WOUND-HEALING PROCESSES.

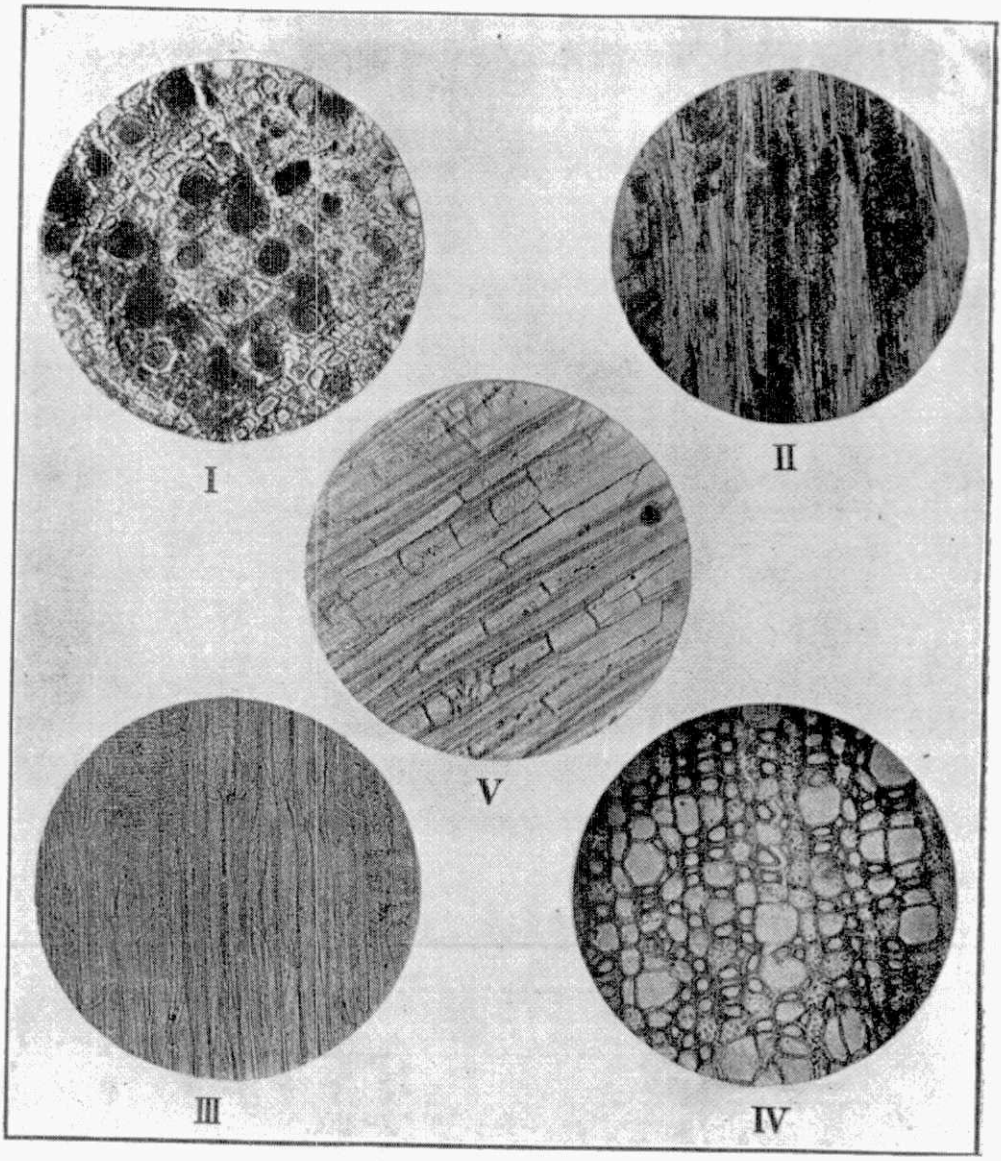
F. R. TUBBS.

It was realised early in the history of forestry that the active growth of callus was of extreme importance in covering the wounds caused by branch removal and thereby preventing the destruction of the timber by wood-rotting organisms. It was observed that the clean removal of the stump of a branch resulted in the wound being buried beneath healthy tissue far more quickly and with the occurrence of fewer cases of woodrot than was the case when a "peg" was left projecting. Later, as timber became more valuable, it became a routine practice of good forestry to disinfect the wound. These operations are every whit as valuable to horticulture as to forestry, and their practice results in similar advantages to the bush.

The importance of the active functioning of the healing processes resulted in further research as the result of which the existence of an additional protection against the entrance of harmful organisms into wounds was discovered. Brooks and Moore [1] found that in the lignified tissues of plum trees a gum was deposited soon after a wound had been inflicted. Formation began in the medullary ray cells and after two days was found to have extended into the vessels. They consider that the gum in the vessels is partly formed from carbohydrates already present, and partly from the products of hydrolysis of the stored food in the medullary ray cells. This process was found to be accelerated by the presence of the fungus *Stereum purpureum* in the wound. Gum formation was found to be the universal reaction to any kind of pathological condition in the plum tree.

