The Control of Forest Insects

I—GENERAL PROBLEMS

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WHEN the problem of controlling insect pests in forests is discussed, two approaches are possible: one may discuss the present situation in the forests of a given country in the light of what is known about their insects; or one may attempt to produce a plan which can be modified to deal with the pests of any country. This article deals with the second possibility, and is not therefore directly concerned with the present practice in Ireland.

It is common in many countries today to rely on the observation of foresters to draw attention to the presenece of insects, or their damage in a plantation and this the forester is willing to do. He will report that an outbreak has occurred in a particular area, and will await further action by the central forestry authority. Although the notification of outbreaks is essential for the efficient management of the forest, it is worthwhile to ask if that is all the useful information a forester can provide without seriously overburdening himself. Consider a hypothetical outbreak.

The forester has noticed that there is a defoliating insect at work in a plantation. Does he merely report the presence of the defoliator, or does he try to assess its importance in terms of potential economic loss? If he reports only the presence of the outbreak then someone else must assess its importance, although if he is to assess it himself he must have a rapid method of gaining the relevant information. He must know the questions to ask, and the way to answer them: for instance, how many trees are affected, how extensive is the defoliation, are all the trees affected of the same age, or are all ages of tree affected? These could all be answered in different ways, but if the assessment is to be useful it must be comparable with assessments made anywhere else in the country. This will occur only if the forester who is to assess the insect damage is trained to use a standard technique which is applied throughout the country.

Let us extend the hypothetical example and suppose that the foresters in the east find that there is damage to their trees which is caused by a particular species of insect, but the damage has not been recorded from the west. Does this mean that the insect does not occur in the west or that there is a smaller population of the insect present which is too small to cause damage that is worth reporting? No matter how helpful a forester wishes to be, he cannot spend all his time chasing insects and looking at random for small

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outbreaks of insect attack, particularly when it may be obvious that these small outbreaks have little immediate economic significance. This suggests that there is need to keep a list of insects which are known to be of economic importance, and which every forester is trained to recognise on sight. The status of these insects is reported by the forester at regular intervals, whether they appear important or not. Such a system allows the spread of economically important insects to be recorded, and warning of a likely increase in their potential danger in a particular forest can be given. With this system in operation it would be possible to plan control techniques and know with greater certainty the potential dangers which confront a given forest. Control techniques can then be applied before serious economic loss occurs.

The role of the forester in detecting and appraising insect attack is vital if the forest is to run successfully, but the forester cannot be expected to assume responsibility for initiating surveys on his own. His greatest contribution is in accurate observation and reporting, in the use of the national systems that the state entomologists have devised. Clearly for such systems to exist there must be a group of entomologists large enough to perform the research that is needed to organise and run the surveys and also to devise control methods.

The problems of controlling insect pests must be considered in relation to the economic effect that the damage produces; the damage can occur in one of three ways, the death of the tree, damage to the tree, or delay in rotation. A sudden heavy attack by insects during one season may be sufficient to kill a tree outright, or the tree may not die for two or three years if the insect is allowed to remain unchecked. This situation produces an economic loss which is measurable in dead trees, but if the trees do not die then the time that they take to grow to a certain size is prolonged, and the increased growing time can again be measured in economic terms. This assumes that there is a predictable relationship between insect attack and reduction in growth, but this is not always so, and the answer can be provided only if sustained research is performed on trees growing in an environment which is equivalent to the natural forest. Again, this research must be the responsibility of entomologists who can show which factors are important in deciding the ultimate effect of an outbreak, and whether it is economically worthwhile to apply measures at particular levels of infestation, or to any particular age-group of trees. Thus the effect of insect attack on trees, measured in economic terms, is likely to be complex and to require intensive study. It is nevertheless important to note that the field assessment of actual insect damage can be performed by foresters who use the standardized techniques referred to earlier.

Mechanical damage to the wood by wood boring insects may result in the timber becoming weakened or aesthetically spoiled by the presence of tunnels causd by insect activity. In addition,

the tunnels may provide a possible entry site for fungal attack in growing trees. In economic terms the loss caused by the tunnels may be calculated.

In addition to the actual damage that insects produce, they may be responsible for transferring fungal or virus diseases from infected to non-infected trees. Again it will be the task of the entomologist to decide which species of insect act as vectors and to include their names and descriptions in the list of recognised insect pests.

At present, the decision to control an insect pest in a forest is usually based on evidence which shows that there is a major outbreak present in the forest although we have seen that the aim should be to recognise that such an outbreak is likely to occur. Once the decision has been made to control an insect species, what control and what criteria should be used to judge which method is the most appropriate? Ideally, a method which gives complete control (or eradication) should be used, but such methods have not yet been developed for all pest species because this important aspect of pest management is being neglected in many countries, even in those which have serious pests in their forests. Virtually all the methods of control that are in general use today are unlikely to provide a permanent solution for any outbreak and so must be applied at intervals, to keep the population of insects at a level which ceases to be economically important or at which it would be unprofitable to apply further control. At first sight insecticides appear to be the most practical means of control, but the disadvantages in their use can be great, and it is generally agreed that they should not be used indiscriminately.

The use of insecticides tends to be a controversial subject, with the commercial interests of the suppliers and appliers being ranged against the concern of those who are interested in wildlife conservation. The main arguments are that insecticides can be effective in temporarily reducing an insect population, that the cost of control may be calculated directly (an argument which appeals to administrators), which is true, and that the use of non-specific toxic substances results in the death of many organisms either immediately or as the result of toxic residues being absorbed over a period of time, which is true. At best, it should be recognised that existing insecticides are toxic substances which have unwanted side effects, and that extensive research must be carried out to determine both the best methods of applying these substances, and of biological control, that is methods which provide control of the pest without the use of non-specific toxicants.

