, be microscopically examined in normal salt solution, the surface shows an unceasing shimmering appearance, comparable to a rapidly waving field of barley. Each cilium, it has been found, is erect and straight. Then it bends rapidly on itself, and, very much more slowly, resumes the straight condition. The force of the vibrations is in one direction, and as successive rows of cilia do not bend simultaneously, but in regular succession, the result is a progressive rythmic undulation. When the cilia are arranged in a circle or crown, as in a Rotifer, say *Melicerta*, the appearance produced is that of a swiftly rotating wheel. Hence the Rotifers have been erroneously called wheel-animalcules.

The vibrations of the cilia continue for some time after death : but, in an injured, feeble, or dying condition, they are abnormally slow, and can then be best observed. Heat (up to 104° F.) increases their vigour, carbonic acid gas arrests them, while under the influence of oxygen, and of induced electrical currents, the vibrations may be repeatedly revived. They are independent of nervous control. They are automatic and as inexplicable as the inherent contractibility of muscle. Ranvier's experiments, indeed, show that the living protoplasm, of which cilia are composed, is essentially the same as that of ordinary protoplasmic cells.