AERIAL APPLICATION OF NUCLEAR POLYHEDROSIS VIRUS TO CONTROL EUROPEAN PINE SAWFLY, NEODIPRION SERTIFER (GEOFF.), AT SANDBANKS PROVINCIAL PARK, QUINTE ISLAND, ONTARIO IN 1975.

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ABSTRACT

An area of 125 ha in Sandbanks Provincial Park, Prince Edward County, Ontario was sprayed with a nuclear polyhedrosis virus in 1975 to control European pine sawfly, Neodiprion sertifer (Geoff.). An aqueous suspension of the virus containing 5.3 billion polyhedral inclusion bodies per litre was applied by aircraft at a rate of 9.4 l/ha when larvae were mainly in the first instar. The operation was an unqualified success, larval mortality was rapid and severe defoliation was prevented.

RÉSUMÉ

En 1975, on arrosa une superficie de 125 ha dans le Sandbanks Provincial Park, comté de Prince-Edouard, Ontario, avec un virus a polyhérose nucléaire afin de lutter contre la tenthrède du pin d'écosse, Neodiprion sertifer (Geoff.). Une suspension aqueuse de virus contenant 5.3 milliards d'inclusions polyhédrales par litre fut répandue par avion au taux de 9.4 l/ha alors que les larves se trouvaient surtout au premier stade de leur développement. L'opération s'avera un succès sans réserve, avec mort rapide des larves et prévention de la perte du feuillage des pins.

INTRODUCTION

The European pine sawfly was first recorded in New Jersey in 1925 (Schnaffner, 1939) and its spread through Southern Ontario and as far north as Sault Ste. Marie is reviewed by Griffiths *et al*. (1971). A nuclear polyhedrosis virus (NPV), which was known to cause epizootics in Europe, was imported from Sweden in 1949 and was field tested by spraying from ground equipment in 1950 and 1951, and from a aircraft in 1952 (Bird, 1953). In the aircraft spray trials virus suspensions containing 2×10^5 polyhedral inclusion bodies/ml, 10^6 and 5×10^6 were applied in swathes 90m apart at a rate of about 4.7 l/ha.

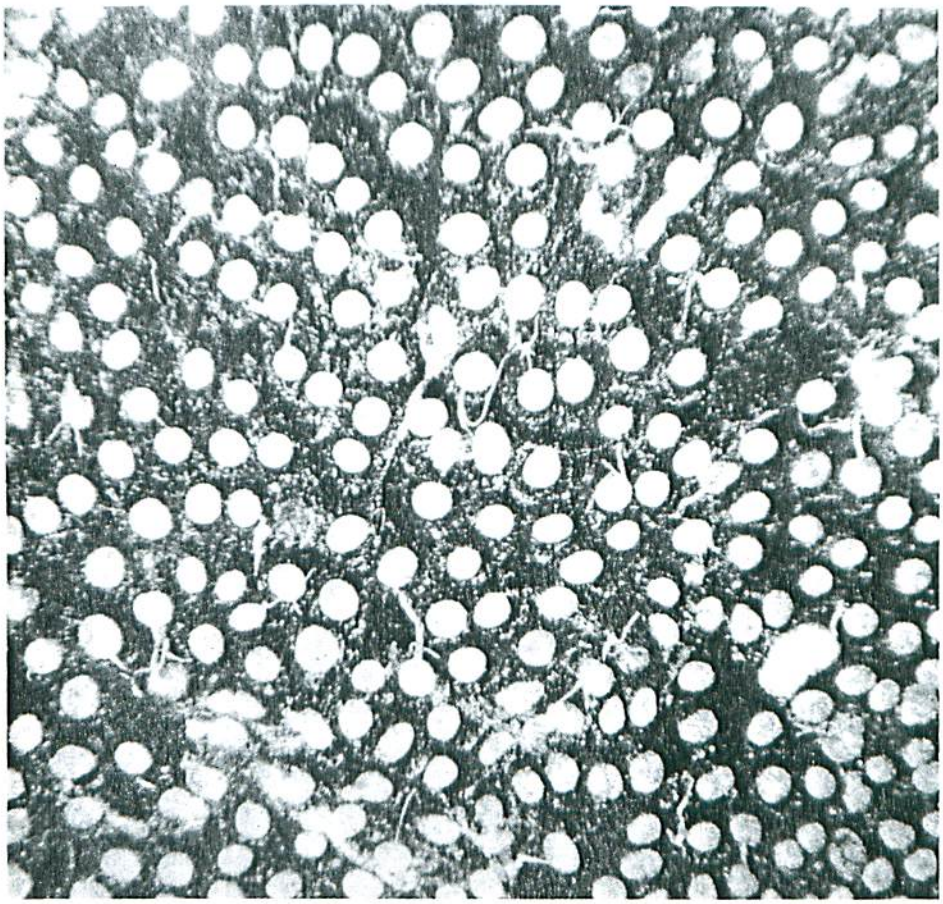
In the same area a 20 ha block was sprayed with 75l of suspension containing 5×10^6 polyhedra/ml and with skim milk powder added as a sticker. Over 94% mortality resulted 21 days after the spray application.

