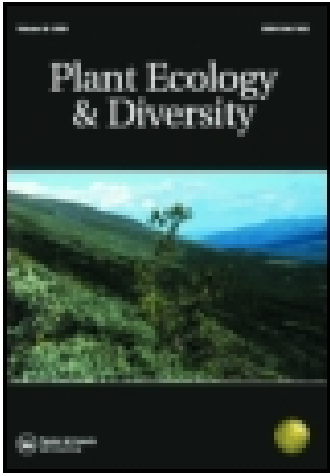


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the Arctic regions of North America, and in Asia. In other words, we find it growing from regions rendered humid under the influence of the Gulf Stream, to the regions of perpetual snow and ice.

But that is not all. We find that its natural situation is peat bogs, but it has been transplanted to a dry soil in a garden border, and grown successfully without any special care for years. My own attempt in the same direction I have told you of, but surely it is some evidence that the plant is thriving when it flowers out of time after being transplanted.

It would be unsatisfactory to pronounce any definite opinions as to the causes which enable the plant to exist under such different conditions with the meagre evidence before us, but I might almost hazard the guess that it will be found that some constituents in the soil (possibly lime or peat) have more to do with the healthy growth of the plant than mere climatic conditions.

May I ask that some of you, better equipped for such investigations, will give *A. polifolia* your consideration and study, in the hope that more light may be shed upon its cultivation, life-history, and distribution?

ON THE DEVELOPMENT OF QUADRIFOLIAR SPURS IN *PINUS LARICIO*, POIR. By A. W. BORTHWICK, B.Sc. (With Plate.)

(Read 12th January 1899.)

Pinus Laricio, the black pine, was introduced during the present century into Britain. It is a forest tree of no mean importance, and for ornamental purposes it is greatly prized. The stem is straight and well formed, reaching a height of sixty to seventy-five feet at maturity. The natural distribution of this species is in Southern Europe, stretching from the south of Spain to Asia Minor, and from Wiener Wald south to Sicily.

On account of the regular whorl branching, the deep corona, and thick dark green needles, this tree is well adapted for parks and ornamental grounds, especially in the vicinity of large towns, as it withstands the smoky atmosphere better than any other pine. This species has been relegated to the section *Pinaster*, sub-section *Pinea*,

but for practical purposes the pines might be divided into three sections—Pinaster, Tæda, and Cembra, according as they have two, three, or five needles on one branch of limited growth. In this classification *Pinus Laricio* might belong to the sections Pinaster or Tæda equally well, since it is a common thing to find two or three needles in one sheath on the same individual. Beissner's classification, however, obviates this difficulty, and owing to the structure of the cone, which has no strong protruding spur such as is found in the section Tæda, the black pine takes its place in section Pinaster.

Like other pines, this species occurs in several different forms, distinguished by the leaves or habit of growth, such as—(1) *Pinus Laricio Austriaca*, the black Austrian pine, whose needles are long and coarse with yellow tips; (2) *Pinus Laricio Poiretiana*, the Corsican black pine, with needles like the former, but twisted in young plants; (3) *Pinus Laricio Pallasiana*, needles long, coarse, and stiff; the periderm of young shoots is yellowish, while it is grey-brown in *Austriaca*, and light brown in *Poiretiana*; (4) *Pinus Laricio Monspeliensis*, of Southern France, has softer and more delicate needles of a lighter green, with very distinctly serrulate margins, and the periderm of young shoots is reddish yellow. In all these we may get growth forms, as—the drooping form, *Pendula*; the dwarf forms, *Pygmea*, *Monstrosa*, and *Bujoti*; and lastly, the serpent form, *Virgata*. In a young mixed plantation, consisting of larch, spruce, and pine, I found a black pine, the age of which I estimated to be twelve years. It had a diameter of three and a half inches, and a height of eleven feet. For the last two years it had produced no whorl branches, and the apex was occupied by an unusually large single bud, which was fully an inch long and half an inch broad. About three inches below this bud was a ring of undeveloped buds, five in number, alternating with four side shoots averaging about six inches in length. Farther down, about eighteen inches below the apex, was one side shoot eight inches long. This shoot was undoubtedly developed from a branch of limited growth, since the needles were still adhering to its base. The origin of the ring of buds farther up is more obscure.

