SUCCESSION OF EPiphyTES IN THE QUERcuS INCANA FOREST AT LANDOUR, WESTERN HIMALAYAS. PRELIMINARY NOTE.

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Landour is situated in the outer Western Himalayas, 78° 6' E. Long., and 30° 27' N. Lat., at an altitude of 1900-2200 m., in the midst of the Quercus incana climatic climax forest. The climate is decidedly periodic, due to the combined effects of: latitude, producing a distinct alternation of winter and summer; altitude, making Landour about 10° C. colder than the nearby-Plains; and nearness to the Plains, resulting in an alternation of wet and dry seasons, characteristic of a monsoon climate. Spring is dry and sunny; June to September is mild or cool, with heavy rains (about 85 per cent. of the total 250 cm. precipitation falls during this period) and high relative humidity; autumn is dry and sunny; and winter is cool with considerable snow. Epiphytes make practically all of their growth during the summer monsoon.

This study, made during the summers of 1921 and 1922, is concerned with the "topographic" succession of the epiphytes on the trees of the Quercus incana forest, mainly on Quercus incana itself.

The following stages may be distinguished:

1. Crustose lichen stage, beginning with little flecks of color on the bark when branches are 3-4 years old. Of the numerous pioneer crustose lichens, two species produce about 75 per cent. of the vegetation of this stage.

2. Foliose and fruticose lichen stage; starts almost as early as the crustose lichens, but begins to make a characteristic showing 3-4 years later. Usnea barbata is a prominent member. When this stage is fully developed, in 9-12 years under favourable conditions, the numerous species nearly or quite cover the branches.

3. Pioneer moss stage. Pioneer mosses (especially Lindbergia pachytheca) and a liverwort (Frullania? sp.) gain a foothold in favorable spots. Other trailing and erect mosses follow, gradually crowding out the lichens, probably by shading them.

4. Climax moss stage, when Leucodon secundus, Diaphanodon blandus, and Cryptoleptodon flexuosus develop a thick continuous pad about the branches. Under favorable conditions this stage is reached
in about 20 years. Lichens, with Myxophyceae as the alga component, become frequent. A bed of soil from wind-borne dust particles gradually accumulates in the moss pad.

The greatest advance of the moss stage is indicated by the appearance of mesophytic mosses (as *Meteorium buchanani*), lichens (as *Sticta pulmonaria*), and liverworts (as *Porella*).

5. Fern stage. *Pleopeltis simplex*, the most xerophytic of the epiphytic ferns in the area, gains a foothold in the moss pad; it is followed by *Leucostegia pseudo-cystopteris*, which forms the bulk of the epiphytic ferns observed about Landour. In protected humid places *Goniophlebium lachnopus* becomes common. The fern stems and roots collect and hold more dust, forming a soil bed that may attain a thickness of 10 cm.

Increasing density of shade of the leaves of *Leucostegia* gradually kills out the climax mosses, and in their stead small erect soil mosses appear, recalling the development of herbaceous vegetation on the floor of a dense shady forest. Some of these little mosses seem to be exclusively epiphytic.

6. Flowering plant stage—perhaps only the highest expression of a vascular plant stage. *Tripogon filiformis*, *Thalictrum santiculaforme*, *Sedum trifidum*, and *Begonia amoena* in order of importance, often become as prominent as the ferns. This is the climatic climax of the epiphytes in the Landour area.

Secondary successions are as common and well marked among epiphytes as among terrestrial plants. With increasing stem size and inevitable bark decay, moss pads slip off here and there, leaving patches of bare bark to be invaded by pioneer secondary succession mosses. Even the mat of vascular plant stems and roots may at times give way leaving bare spots.

Identification of species of lichens, liverworts and mosses is incomplete. Lichens are being identified by Miss Annie Lorrain Smith, Liverworts by Prof. Shiv Ram Kashyap, and mosses by Mr. H. N. Dixon. To these persons I am deeply indebted.

About 45 species of lichens, 10 of liverworts, 50 of mosses, 5 of ferns, and 12 of flowering plants have been found in the various stages of the succession.

Details of succession, and composition of the various stages vary widely, depending on (1) exposure to wind, (2) bark characters of the trees, (3) position on the branches and position of branches on trees, and (4) on chance dissemination of the species involved.

Exposure retards succession, so that isolated exposed trees may progress no further than the foliose and fruticose lichen stage, while
trees in the most humid locations bear a luxuriant growth of quite mesophytic lichens, liverworts and mosses.

Physical and perhaps chemical, characters of the bark of the various trees are of great importance. *Rhododendron arboreum* bark flakes off so easily that succession rarely progresses to the climax moss stage and the species involved are somewhat different from those found on oaks.

Position of the branches and other features produce widely varying habitats even on the same tree. "Edaphic" spots, as the under side of branches, crotches, and nearness to the ground level, permit succession to proceed beyond the average for the tree.

Chance dissemination determines whether or not a particular species shall appear on a given tree. For example, it is very common to find some trees remaining for many years in the climax moss stage, while nearby trees are covered with ferns.

Seasonal differences in climatic conditions cause very large seasonal difference in the aspect, and probably also in the composition of the epiphytic flora. Lichens, liverworts, and most mosses simply dry up during dry weather, and revive and resume growth with each rain; nearly all the vascular plants remain alive only by means of perennating organs, and are conspicuous only during the summer monsoon; while little mosses in the shade of the vascular plants reach their maximum development in August and September. Further study is necessary to determine the extent and character of seasonal phenomena in the epiphytic vegetation.

Succession shown by epiphytes is considered to be unique, because of (1) the short time required for completion, (2) the unusual clearness of the successive stages, (3) the small size of the plants involved, and (4) the adaptation of the plants to repeated and prolonged dessication.

It is possible that further study of the succession of epiphytes may throw new light on the problem of succession in general, especially in a strongly periodic climate.