

that abscission may occur under water (poplar, maple, horse chestnut, etc.) is, of course, to be accounted for in some other way than reduction of water.

In general, therefore, we must conclude, in view of the effects of drought upon trees and shrubs, that there is a relation between lack of water and defoliation, but it is not possible to attribute abscission directly to a reduction of water content, such as may be measured. It may, however, result indirectly by the disturbance of some other relation. As we shall see, very slight departures from the normal condition of the environment in other regards are sufficient to cause or to hasten abscission.

#### MECHANICAL CAUSES OF ABSCISSION.

This apparently indirect effect is further exemplified in the abscission response to mechanical stimuli. For convenience we regard as mechanical, stimuli such as shaking and wounding, though we cannot consider these as working directly.

*Shaking.* It is to Darwin (35) that we owe the observation that, if the flower stalk of the mullein (*Verbascum*) is sharply jarred the corollas will presently fall off. Fitting, having satisfied himself that the falling of the corolla was not due to accident or to the movement of the calyx, as held by Devaux, found by repeating Darwin's experiment, that separation was consummated in from 45 seconds to 5 minutes, but for the most part in from 1 to 3 minutes. This is equally true of young and older flowers, so that it is not due to their age. He found a similar behaviour in *Geranium pyrenaicum*, with a reaction time of from 30 seconds to 6 minutes. This phenomenon has been little studied, and only few plants are known to show it.

*Wounding.* The importance of the effect of wounding on abscission will at once be realized in view of the great economic losses occurring each year from the dropping of buds, flowers and fruits from the plants of our orchards and gardens, as a result of insect and other injury in the form of wounds. Young peaches, when wounded by curculio, drop. The great loss to cotton growers in Alabama, Louisiana and Texas, and the great financial disturbances accompanying it, caused by the boll-weevil, to which must be added the immense expenditures involved in scientific research in finding a way out of the difficulty, have caused a highly dramatic interest to attach to the problem. This case will serve, therefore, as a good example for the present discussion.

The boll-weevil lays its egg in a young "square" or flower bud. In from 1 to 22 days<sup>12</sup> the square falls to the ground, the

<sup>12</sup>I am indebted to the United States Bureau of Entomology, through the courtesy of Dr. L. O. Howard and Dr. W. D. Hunter, for the use of valuable data on the shedding of bolls after weevil injury.