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ON INTERFOLIAR BUDS IN PINES.

By A. W. BORTHWICK, B.Sc.

(Read 12th January 1899.)

The bud which represents the future shoot is found in very various stages of development, according to the species of plant to which it belongs. In many cases it consists merely of a papilla of cells, and will develop only under certain conditions. The winter buds of our trees and shrubs are more or less highly developed, but it is among the conifers that we find the two extremes. The one extreme—the highest development—is found in the end and whorl buds of pines. There all the leaves are metamorphosed into dry scales, and their axillary buds are so highly differentiated that the foliar spurs may be recognised. The other extreme—the lowest development—is seen in the winter buds of *Abies* and *Picea*, where the future shoot is represented merely by a green, fleshy tubercle, bearing on its surface small papillæ, which are the leaf rudiments. In order to protect this bud, the apex of last year's shoot is swollen out, and the needles belonging to it are changed to scales, which cover the real bud like a cap.

The pine tree possesses the following kinds of buds:—(1) apical buds; (2) whorl buds—(a) such as produce whorl branches, (b) such as produce female flowers, (c) dormant buds, or cryptoblasts, which develop after severe damage to the leaves, etc.; (3) interfoliar buds, or brachyoblasts; (4) axillary buds in the axils of primary leaves in the young plant (such buds become functionless after the fifth year, when bark formation begins); lastly, primary leaf axil-buds on young shoots, which produce male flowers.

The apical and whorl buds, or macroblasts, I have already briefly described, and will now pass on to consider the occurrence, structure, and function of dormant buds or cryptoblasts.

Regularly one or two of the whorl buds remain dormant, that is, do not shoot out the year after their formation. Some authorities hold that dormant buds occur only on very old trees, and will develop only after the tree has

been badly damaged by insects. In these quiescent buds, the primary leaves having been only partially changed to scales, the so-called rosette shoot results. On the other hand, according to Hempel and Wilhelm, the cryptoblasts of *Pinus Laricio* often develop after a year or two into normal branches of unlimited growth, which are covered with scale leaves, in whose axils foliar spurs are produced, and this happens with apparently no cause.

My observations go to confirm the statements of these latter investigators, that the dormant buds can produce more than mere rosette shoots. I have frequently found between the old branches of a whorl young shoots only a few millimetres in length, on which bifoliar spurs were appearing. On a young Scots pine I found a ring of some very young shoots developing between the branches of a whorl which was four years old. That these young shoots were not developed from interfoliar buds was evident for two reasons—first, they showed no subtending leaf-scars; second, the main axis had lost all its bifoliar spurs for a considerable distance above this whorl. At present I have numerous experiments in course of progress, by which I hope to obtain evidence confirmatory of the opinion I have just expressed as to the origin of these extra shoots.

Hartig states that the conditions under which such buds develop are very various; but they have this in common, that an increased supply of nutriment reaches the buds, and this may be caused, for example, by pruning, light thinning, defoliation by insects, or late frosts. All these factors are at work in the plantation where I made my observations. It is true, the late frosts were not very intense, and the defoliation was only partial, but to compensate, the thinning and pruning were very severe.

Very similar to the dormant are the interfoliar buds which occur between the needles at the apex of the branch of limited growth. The first leaves of the branch of limited growth form the needle sheath, the last leaves the needles themselves, between which is found the interfoliar bud, which generally undergoes no further development.

The duration of the bifoliar spur varies from one and a half to twenty years, according to the age of the tree and

the climate. In order that it may not be grown over by the thickening stem, the cells of the branch remain merismatic where it passes through the cambium of the mother axis, and increase in length takes place inwardly equal to the breadth of the wood ring, and outwardly equal to that of the bast.

The branch of limited growth thus elongates in a manner similar to that of a medullary ray. The interfoliar bud develops only under the stimulus of an increased supply of nutriment. This may occur—(1) if the phloem of the shoot is damaged, and the elaborated sap consequently cannot pass down beyond the seat of injury; (2) if the side branches are suppressed; and lastly, if the end and whorl buds of the shoot are destroyed.

