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

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There are many problems in connection with production and collection of good quality seed and one of these problems is insects. "No destructive agency short of climatic injury can so completely nullify a seed crop as insects." (Baldwin, 1942).

Large quantities of tree seeds are produced for a number of purposes. Some are potential sources of vegetable oils, drugs, dyes, and other chemicals; others are used for food. Millions of pounds of walnuts, almonds, pistachio nuts, and coconuts are consumed each year (Baldwin, 1942). However, the forest industry is primarily interested 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, but 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 percent 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 percent 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 M**egastugmus** 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 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. The following are some of the stations actively engaged **in** cone and seed insect research in this region

1. Pacific Southwest Forest& Range Experiment Station, Berkeley, California

2. Weyerhaeuser Timber Company Research Center, Centralia, Wash.

3. University of California, Berkeley, California

4. University of Idaho, Moscow, Idaho

5. Forest Biology Laboratory, Victoria, B. C.

Work 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 is also conducted **on** other trees. For example, at the University of California systematic and biological studies of pine cone insects were conducted. In general, the approach has been to carry out studies on life history, habits and seed-destroying capabilities. Then if chemical control measures are deemed necessary later, it will be possible to approach the problem 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) lists 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 lists 65 different insects which he considers of economic importance. Those 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, in the Okanagan Valley **in** British Columbia were high, up to 90 percent 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; usually several to many 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 forest 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. 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). Severe infestations in a desirable area or areas can seriously decrease the amount of seed obtained or even make collection uneconomical.

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 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 importatnt 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 I think 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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