In a review of biological control methods of European pine sawfly, it was suggested that virus has not been used to the extent that it should be because (1) information has not been distributed to the growers on the advantages of virus over insecticides, (2) facilities are not available for the large scale production of virus, and (3) the virus requires exact timing of application and,

in this respect, is more difficult to use than chemical insecticides (Griffiths et al., op. cit.). Further, it was stated that if the virus is applied at the time the eggs hatch, larvae die in the second and third instar and defoliation is negligible.

Following the aerial spray trial in 1952, several ground spray trials using virus has been conducted by staff of the Canadian Forestry Service, Ontario Ministry of Natural Resources and some private growers to control small infestations of European pine sawfly in plantations. No further aerial spray operations have been undertaken.

This sawfly was first found in Sandbanks Provincial Park, on Quinte Island, Prince Edward County, in Southern Ontario in 1966, but infestation had not reached severe proportions until 1974. A large proportion of this park is composed of sand dunes which are constantly moving and the tree cover is most important in the prevention of wind erosion. The use of a wide spectrum chemical insecticide in this high use recreational area was considered undesirable and Mr. K.B. Turner of the Ontario Ministry of Natural Resources invited the assistance of the Insect Pathology Research Institute and Great Lakes Forest Research Centre to conduct an aerial spray operation using NPV.



Frontispiece. A squash preparation of a sawfly gut heavily infected with NPV observed microscopically under phase contrast. The highly refractive white spots are nuclei packed with polyhedra. X150.