The upper part of the tree, which I may call the *virgata* or serpent part, was densely covered with long thick needles, occurring in bi-, tri-, and quadrifoliar spurs. The bifoliar spurs of the upper part were much longer than those of the lower or normal part, the average difference being 2·2 inches. Bifoliar and trifoliar spurs occurred all over the tree, but the quadrifoliar spurs were entirely confined to the upper part. The quadrifoliar spurs were heterophyllous, the fourth needle being shorter and thinner than the other three, which averaged 6·78 inches in length, while the fourth needle averaged 4·08 inches, it is therefore 2·7 inches shorter than the other three. In addition to being the smallest, it is the highest inserted needle of the sheath. A longitudinal section shows that it belongs to the interfoliar bud, being, in fact, a metamorphosed bud scale. The other three needles were produced by the last three leaves of the branch of limited growth in the normal manner, and they are therefore arranged round the apex of the branch, with their bases nearly in the same plane; but the base of the fourth needle is much higher, its point of insertion being opposite that of the first scale leaf of the interfoliar bud, as may be seen from the photomicrograph. That the fourth leaf is a subsequent formation may be seen by a transverse section just above the leaf sheath. The three larger and first formed leaves together form a circle, their inner sides converging at angles of 60°. The regularity of this arrangement, however, is broken by the fourth leaf, which has grown up between the others, flattening their inner angles, and giving them a more or less polygonal outline. The fourth needle itself is plano-convex, but at one of its angles there is a peculiar outgrowth which has been caused by the crushing of the other leaves.

A transverse section of the three larger needles showed them to have the typical structure. The resin canals were not in contact with the hypoderm, as in the the Scots pine, but were embedded in the mesophyll, and though varying in number in different leaves, still they all showed the median upper resin canal so typical of a certain number of pines, including *Pinus Laricio*. The vascular bundle was



DESCRIPTION OF PLATE.

A quadrifoliar spur in longitudinal section. On the left is seen the base of a normal needle, on the right two needle bases, the outer and lower inserted being normal; the inner, smaller and higher inserted, being the fourth and abnormal needle of the spur. Centrally is the interfoliar bud with its scale leaves.

double, and its orientation normal. The transfusion tissue was present in the usual amount.

On examining a transverse section of the fourth needle, I found only two resin canals, right and left of the vascular bundle, embedded in the mesophyll. The transfusion tissue was not so abundant as in the other needles, and the vascular bundle was single. The xylem was towards the convex, and the phloem towards the plane side of the leaf, exactly the opposite of what is found in the normal condition. In the position and number of the resin canals, and the orientation of the vascular bundle, this leaf agrees in structure with what is found in the leaf of *Pinus Monophylla*, according to the description given by Maxwell T. Masters in the "Annals of Botany," vol. ii. p. 124.

It may be interesting to notice here that according to Bertrand—"Annales des Sciences Naturelles," series v. vol. xx.—the resin canals of the scale leaves are not continuous with those of the axis, but the photomicrograph of the longitudinal section of the branch of limited growth and interfoliar bud shows distinctly a branch passing from a resin canal at the axis into a scale leaf. I have also found scale leaves of other buds receiving branches from the resin canals of the axis.

After the third year the primary spirally-arranged green leaves of the pine appear only as dry scales, bearing branches of limited growth in their axils, and most authorities agree that when such scales become changed into green leaves, they are short and flat, in fact, they become the typical rosette-shoot leaves; but the fourth needle, which has the same origin as the rosette-shoot leaves, is thin and needle-like, and although it shows some of the primary leaf characters internally, still, in outward appearance, it resembles the normal acicular leaves, exhibiting, in fact, a transition stage between the two.

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