Before methods of control are considered it is essential to describe the factors that affect the way in which the insects are likely to be distributed in the forest during an attack.

Unless an insect attack has been allowed to develop to catastrophic proportions it is unusual to find that every tree (of a given species)

has been attacked. The attack may be concentrated on a particular age group, or on trees that are situated in a particular location. An irregular distribution *may* be due to chance and the presence of insufficient insects to attack all the trees. However such small numbers of insects are usually unnoticed, so there must be some other cause, perhaps the selection of some trees in preference to others, or perhaps the insects can survive in certain locations only. Selection mechanisms depend, in many instances, on chemical stimuli, and the presence or absence of a relatively small amount of some chemical (either attractant or repellent) may be sufficient to determine whether a tree will be attacked or not. The presence of sustances which act as repellents is often related to the vigour of the tree, sickly trees or trees which have become stunted having less of these substances than trees which are growing well, and as a result the least vigorous trees are often the first to show signs of insect attack.

Susceptibility differences which are related to the age of the tree result from similar chemical stimuli, which may either inhibit or attract insect attack.

These chemical substances are often specific in the sense that they affect one or at most, several very closely related species of insect. The forester (or the forest entomologist) has therefore a powerful means of controlling the behaviour of the insects which respond to the chemical. If the substance is attractive ,then a tree or an artificial surface can be sprayed with this substance plus a suitable insecticide, and the insects will be attracted to the trap. In principle this technique is simple to apply, but before it can be applied as a routine control method it will be essential to know how much more attractive the trap is than the naturally growing trees, from what distances the trap will attract the pest insects and for how long the trap is, or needs to be, effective. Again, research into these problems must be performed by entomologists under conditions that pertain to the forests of a given country.

No matter how great an outbreak appears to be, the population of the insect never reaches the proportions which in theory it could attain. The reason for this is that the insect is used as a source of food by other insects, birds and mammals. In addition, there is usually some parasitic organism which will help to limit the size that the population attains. Manipulation of these predatory and parasitic organisms in order to help reduce the level of the pest species of insect is the essence of the method of biological control. It has been recognised for several years that biological methods of control can work effectively and with safety only if the environmental factors which affect the controlling organisms are known. It must also be considered if there is any danger of releasing an organism in such large numbers that it could itself become a pest. This latter consideration is particularly important when new species of insect are introduced into a country. It might be added that the

introduction of plant material from other countries may result in the unwitting introduction of insects which are already pests in other countries. Stringent enforcement of plant quarantine regulations is the only means of ensuring that this does not occur.

The principles on which any successful control method will be based can now be summarised. The use of specific attractants to bring a single species of insect into contact with an insecticide which is confined in such a way that it has no unwanted side effects on the rest of the forest is practicable and would disarm the present critics of the use of insecticides. The use of substances which occur in the trees themselves has already been quoted. Other potent chemicals which could be used in the same manner are the sex attractants. Sex attractants are produced by the sexually active females of many species of insect as a means of attracting males of the same species. It does not matter that only one sex is attracted and killed, for if the insects do not mate there cannot be viable young. For the method to be successful it must be known that the males of the pest species can be attracted, and that they will tend to go to the traps rather than the females, in addition the distance over which the males are attracted must be great enough to make it economically feasible to set up efficient traps.

The use of predators and parasites to reduce the size of a pest population has, on occasion, proved very effective. The method can, however, permit fairly large fluctuations in the numbers of pest to occur. Such fluctuations occur because the maximum population of parasites or predators reduces the population of the pest to a level which deprives the parasite or predator of adequate food, with the result that their population falls sharply to a low level. The pest is no longer limited by the presence of the predator or parasite and its population rapidly increases, and the increase in the supply of food allows the parasite or predator population to regain its maximum level, and the pest population falls again. As long as the maximum population of the pest remains at a level which causes little economic loss once the parasite or predator is established, the method is successful.

Other methods which are gaining in popularity aim to interrupt the sexual cycle of the pest insects. One method employs the use of chemosterilants, that is chemical compounds which produce sterilisation in the organisms which come into contact with them. Their use introduces the same type of hazard as occurs with insecticides; non-specificity can cause many other organisms to cease reproducing and die out. Although many of the potential hazards can be reduced, if not eliminated, through careful application by trained personnel, what factors are important in planning control methods with such substances can be discovered only by critical research. A second method which is of limited application in forest entomology is the sterilised male technique. This method is used for species

of insect whost female mates once and at that time stores enough sperm to complete her egg laying activity. Large numbers of males, which have been sterilised by means of irradiation, are released into the wild population where they compete with the fertile males for the females. For this method to be succssful the size of the wild population must be known, so that enough males can be released, and it must be possible to breed large numbers of the males under artificial conditions. When the method is successful it completely eradicates the pest from the area, which should be the ultimate goal of all control methods.

The control of forest insects must not be considered as a task to be performed when it has become obvious that something must be done if trees are not to be ruined. Methods must be devised to give warning that there is likely to be an attack by a specific insect, and the methods must operate on a nation-wide scale if they are to be effective. Whilst the forester can provide the information for the routine surveys, he cannot be expected to perform the research that is essential to determine which insects should be watched carefully and what factors are involved in the development of an insect as a serious pest, for such research is the responsibility of the state entomologists. Similarly, the choice of control method will depend on the data that the entomologist provides about the pest insects. Whatever method is used it should not have unwanted side effects which could destroy the wildlife of the forest and ultimately affect man himself.

This paper has dealt with the problems of insect control in forests in general terms, subsequent papers in the series will deal with specific aspects of the problem and relate the information to the conditions of the forests in Ireland.