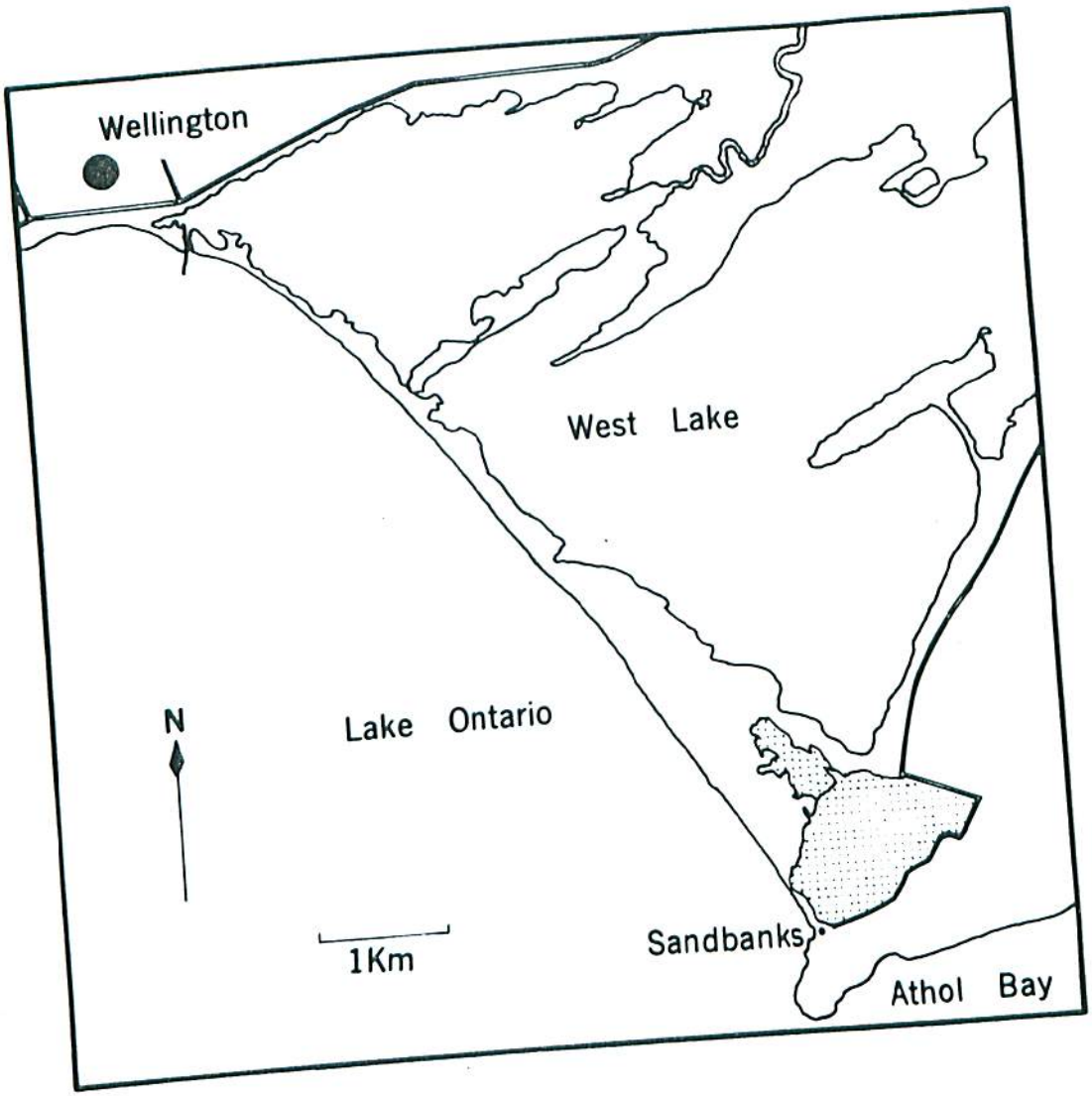


Fig. 1. The location of Sandbanks Provincial Parks and the surrounding area. The stippled area was sprayed with NPV.

