Cyst Formation in Plant Galls.

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HOW the irritation of the developing gall-maker gives rise to repeated cell-division, over-growth and consequent formation of galls, is but little understood. At one time it was held that the injury caused by the puncture in oviposition and in feeding gave rise to increased flow of sap and consequent increased cell-division and gall-formation. Such secondary changes alone do not give rise to gall-formation. While, in this connection, investigating the response of the vegetable tissues to the stimulus from the gall-maker, it was observed by the author that the morphological changes were preceded by complicated physiological ones. These latter are not passive but active changes brought about by the enzymatic secretions from the gall-maker. Where complete resistance and actual prevention of the irritation was not possible, adaptative changes occurred in the vegetable cells. Thus, in the case of the cynipid gall on *Quercus* sp., it is known that the cynip maggot produces a secretion containing two important enzymes, invertase and diastase. These act on the cells and dissolve them, which are then sucked up by the cynip larva. The tannin produced by the vegetable cells precipitates these two cell-dissolving enzymes, thus rendering them inactive. The tannin thereby acts as a barrier to the cell-dissolving activity of the cynip. It is itself, however, hydrolysed to gallic acid by tannase, another enzyme secreted by the cynip. This gallic acid changes to pyrogallol which is oxidised to purpurogallin by other oxidising enzymes, so that in the end tannin disappears totally in the place attacked by the cynip. This results in the dissolution by invertase and diastase of the vegetable cells. Such a series of complicated changes are accompanied by increased physiological activity of the vegetable tissue as is evidenced by the increased protoplasmic streaming and increased rate of respiration. The increased physiological activity brings about rapid mitosis and new cells are thereby formed, the rate of new cell-formation exceeding very much that of cell-destruction and hence the part grows.

Again in certain cases of parasitic fungus it is known that just in front of the advancing parasitic hyphæ the host cells are rapidly and thickly suberised so as to place a kind of barrier in the way of the attacking foe. This alone, however, does not constitute immunity or even resistance to diseases in plants, but an active, resistive, though inefficient effort on the part of the plant is clearly demonstrated. A somewhat similar adaptation in certain entomocecidia also has been observed by the author. The enzymes occurring in the secretion of the Itonid larva are found to give rise to ligninisation or suberisation of cell-walls. The Itonid larva by secreting enzymatic fluids dissolves and absorbs plant cells and thus bores a tunnel in the flesh of the gall. The cells surrounding this tunnel become thick-walled, heavily suberised or ligninised as the case may be. Such suberized or ligninised cells are not dissolved by the secretions of the larva. Gradually this process spreads to several layers of cells, beyond the ones immediately lining the cavity of the tunnel, so that in due time the Itonid larva is completely enclosed in a hard, brittle, fistular structure, which is either completely closed or opens to the outside on the surface of the gall. The Itonid which by this time reaches, in the majority of such cases, the pupal stage, thus appears as if it were encysted in the flesh of the gall. In many cases of parasitism by worms, as in *Tinea solium* in the flesh of pig, it is generally known that due to some kind of irritation of the presence of the foreign body the muscular tissue of the host secretes a shell or cyst in which the worm is completely enclosed. By analogy, the hard fistular structure formed round the Itonid in the flesh of galls described above may also be called *cysts*.

The cyst, being made up of dead and thickened cells, appears to act as a kind of mechanical, perhaps also physiological, barrier to the irritant activity of the Itonid, so that after suberisation or ligninisation (cyst formation), active cell proliferation (the abnormally rapid cell formation by mitosis) is nearly brought to a standstill and the gall practically ceases to grow. Cyst formation begins at different periods in different galls. When it is complete before the Itonid pupates, the growth of the gall is arrested and the gall is relatively small. This however does not appear to be the case always and then the size of the gall is not in any way affected by the presence of cysts.

Cysts are not formed in every gall. In fact, galls may be divided into two distinct classes as *cystiferous* or cyst-bearing and *acystiferous* or non-cyst-bearing. Examples of the former class are the shoot galls of *Cephalandra indica* Nees, *Pongamia glabra* Vent., *Melothria heterophylla* Cogn. and leaf galls of *Odina wodier* Roxb. (all by undescribed Cecidomyidæ) and also the leaf galls of *Mangifera indica* Lin. by *Oligotrophus mangiferæ* Felt. Examples of the latter class are shoot galls of *Momordica charantia* Lin. by *Lasioptera falcata* Felt. and the fruit gall of *Pongamia glabra* Vent. by *Asphondylia pongamiæ* Felt. The cysts of the shoot gall of *Melothria* and *Cephalanda* are longitudinal, sinuous, cylindrical tubes, made up of suberised cells. The cyst in the shoot gall of *Pongamia* is a short, stout, hard tube of ligninised cells. That of the leaf gall of *Odina* is a hard L-shaped, cylindrical structure opening on the surface of the gall and made up of ligninised cells.

Though this extremely interesting structure appears to have been observed by various previous workers, its true nature is not yet understood. The correlation between this curious structure and the growth, shape, size, etc., of the galls bearing them is under detailed investigation and the author hopes to report more about this on some future occasion.

Notes on Some Hydro-Electric Schemes in India.

By Dr. Ram Prasad.

IN these notes an attempt is made to point out some of the important features of Hydro-Electric development in India giving some details of a few of the systems. The development of power in the Mysore State is dealt with first, to show what can be accomplished in public service utilities through Government agency. Next, the two major Hydro-Electric schemes are described which were recently put into service, one in Northern India and the other in Southern India by the respective local Governments and are intended to help forward the industrial and incidentally agricultural development of the provinces by providing a plentiful supply of moderately cheap power over a wide area.

The localities where Hydro-Electric Power is generated in India may be divided into four sections:

(1) The Northern and Sub-Himalayan section including the Ganges canal network.
(2) The West Coast section near the Ghats.
(3) The Southern part of Deccan Plateau.
(4) The Southern section from the Nilgiri Hills downwards.

Under section (1) may be included:

(*a*) The Uhl River Hydro-Electric Project of the Punjab Government near the Himalayan foothills which will serve the Punjab. This scheme was started in 1926 and the 1st stage of 48,000 E.H.P. was put into service in March 1933.

(*b*) The Ganges Canal and Ramaganga Scheme of the Government of the United Provinces of Agra and Oudh which utilize the canal falls of the famous Ganges river canal systems. This scheme of 3,500 E.H.P. was put into service in 1931 and is intended to serve the western and middle section of U. P.

Under section (2) we may include the Hydro-Electric Power systems organized by Messrs. Tata & Sons of Bombay. This big network obtains its power from three generating stations which derive their water from artificial lakes constructed on the Western Ghats and supply the power requirements of Bombay, Poona and the surrounding territory including the G.I.P. and B.B. & C.I. Railways, through numerous sub-stations and transmission lines. The initial stages of the scheme were put into service before 1914 and the system has been gradually extended to its present capacity of about 250,000 E.H.P.

Under section (3) comes the Cauvery Power Scheme in the Mysore State which is the oldest Hydro-Electric system in India and derives its power from the waterfalls of the Cauvery near Sivasamudram where the Mysore plateau descends to the plains. This scheme was started in 1902 with a capacity of 5,000 E.H.P. mainly to supply