Epidemics of Insects on Forest Trees in New Zealand

G. B. Rawlings

In the conventional treatment of insect epidemics it is usual to recognise a number of development stages which may be summarised as follows:—

1. *The biotic balance;* this is the normal state, previous to the epidemic, in which a balance is maintained at approximately the normal level.

2. *The preparatory stage;* in which there is an increase in insect population but no visible damage.

3. *The prodromal stage;* in which damage is visible but not of economic importance; there is a definite increase in insect numbers.

4. *The eruptive stage;* in which the population rapidly attains epidemic proportions and severe damage may be caused.

5. *The crisis;* at which point the epidemic breaks down.

6. *The decline;* in which the population falls to or below the normal level. The biotic balance is then restored.

CAUSES OF EPIDEMICS

The predisposing causes of insect epidemics are numerous and often obscure. In most cases the factors of greatest importance are climatic and should be, therefore, to a certain extent predictable. Epidemics may be initiated by positive factors favourable to the insect or unfavourable to the tree; or by the temporary partial cessation of those controlling factors which maintain the population within normal limits.

INCREASE AND SPREAD

Increase and spread tend to work in opposite directions, increase in numbers produces greatest damage, while rate of spread determines the concentration or dissipation of the attack. The rate of increase is determined partly by the biotic potential, or ability of the female to produce eggs, and partly by the extent to which controlling factors have ceased to operate. The sex ratio is also important, as is the number of generations per year.

Rate of increase is in geometric progression but in most cases *the controlling factors are not completely inoperative* and many generations may be required before the crisis is reached. Increase is soon rendered impossible owing to the limitations of the food supply; spread is therefore necessarily away from the centres of attack. Most frequently outbreaks spread from one or a few centres of infestation.

If the rate of spread is slow the damage is likely to be concentrated and more severe; rapid spread may disperse the population and reduce the severity of the damage. Spread may occur in the larval or adult stage and may be random or directional. The combined biotic potential of predators and parasites is normally greater than that of the host, and unless increase is inhibited, they should attain numerical supremacy in the fourth generation, or at least by the end of the eruptive stage.

THE CRISIS AND DECLINE

The decline of the epidemic is brought about by the factors of natural control which restore the balance at or below its previous level, or adjust it at a new level in harmony with new conditions. Apart from food supply the most important controlling agents are climatic and biological factors. Climatic factors act through their action on the tree, on the insect, or on other controlling factors. Biological control may come through a general increase in parasites and predators, through the dominance of one species, or through a bacterial or virus disease. In some cases control has been attributed to lethal genetic factors.

The net result is an adjustment of the balance between the rate of reproduction and the rate of mortality prior to oviposition, so that the population is first reduced to and then maintained at about its normal level. In general it may be said that the insects will exhaust their food supply or will be controlled by parasites, predators, disease or climatic factors.

EXAMPLES OF OUTBREAKS IN NEW ZEALAND FORESTS

Outbreaks fall naturally into two groups, according to whether they are independent of, or dependent upon, some debility within the tree. Insects causing outbreaks in the first group are called primary and those in the second group secondary. It is then convenient to subdivide the groups according to whether the insect and host are of indigenous or exotic origin.

GROUP A—Outbreaks independent of any debility within the tree.

A 1. *Indigenous insect on an indigenous forest.*

Epidemic outbreaks of caterpillars of the oecophorid moth, *Proteodes carifex* Butl., occur at intervals in forests of *Nothofagus cliffortioides.* These outbreaks have not been studied.

A 2. *Indigenous insect on an exotic forest.*

On 3rd December, 1951, an outbreak of the boarmid moth, *Selidosema suavis* (Butl.) was reported defoliating sixteen-year-old *Pinus radiata* at Eyrewell State Forest in Canterbury. A similar outbreak was reported at Balmoral State Forest in February 1952 which spread over 2,000 acres by September. No conclusive evidence is available to indicate the exact factor responsible for these outbreaks; control was effected through aerial spraying with D.D.T. and on a heavily infested area of 1,000 acres in Balmoral left untreated, control came through disease.

A 3. *Exotic insect on an indigenous forest.*

No outbreaks of this group have yet been reported from New Zealand.

A 4. *Exotic insect on an exotic forest.*

No true outbreak coming within this group has yet been recorded here.

GROUP B—Insects dependent upon some debility within the tree

B 1. *Indigenous insect on an indigenous forest.*

Outbreaks of the buprestid moth, *Nasciodes enysi* Sharp, are of fairly frequent occurrence. The eggs are laid on the bark of the trunks of species of *Nothofagus* and the larvae bore in towards the cambium, which they destroy.

Predisposing causes are:—overcrowding of trees, root injury due to trampling of stock and deer, attack by *Armillaria mellea,* silting, flooding, drought, earthquake, fire and felling operations. Once an epidemic has started, progressively healthy trees may be killed through repeated mass attacks.

Control comes through the elimination of susceptible trees, and, in pole stands, through the temporary relief from severe competition consequent upon the reduction in the number of trees. The return of climatic conditions more favourable to the tree increases host resistance. The buprestid larvae are parasitised by a colydid beetle, *Bothrideres obsoletus,* and a braconid, *Dorycetes pallidus.*

B 2. *Indigenous insect on an exotic forest.*

No outbreak in this group has yet been recorded in New Zealand.

B. 3. *Exotic insect on an indigenous forest.*

No outbreak in this group has yet been recorded from New Zealand.

B 4. *Exotic insect on an exotic forest.*

Outbreaks of the sawfly, *Sirex noctilio* Fabr., occur at intervals in forests of *Pinus radiata* (and other species of the genus *Pinus*). Eggs are deposited, between January and March, in the wood of living trees and at the same time fungal spores are inserted. Successful attack depends on the ability of the fungus to invade the wood and cut off the water supply to the crown. There is one generation each year, at least in the North Island, and an epidemic can develop in three years.

Predisposing conditions are overcrowding and drought conditions continuing for three years. Drought conditions are also favourable to copulation and so increase the proportion of females in the next generation. Populations of between 250,000 and 500,000 per acre may occur.

Control is through the reduction in stocking by 25-30 per cent. and by the return of favourable climatic conditions. *Sirex noctilio* is parasitised by the introduced ichneumonid, *Rhyssa persuasoria* L.; by the cynipoid, *Ibalia leucospoides* Hoch., introduced but not yet established.

Discussion

The discussion was opened by DR. J. T. SALMON who said that Dr Falla's paper had brought out two very important points; one was the rapidity of change in a community and the other the importance of studying the living community as a whole. It was quite wrong to study the ecology of an animal community divorced from the plant community with which it is associated. He congratulated Dr. Batham on stressing the importance of the relationship between animals and plants, and pointed out that many workers overlooked the importance of the relationship between the community under study and other communities. Referring to Mr. Rawlings' paper he said that it was unfortunate that Mr. Rawlings was not present as there were several statements in the paper that were open to criticism from an entomological point of view. Studies abroad have shown that climate plays a very important part in the development of insects. It is recognized that humidity, temperature, etc., are all-important in governing incubation, rate of hatching and survival values of the larvae and nymphs of insects. Mr. Rawlings stated that by the third generation the predators and parasites overtake the increase in the damaging insect species. This was too sweeping a statement in the present state of our knowledge. The biotic potential of an insect depends on two things, the availability of the food plant and climate.