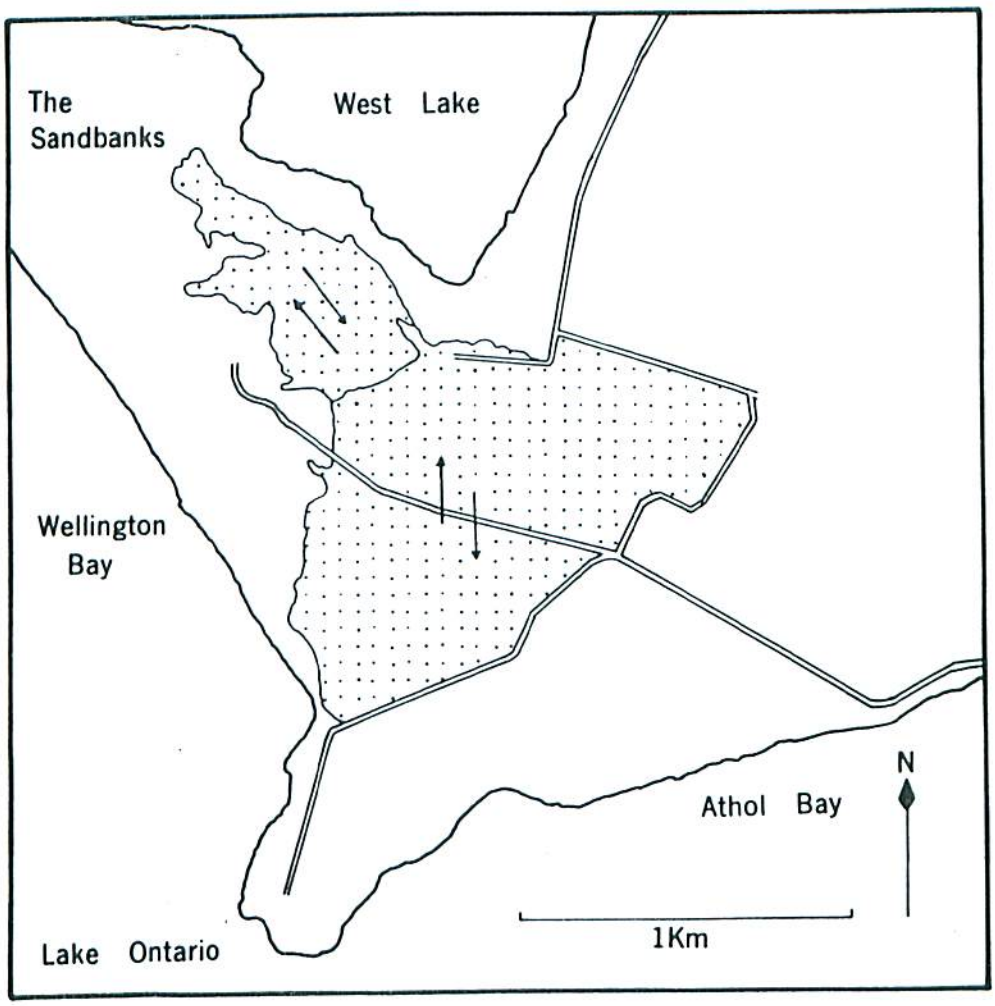


Fig. 2. Detailed map showing the two blocks sprayed with NPV in Sandbanks Provincial Park (stippled area). Direction of flight lines is shown with arrows.

MATERIALS AND METHODS

The Area.

The location of Sandbanks Provincial Park is shown in fig. 1 and a diagram of the 2 blocks infested with European pine sawfly in fig. 2. The first block was 89 ha and the trees were 6 to 9 m tall: the second block was a sand dune area of 36 ha where tree growth was poor and size varied from 0.3 to 4.5 m. In the first block there were jack pine, Scots pine and underplanted red pine which were all heavily infested with sawfly eggs and in the second block there were Scots pine and small jack pine.

The Virus.

The NPV used in this operation was propagated in an abandoned Scots pine plantation near Gore Bay, Gordon Twp. on Manitoulin Island, Ontario in 1974. When larvae were in the late fourth instar they were sprayed with a mistblower using a suspension containing 10^6 polyhedra/ml at a rate of about 20l/ha. Collections of diseased larvae were made 9 and 12 days after the application and approximately 25,000 larvae were recovered. These larvae were freeze-dried and ground to a fine powder in a domestic blender. They yielded 500 gm of virus-infected material.

The Formulation.

The infected larval powder was weighed and the quantity required for the operation was put into suspension in 40 l of distilled water using a Kalish^{R} turbo-homogenizer. The suspension was then filtered through a 20 mesh sieve. This was done in the laboratory 2 days prior to the application. For the final mix at the airport, a volume of this concentrated material containing the equivalent of 1 g of freeze-dried powder was added to each U.S. gal (3.785 l) of water. Water from a nearby river was used, as the effect of chlorinated domestic water on the virus has never been established. The concentration of virus in the formulation was 5.3 billion polyhedra per litre. IMC 90-001 U.V. protectant was added at the rate of 30 g/l to inhibit the inactivation of the virus by sunlight. It has a dark coloration and also makes a good marker for spray cards. Chevron^{R} sticker was added at the rate of 1.25 ml/l. This formulation has been used with nuclear polyhedrosis virus for the control of spruce budworm (Cunningham et al., 1974).

