SOME ASPECTS OF THE CONE AND SEED INSECT PROBLEM IN THE PACIFIC NORTHWEST [1]

By A. F. HEDLIN [2]

There are many problems in connection with the production and collection of good quality seed and one of these problems is insects. According to Baldwin (1942), "No destructive agency short of climatic injury can so completely nullify a seed crop as insects." Tree seeds are collected for many different uses but the interest of the forester lies in producing sufficient quantities of high quality seed to carry out necessary reforestation programs.

Logging has been carried out in the Pacific northwest on a large scale for many years; however it is only recently that serious concern has been shown in reforesting the vast tracts which are being cut. Although plantations of commercial conifers were set out in the lower Columbia River Valley in the 1890's, by 1940 only two-tenths of one per cent of the commercial timberland on the Pacific Coast had been planted after logging (Vaux, 1954). Fortunately, since 1940 the situation has improved; on the one hand the number of forest plantations established on the Pacific Coast has been increasing and on the other hand legislation has been enacted in both the United States and Canada which directly or indirectly serves to emphasize plantings as an essential part of forest policy. In the United States tree planting was 37 per cent greater during the 1958-59 season than during the previous year; the annual rate of planting has doubled during the last three years (Anonymous, 1960). Legislation by some of the Pacific Coast States includes the Forest Practices Acts under which planting may be required if necessary to keep logged-off land productive (Vaux, 1954). Similar powers are given the British Columbia Minister of Lands and Forests by the Forest Act (Sloan, 1956). Obviously large quantities of seed are required to carry out these reforestation programs.

Insects have been recognized as a factor in tree-seed production for many years. More than a hundred years ago, Parfitt (1857) described a species of *Megastigmus* causing damage to seeds of *Abies* in California. Following this, reports on seed insects on the Pacific Coast were infrequent for a number of years. J. M. Miller, who recognized that insects were a detrimental factor in seed production, felt that more should be known about them and the damage they were causing. As a result, in 1912, the United States Bureau of Entomology and Plant Quarantine authorized work to be carried out on cone and seed insects at Placerville, California. The following year the work was transferred to Ashland, Oregon. It was here that much of the ground work in cone and seed insect studies in this region was laid during the years 1913 to 1917 by Miller and his associates, J. E. Patterson, and F. P. Keen. The studies were interrupted by World War I and since the problem was not considered of much

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economic importance, they were not continued. The results of the work by these men have been organized and published in a very useful and timely bulletin (Keen, 1958).

Since World War II, increased reforestation has created a greater demand for seed and also more concern over factors which affect its production. As a result, work on cone and seed insects has been started again and projects have been, or are being, conducted in different parts of Canada as well as the United States. Studies have been made on a number of seed-destroying species by workers of the Forest Biology Division, Canada Department of Agriculture in Ontario, Saskatchewan and British Columbia. Some of the stations currently engaged in cone and seed insect research in the Pacific Coast region of the United States are: Pacific Southwest Forest and Range Experiment Station, Berkeley, Calif.; Weyerhaeuser Timber Company Research Center, Centralia, Wash.; University of California, Berkeley, Calif.; University of Idaho, Moscow, Idaho.

Research conducted by these stations is determined largely by the nature of problems peculiar to the region. Douglas fir, the cones of which are host to many species of insects, receives more attention than any other species but work also is conducted on other trees. For example, at the University of California systematic and biological studies of pine-cone insects are conducted. In general, the approach has been to carry out studies on life history, habits, and seed-destroying capabilities. If chemical control measures are deemed necessary later, the problem may be approached with sufficient knowledge of the insect that at least some of the guesswork is eliminated.

There are many species of cone and seed insects, and probably few species of trees escape at least some seed damage by one or more of them. As an indication of the size and extent of the problem, Keen (1958) listed 38 species of trees from which cone insects were reported and some of these are host to many different insects; for example, nearly 20 species of seed-destroying insects were reported from Douglas-fir cones. For 33 of these tree species he listed 65 different insects which he considered of economic importance. These more important species are usually found throughout much of the range of the host and may destroy high percentages of seed even in years of good cone crops. As an example of this, despite the good crop of cones on Douglas fir in 1959, infestations by the Douglas-fir cone moth, *Barbara colfaxiana* (Kft.), in the Okanagan Valley in B.C. were high, up to 90 per cent of the cones in some localities being infested.