In the plantation to which I have already referred, the pine shoot beetle (*Hylesinus piniperda*) is very common. The thinnings and other cut material were allowed to lie in the wood, thus forming the best breeding place possible for the beetle, which consequently appeared in great numbers last spring. The adult beetle hibernates in the cut material, and flight occurs in spring. The adult attacks the young shoots, boring into them and tunnelling out the pith towards the apex. The shoot is killed, becomes dry, and is snapped off by the wind at the spot where the insect began its operations. At a distance, the tree looks as if it had been clipped with scissors, hence the Germans call this insect the *Waldgärtner*, or forest gardener. Nearly every tree in the plantation lost a great many buds in this manner. In most cases where the leader had been destroyed, the developing interfoliar buds gave the appearance of miniature witches' brooms on the tree. This curious effect was produced by their thick bushy growth and by the character of the needles, which were short, thick, and fleshy, and much lighter in colour than the rest. A transverse section of those short thick needles showed them to have an abnormal number of resin canals, as many as eighteen or twenty occurring in one leaf. A case is cited by Schacht—"Lehrbuch d. Anatomie u. Physiologie," p. 121—where as many as twenty-four were found. This great number he attributes to the very luxuriant growth of the tree. A longitudinal

section of one of those buds showed a structure agreeing in every respect with the apical or whorl buds, except that the bud is joined to the branch of limited growth by a narrow neck, which gives a peculiar constricted appearance to its base. A section of the undeveloped interfoliar bud in the normal condition shows simply a papilla of cells occupying the apex of the shoot between the bases of the two needles. Its primary leaves are not changed to scales, nor does it develop under ordinary conditions. We have evidently a bud here agreeing very closely in structure and function with the dormant whorl bud, and might reasonably expect it to produce the same results. But authorities differ very widely on this point, some say that interfoliar buds produce branches of unlimited growth, and that dormant buds produce only rosette shoots, while others say that both can produce branches of unlimited growth.

My observations tend to show that both cryptoblasts and brachyoblasts can produce either kind of branch, the results varying with the conditions under which the buds are induced to develop and the general health of the tree at the time. We have seen that complete defoliation by insects can cause dormant buds to develop, also that an accession of nutriment may have the same effect; but in the former case a rosette shoot results in, in the latter, a branch of unlimited growth. The reason for this is not far to seek. In the first case, the vitality of the tree has received a severe check, and there is neither time nor energy left for the formation of bifoliar spurs in the axils of the primary leaves, so we get a rosette shoot. In the second case, the conditions are more favourable, and buds are formed in the primary leaf axils, with the result that we get branches of unlimited growth. This holds good for the brachyoblasts also. That the health and vigour of the tree affects the formation of axillary buds is shown even in the seedling. At the end of the first year weak plants form only an apical bud, stronger plants form, in addition to this, buds in the axils of their primary leaves, which in even stronger plants may develop. If at this early stage the bifoliar-spur needles are destroyed by insects, the brachyoblast develops into a shoot covered with primary

leaves, which, only if the plant is strong, produce bifoliar spurs in their axils. We thus see that brachyoblasts and cryptoblasts produce either rosette shoots or branches of unlimited growth according to the conditions which induce their development. A knowledge of these conditions is not only of interest to the botanist, but is of practical importance to the forester and gardener. In order to make my meaning more apparent, let me quote Dr. Masters. On page 7 of "The Report on the Conifer Conference," he says: "I may also call your attention to the way in which some of the shoots of some species of pines are clothed to the base with leaves, whilst in others the base of the shoot is bare. The scraggy unfurnished appearance of some old pines is accounted for by this peculiarity. What to suggest as a remedy in this case is not so easy; nevertheless the frequent appearance of numerous adventitious shoots on the trunks of such species as *Pinus rigida* and *Sabiniana* or *Sequoia sempervirens* seems to show that, by a judicious disbudding or removal of the tips of some of the upper shoots forming the head, a more bushy, or, as gardeners call it, a more furnished, habit would result." I willingly agree with Dr. Masters, that by a careful and judicious disbudding the appearance of a scraggy pine tree might be vastly improved, and if all pines are not so fortunate as *Pinus rigida* and *Sabiniana* in possessing adventitious shoots, still they all have interfoliar buds which, given the proper conditions, would produce the same results; and I hope to be able to throw fresh light on the matter when the results of my experiments, now in progress, are to hand.

The work of this, and the preceding paper, was done in the Botanical Laboratory, St. Andrews, and I have to express my appreciation of the facilities afforded me there. I am specially indebted to the lecturer, Mr. Robertson, for the photomicrograph.

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