Monitoring the Deposit.

Kromkote^{R} spray cards mounted on plywood backings were placed at 15 m intervals along a road running through the centre of the first block at right angles

to the flight lines. They were placed across the sand dunes on the second block and also clipped to branches below the 100 sawfly colonies selected for observation.

Spray Application.

The spray was applied on the morning (0600 to 0830) of May 23rd using a Piper Super Cub owned by Sandham Air Service and fitted with a boom and nozzle spray system. With 26 D7 nozzles on the spray boom, and flying a 41 m swathe width, the rate of application was 9.4 l/ha. The aircraft carried 284 l; 4 full loads and one partial load were required to complete spray operations.

The Insect.

At the time of spray application most colonies were in the first instar and a very few second instar were present.

Assessment of Efficacy.

For an assessment of the spray efficacy, 100 colonies were tagged and observed at weekly intervals following the spray. Prior to the spray application 10 additional colonies were removed from the Park and reared elsewhere as a check for naturally occurring virus; also 5 colonies were tagged at Cherry Valley, 5 km N.E. of the Park as a further check.

A sample of 50 randomly selected larvae were sent to I.P.R.I. for microscopic diagnosis one week after the

application. The guts were dissected from these larvae and examined under phase contrast to determine if the nuclei of the gut cells contained polyhedra.

RESULTS

Deposit Analysis.

The diameter of droplets and mean number/cm^2 were calculated for the two blocks. In the larger area which was sprayed first, the mean number of droplets/cm^2 was 15 ± 5; on the sand dune area it was 5 ± 2. The reduced deposit on the sand dune area was due to a deterioration in spray conditions as the sun rose. An analysis of the droplet spectrum in both areas is given in figs. 3A and 3B. From these histograms it can be seen that in the first area the droplet diameters were mainly less than 100µ; in the second area they were larger, few less than 150µ and most were in the 200-700µ range. The change in droplet spectrum is due to the evaporation and loss of the smaller droplets.

No analysis was made of the cards clipped below selected colonies but it was observed that there was a good deposit on every card.

Microscopic Examination.

Of a random sample of 50 larvae examined microscopically 45 (90%) were found to be infected with NPV. (see frontispiece).

Field Observations.

Two weeks after the spray application the 100 tagged colonies were examined and no healthy larvae

were found. Six of the colonies contained diseased individuals which were still living but had ceased to feed. Three weeks after the spray, following an intensive search, no European pine sawfly larvae could be found in the Park.

Two weeks after the spray the 15 check colonies were examined and the number of larvae counted. In the 10 colonies removed from the Park, 31, 16, 18, 21, 26, 27, 31, 36, 42 and 52 healthy larvae were counted; at Cherry Valley, the 5 colonies contained 29, 37, 40, 47 and 51 healthy larvae. Observation of these check colonies was continued until larvae became fully grown and no disease occurred.

Except for the browning of one-year-old needles near the tips of branches, which is caused by the feeding of first and second instar larvae, no injury typical of that caused by sawfly colonies was in evidence. Moreover, infestations of similar intensity in other parts of southern Ontario developed normally in 1975 with the usual heavy defoliation of old needles resulting.