Further information was provided by Swarbrick [2] who carried out observations on several species of temperate trees in various seasons. He found that a gum, termed by him "wound gum", was formed in the vicinity of a pruning cut, provided that the cut was not made during a resting season. The amount of gum formed was closely related to the physiological periodicity of the tree, cuts made during the rapid growth season of May to August being quickly blocked, while those made in the autumn were only partially blocked by the gum. During the winter season no gum was formed and it was not until the ensuing spring that the partially blocked autumn cuts and the unblocked winter cuts were protected by gum formation.

Observations upon sections cut in the vicinity of a cut showed a relationship between gum formation and starch loss similar to that already noted. The layer of cells immediately below the cut dried out, starch loss being thereby prevented. A layer below this about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a quarter-of-an-inch in thickness suffered a gradual loss of its starch, which was replaced by a viscous yellow substance, a certain number of colourless globules being formed at the same time. Gum formation occurs in the vessels as well as the medullary rays, it being observed that this process was sufficiently rapid to forestall the passage of fungal hyphae beyond this layer. The gummy material gradually becomes darker and more resistant to chemical change.

Evidence of the completeness of this barrier was found from the resistance offered to the passage of water through the cells. A suction pressure of 70 mm. of mercury applied for 36 hours failed to suck dye through stems in which gum formation had occurred, whereas the dye penetrated through unblocked stems in the course of a few minutes under similar treatment.

It is obvious that this question is of considerable interest in relation to pruning practice on tea estates. Keiller [3] noted that starch disappeared in the vicinity of a pruning cut and that some form of blocking took place. These observations raised the possibility of influencing the abundance of wound gum by cultivation prior to, or at the time of, pruning. Before initiating such experiments, it was necessary to discover whether the observed changes did actually lead to the formation of a "wound gum" beneath the pruning cut. By the courtesy of Mr. Swarbrick, microscope slides illustrating the formation of gum in apple and plum stems were received by the Tea Research Institute, which desires to record its thanks for this assistance.

Photomicrographs of these sections are shown in Figures 1, 2, and 3. The gum is clearly visible in Figures 1 and 2 which are transverse and longitudinal sections of plum and apple respectively. None is to be seen in Figure 3 which is from a region of about three-quarters-of-an-inch below the pruning cut. This illustrates the local nature of the deposit. With these may be compared Figures 4 and 5 from tea wood two months after pruning, in the region in which wound gum would be expected. No deposit similar to wound gum as described by Brooks and Moore and by Swarbrick can be detected.

Swarbrick suggests that in trees where wound gum has been observed in addition to the formation of a soft exuded gum on the bark where attacked by disease organisms, the two gums may be initially of the same nature, but that the former undergoes later a lignification process. In this connection it may be noted that the Institute has no record of external gum formation in tea. It is possible, therefore, that the metabolism of the tea bush does not normally permit of the formation of such materials, although wound

gum is recorded by Tunstall [4] as being formed in small quantity. The reasons for this inability are somewhat obscure, but the distribution of reserve carbohydrates in the tea bush provides a partial explanation. In the tea bush the major portion of the reserves is located in the roots, the stems containing relatively little starch. This difference is even more marked in the plucked bush than in a rested bush or seed-bearer, the removal of flush causing a diminution in the amount of locally stored reserves. The dependence of wound gum formation on starch reserves has already been noted, and it may be concluded that the relative scarcity of the latter is prejudicial to gum production.

It may be noted, however, that a re-distribution of materials similar to that observed by Swarbrick actually takes place. Investigations here show that where starch is present, it diminishes in quantity near the pruning cut, as noted by Keiller. A similar effect occurs with the alcohol soluble material. Samples drawn from a clean pruned field three-and-a-half months after pruning showed the following amounts of material soluble in 85% alcohol, expressed as a percentage of the dry weight.

(1) 5·05% in the $\frac{1}{8}$ in. next to the cut.
(2) 4·50% in the $\frac{1}{2}$ in. next below (1).
(3) 4·76% in the $\frac{1}{2}$ in. next below (2).
(4) 5·47% in the $\frac{1}{2}$ in. next below (3).

This distribution is what one would expect on the hypothesis that the uppermost layer dried before translocation took place, while in the lower a partial mobilisation or transformation of materials had occurred.

The question may be raised as to whether gum may be formed only at certain seasonal periods in the tea bush. This was tested by examining cuts ten months and four-and-a-half years old. In neither case was gum seen.

The method of testing by means of dyes was also used, contradictory results being obtained. In some cases dyes moved easily through the region of the pruning cut, while in others resistance was offered to their passage. As gum cannot be directly demonstrated, one cannot postulate its presence as an explanation of the latter cases. It is possible that the formation of air locks may play a part, while since the existence of a certain amount of chemical change has been shown, it is possible a certain amount of change in the structure of the cell walls may take place [1].

REFERENCES.

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(3) Keiller, P. A.—*Tropical Agriculturist*, 1928, **70**, 288.
(4) Tunstall, A. C.—*Quarterly Journal, Indian Tea Association*; 1931, 150.