Cone and seed insects cause damage in four different ways depending on their feeding habits. They may: 1. Live within a seed, each insect destroying a single seed, e.g. seed chalcids. 2. Form galls or mines within a cone scale thus robbing seeds of nutrients; several insects may destroy one or both seeds on a scale, e.g. cone midges. 3. Feed at random within the cone, damaging both scales and seeds thus causing indirect as well as direct damage; one insect may destroy a number of seeds, e.g. cone moths. 4. Mine the cone axis thus killing the cone and its potential seeds, e.g. cone beetles.

The damage caused by these insects affects seed production in different ways:

1. Natural regeneration following removal of mature timber may be delayed, reduced or prevented by cone and seed insects. In Maine a situation developed following severe fires in 1947 where there was "almost total destruction of white pine seed for 3 or 4 years" (Anonymous, 1955). The damage was caused by cone beetles, cone moths and seed chalcids. In lower Michigan "the scattered red pine stands . . . usually yield poor cone crops largely because of chronic heavy insect infestation" (Anonymous, 1948).

2. Severe infestations in a desirable area or areas can seriously decrease the amount of seed obtained or even make collection uneconomical. Often for best results seed should be taken from trees growing under certain ecological conditions. "There is no lack of evidence that provenance is of tremendous significance to the outcome of plantations" (Baldwin, 1942).

3. In recent years the trend has been towards establishment of Seed Production Areas and Seed Orchards. A Seed Production Area is one that is upgraded by removal of undesirable specimens and cultured for early and abundant seed production. A Seed Orchard is a plantation consisting of clones or seedlings from selected trees, isolated to prevent or reduce pollination from outside sources (Snyder, 1959). Obviously seed produced in either of these areas, and particularly in the Seed Orchard, represents a large investment, and thus destruction of these seeds by insects represents a correspondingly greater loss.

4. Paralleling the interest in establishment of Seed Orchards is an interest in forest tree improvement. Intensive tree-breeding programs are being carried out at several locations. Damage to seeds and cones used in genetic studies can seriously retard breeding programs.

Although fairly intensive investigations have been carried out for several years at most of the stations mentioned, only a good start has been made. Fairly detailed studies have been carried out on some aspects of the more important insect species, but many have received little attention beyond being described, and some have not even been described. Studies should be conducted to obtain an inventory of all cone and seed insects, and biological data on all important seed-destroying insects, in tree species which may be included in reforestation or tree-breeding programs.

In addition to other studies that must be carried out there are two phases in the study of cone and seed insects which are important and bear special mention. Both relate to any insect being studied but they are particularly important in a study of insects whose food supply may fluctuate tremendously from one year to another. The first is the development of good sampling methods. It is important that accurate methods of estimating populations are devised so that infestation levels can be compared for different areas and different years. The second point involves factors affecting population fluctuations. We know that fluctuations in cone crops must have important effects on cone insect populations. It would be useful to know the relationships and be able to predict these effects with some degree of accuracy. Good estimates of insect populations in conjunction with annual cone crop records should yield some interesting comparisons and aid in the analysis of the causes of fluctuations in cone and seed insect populations.

From the foregoing discussion it is clear that cone and seed insects can seriously impair and greatly increase the cost of reforestation programs. It is important that research directed towards reducing losses caused by them be continued and intensified.

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His article was reprinted by the Queen's Printer, Ottawa, in 1957. He divided Canada into thirteen zones, within which acceptable average annual burning rates were calculated for experimental, recreational, productive, and non-productive forest areas, and for non-forested areas. His burned-area objectives took into account both values requiring protection and factors which affect the difficulty of protection. They were determined on a basis compatible with the least cost theory of fire control, provide excellent guides, and should be accepted and used widely.

Applying the least cost theory, optimum protection is attained when combined damage and cost are at a minimum. If we apply this theory to all of Canada it appears as if we are approaching the stage when total costs plus damage, as currently estimated, will be relatively stable.

Canadian foresters should be re-stating and doing something constructive about Beall's 1949 question "How much *more* protection can be justified on economic grounds, and how can this best be achieved?"

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