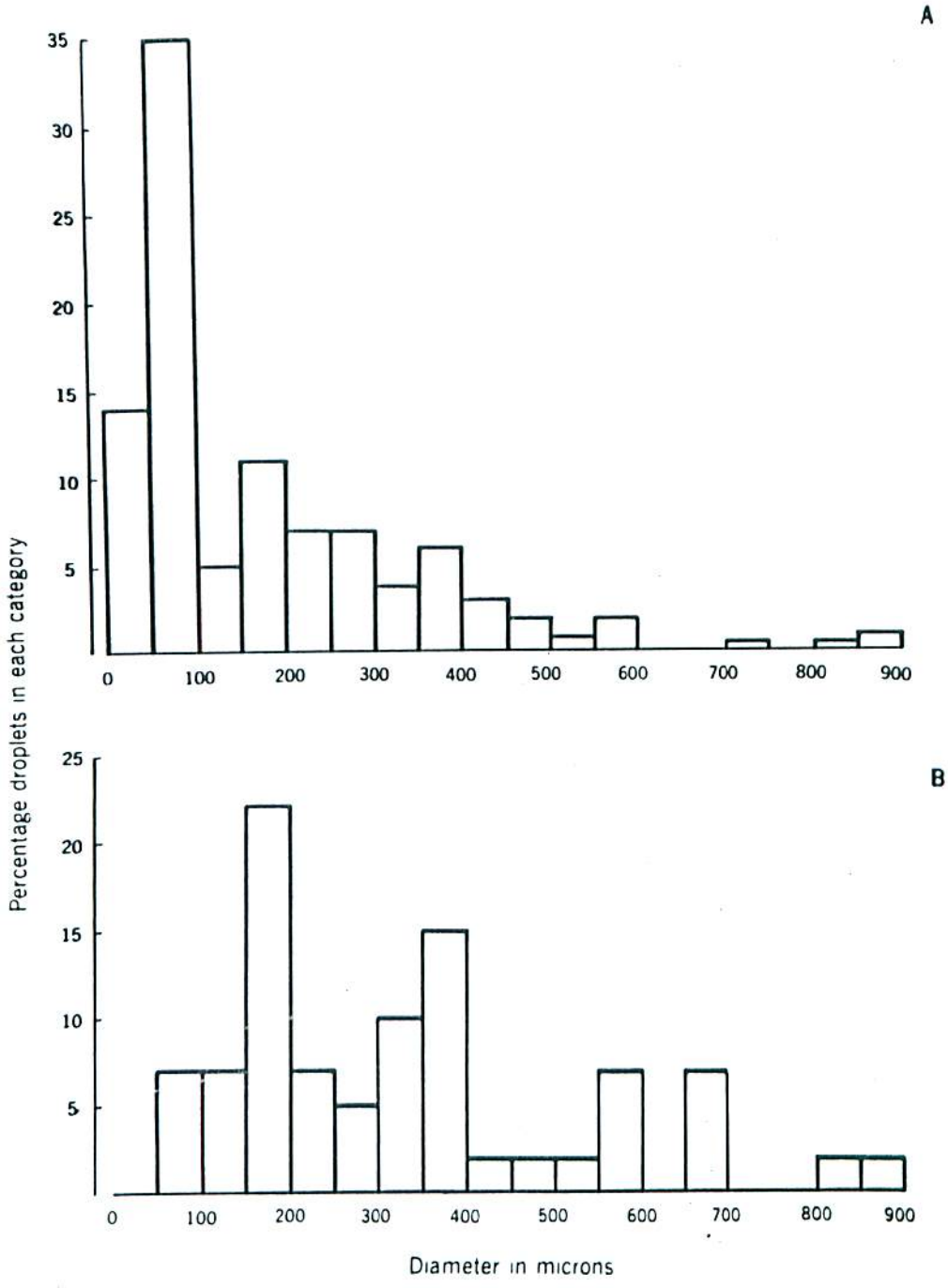


Fig. 3. Analysis of droplets by size categories
A) in the 89 ha block at Sandbanks Provincial Park
B) in the 39 ha sand dune area.

DISCUSSION

The NPV of the European pine sawfly is one of the most virulent viruses in the arsenal for biological control of forest insect pests. Colonial feeding larvae are probably better targets for control by viruses than solitary feeding larvae and infection rapidly spreads through colonies.

The operation was an unqualified success, and, although the spray deposit was no more than adequate, it was obviously sufficient to give complete control. The timing of the operation was ideal and defoliation prevented. Small larvae are more susceptible to virus infection than larger larvae and take less time to die. This has been demonstrated for the balsam fir sawfly Neodiprion abietis Harr. (Olofsson, 1973) and is true for other species of sawflies (Bird, unpublished) and many species of Lepidoptera.

