incisions on the opposite sides of apple branches during the winter season ; yet, through these branches, the sap flowed in spring, and pushed forth the buds as usual.

From the facts stated above. It appears, that, *before* the period of vernation, temperature is the chief agent in pro­moting the flow of the sap ; and that, *after* that: period. Its progress is aided principally by perspiration from the leaves. There must, however, exist in the plant itself some condi­tion or structure which favours the operation of these agents. At different periods, different causes have been assigned for the ascent of the sap. It has been supposed to exist in the state of vapour, and its ascent has been ascribed to its levity: others have attributed its rise to some imagined action of the spiral vessels ; others to fermentation, or to the me­chanism of valves ; and others to a power of contraction and dilatation in the vessels, or to capillary attraction. Of these alleged causes, the two last alone deserve particular notice. That a contractile power, derived from a vital source, is not necessary to the motion of the sap in plants, seems certain from the fact of the ready transmission of fluids through dead vegetables. Even the dissevered particles of vege­tables, as the ashes of wood, were found by Hales capable of attracting water with a force nearly equal to living orga­nized structures. From these and other facts, he considered the rise of the sap to be produced by capillary attraction, aided by temperature, and especially by perspiration from the leaves.

The force of capillary attraction, when thus aided by evaporation, is strikingly illustrated by an experiment of Professor Leslie. He found that the attractive force, exerted by the very fine pores of a thin hollow ball of earthenware, from which water was continually evaporating, was more than sufficient to support a load of mercury, in a tube attach­ed to the ball, equal to that of 400 inches of water, or a co­lumn of thirty-four feet of that fluid. He estimates the dia­meters of the pores in the ball at the 10,000th part of an inch, and supposes the pores in the leaves of plants to pos­sess nearly the same dimensions.

Although capillary attraction, when aided by perspira­tion from the leaves, may exert great influence over the motion of the sap. It is yet probable that some power or property, inherent in the vessel as a living organ, assists its action. the direct effect of heat in promoting the flow of the sap in the bleeding season, and of cold in retarding it, seems to be more connected with some living property in the vessels, than with their powers as simple capillary tubes. If this heat be supposed to dilate the vessels. It ought to check capillary action, and cold, by diminishing their dia­meters, ought to increase it ; but the results afforded are exactly the reverse of these. “ If a capillary tube,” says Dr. Thomson, “ be taken of such a bore that a fluid will rise in it six inches ; and if, after the fluid has risen to its greatest height, the tube be broken short three inches from the bottom, none of the liquid in the under half flow’s over— But if we cut a plant, the *Euphorbia peplis,* for instance, in two places, so as to separate a portion of the stem from the rest, the milky juice of that plant flows out at both ends so completely, that if afterwards we cut the portion of the stem in the middle, no juice whatever appears. Now, the diameter of these vessels is so small, that, if it were to con­tinue unaltered, the capillary attraction would be more than sufficient to retain their contents, and consequently not a drop would flow out. Since, however, the whole liquid escapes. It must be driven out forcibly, and consequently the vessels must contract.” From similar experiments, Du Hamel inferred that the proper juice is forced out by a contraction of the vessels that contain it.

Du Petit Thouars believes that the expansion of the buds and the extremities of the branches in spring is the first cause of the movement in the sap. He ascertained, by experiment, that the sap begins to move at the extremities

of the branches before it stirs at the roots. Dutrochet brings forward his theory of galvanic currents to account for the flow of the sap. The fluids of plants, he says, are denser than those which surround them, and hence a gal­vanic action, or *endosmose,* takes place, by means of which the water of the soil is propelled into their system. These two theories may be combined, and we may suppose that, when the buds are developed in spring, the fluid which they contain increases in density by evaporation ; thus leading to a flow of the thinner fluids upwards by endosmose, the motion being propagated through the whole plant down to the roots which attract the fluid from the soil.

From all that has been advanced relative to the flow of the sap, we may conclude that temperature, the develop­ment of buds and leaves, and the exhalation from them, endosmose, and probably some vital actions, may all con­spire to promote this important vegetable function.

In addition to the general circulation of sap, there are also special motions of it, confined to particular parts, and partaking more of a vital nature, to which the names of *rotation* and *cyclosis* have been given. The first of these motions is met with in plants of low organization, but is not confined entirely to flowerless or cellular plants ; while the latter occurs only in plants of a higher organization, although not limited exclusively to flowering species.

Rotation has been noticed chiefly in the genera *Chara* and *Nitella,* and consists of currents setting from joint to joint, flowing down one side, generally that next the axis, and returning up the other, without any membrane inter­vening to separate the opposing currents, and the motion in each cellule being independent of that in the cellules next to it. The motion occasionally intermits, and is ren­dered obvious by green granules of starchy or oily matter, which float in the fluid of the cellules, and are carried about by the currents. Some interesting observations have been made on these peculiar vital movements by Treviranus, Amici, Solly, Varley, and Slack, in the Annales des Sciences Naturelles, and the Transactions of the Society of Arts.

*Cyclosis* was discovered by Professor Schultz of Berlin in 1820, and consists of the motion of a fluid called *latex,* analogous, in many respects, to the blood of animals, and contained in peculiar vessels, to which the name of *cinen- chgma* or *laticiferοus* vessels has been given. These vessels consist of branched anastomosing tubes, lying in no definite position with respect to the rest of the tissue, and so thin and capillary in the young state as to be scarcely visible. They are expanded and contracted at intervale, and their sides are not parallel as in other vessels. They exist often in connection with spiral vessels. The latex is sometimes transparent and colourless, but in many cases it is opaque, and either milk-white, yellow, red, orange, or brown. Its colour is due to the presence of numerous minute globules, which are constantly agitated as if by a spontaneous mo­tion, and appear to be alternately attracted and repelled by each other. The latex is looked upon as the proper juice of the plant. On exposure to the air it separates into a tenacious coagulum and a thin serum. The motion of the latex, or cyclosis, consists of currents, which are ob­served traversing the laticiferous vessels, and passing through the lateral connecting tubes or branches into the principal channels. These currents, which are rendered visible by the movement of the globules in the latex, follow no de­terminate course, but seem to be very irregular in their direction, some proceeding up, others down, some to the right, and others to the left ; the motion occasionally stop­ping suddenly and then recommencing. The motion is checked by diminution of temperature, or by a wound in the vessels, and it is completely arrested by a strong elec­tric shock.

Cyclosis has been observed in *Ficus elastica,* or the In-