Transmission of sawfly viruses from colony to colony and tree to tree and their persistence from one year to the next has been discussed in detail by Bird (1961). He demonstrated that virus will spread from infected colonies at the top of a tree downwards and suggests that rain is the agent responsible. There was no rain for at least a week following the spray application,

so it can be discounted as a factor in this particular test. Bird found that year to year transmission occurred only on larger trees and that trees of less than 1 m did not produce enough foliage to support high sawfly populations and that virus introduced into plantations of small trees did not persist. The question of persistence is of little importance at Sandbank Park--with complete elimination of the pest it is most unlikely that there will be any problem with European pine sawfly in 1976 or for several years to come, unless there is a massive reinfestation by adult sawflies from another site. If thus unlikely event occurs it is probable that there will not be sufficient residual virus to initiate an epizootic and another virus spray application will be required. In fact, the virus was used as an insecticide on this occasion and its full potential as a biological control agent was not exploited. With lower dosages or a later application date, some larvae would survive, carry a sub-lethal infection, reach the adult stage and lay virus-contaminated eggs (Bird, 1961), which would give foci of virus infection the following year and maintain a host-parasite equilibrium.

The concentration of virus sprayed and the volume per hectare could probably be reduced considerably. A heavy dosage was used on this occasion because of the severity

of the consequences of heavy defoliation. A series of dilutions of virus should be tested in aerial spray trials to establish the minimum dosage required to prevent unacceptable defoliation and the minimum dosage to establish an epizootic in areas where a certain amount of defoliation can be tolerated.

It is difficult to accurately estimate the cost of the material used in this operation so that it can be compared to a chemical application, but virus production costs are fairly low when viruses are propagated in field populations. This is only possible for a limited number of insect species and colonial sawflies are ideal for such an exercise. With the dosage of virus applied in this operation the cost of the material was about $2.50/ha, this figure being calculated from the number of person hours used in production.

The above results clearly demonstrate the efficacy of the nuclear polyhedrosis virus of the European pine sawfly. Its use should be strongly promoted and efforts should be made to register it as a biological insecticide for control of this pest.

ACKNOWLEDGMENTS

We wish to thank various staff members of the Ontario Ministry of Natural Resources: Mr. K. B. Turner for his invitation to participate in this virus control program. Mr. W.A. Perrin for arranging various operational details, staffs of Outlet and Sandbanks Provincial Parks for their cooperation and assistance; also Dr. F. T. Bird of the Insect Pathology Research Institute, Sault Ste. Marie for his advice and encouragement.

REFERENCES

Bird, F. T. 1953. The use of a virus disease in the biological control of the European pine sawfly, Neodiprion sertifer (Geoffr.). Can. Entomol. 85, 437-446.

Bird, F. T. 1961. Transmission of some insect virus with particular reference to ovarial transmission and its importance in the development of epizootics. J. Insect Pathol. 3, 352-380.

Cunningham, J. C., J. R. McPhee, G. M. Howse, A. A. Harnden. 1974. Aerial application of a nuclear polyhedrosis virus against spruce budworm near Massey and Aubrey Falls, Ontario in 1973 and a survey of the impact of the virus in 1974. Can. For. Serv., Sault Ste. Marie, Inf. Rept. IP-X-4.

Griffiths, K. J., A. H. Rose and F. T. Bird. 1971. Neodiprion sertifer (Geoff.) European Pine Sawfly (Hymenoptera: Diprionidae). In "Biological control programmes against insects and weeds in Canada 1959-1968. Tech. Commun. Commonw. Inst. Biol. Control 4, 150-162.

Olofsson, E. 1973. Evaluation of a nuclear polyhedrosis virus as an agent for the control of balsam fir sawfly, Neodiprion abietis Harr., Can. For. Serv., Sault Ste. Marie, Inf. Rept. IP-X-2.

Schaffner, J. V. 1939. Neodiprion sertifer (Geoff.) a pine sawfly accidentally introduced into New Jersey from Europe. J. econ. Entomol. 32, 887-888.