PROGRESS IN ESTABLISHMENT OF *Ibalia leuco spoides*

A Parasite of *Sirex noctilio*, the Horntail Borer of Pine

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THE first attempt to introduce *Ibalia* was made in 1928 by the Cawthron Institute. Only one male was reared from 21 larvae, and the attempt was abandoned. In 1950, 19 male and 18 female adults and 107 larvae were received by the Forest Research Institute. In this consignment, 104 *Sirex* larvae thought to be parasitized, were also received. This material, being consigned by air, arrived in better condition than the 1928 shipment, and as the adults appeared to travel better than the larvae, it was decided to secure further supplies of this stage during the winter of 1951.

The female *Ibalia* oviposits in *Sirex* eggs which are normally laid between January and March. In order to have host eggs available for *Ibalia* during the winter, it was necessary to rear *Sirex* in incubators. A technique for this had already been developed, and a programme was drawn up accordingly.

Programme for 1951

Arrangements were made for the importation of ten pairs of *Ibalia* each week between August 7 and December 11. It was considered that each female would lay 700 eggs, giving a total for 180 females of 126,000 eggs. To avoid wastage by superparasitism, it was decided to provide for approximately three times this number of *Sirex* eggs. Assuming that each *Sirex* female would lay 400 eggs, 50 per week would be required to produce 360,000 eggs in eighteen weeks. It had been found that 70 per cent. of larvae incubated at 21°c. would produce adults in seven weeks. To maintain supplies of ovipositing adult *Sirex*, 100 larvae were incubated on June 11, 80 on June 18, 70 on June 25, and thereafter 60 per week until October 8. Allowing for 20 per cent. mortality, it was expected to obtain 50 emerging females each week from these incubations from July 24 onwards. As *Sirex* takes about two weeks to deposit its eggs, from the end of the first week of emergence, 100 females should always be ovipositing.

The above programme was very closely approximated, slight irregularities being due to *Beauveria* attack on *Sirex* larvae, and irregularity in arrival of *Ibalia*.

Collection of *Sirex* larvae

Trees selected for felling were generally those killed the year previously, as these contained large, second-year larvae. *Pinus radiata* was unsatisfactory for several reasons, and usually harboured few and small larvae; *P. laricio* contained large larvae, but many were wet, drowned, or infected with *Beauveria*. *Pinus ponderosa* was found to be the most satisfactory species, and about twelve suitable larvae were found in each selected tree felled. Larvae were handled with sterilized forceps and each placed in a sterile tube.

Sexing of Larvae

At first, sexing was done by means of the hypopleural organ. This necessitated removal from their sterile tubes for microscopical examination, resulting in considerable contamination by *Beauveria*, and consequent mortality. A ventral sclerite was found to be present on the ninth abdominal segment of the males, and this characteristic could be detected without removal of larvae from tubes. Doubtful specimens were classed as females, and about 2 per cent. of adults reared were incorrectly sexed.

Rearing of Larvae

Double rearing tubes were prepared as described in *Forest Research Notes* (Vol. 1, No. 3, Jan., 1951) with the modification that the strips of blotting paper were slit several times at one end to enable them to be pressed into the bottom of the tube. Transference of larvae from collecting to rearing tubes was carried out under sterile conditions. Rearing tubes were sterilized by being held at 100°c. for 24 hours in a drying oven.

Trees just killed by *Sirex* were found to have a 40 per cent. water content, and as it was found that one drop of water represented 15 per cent. moisture content in the strips of blotting-paper used, 3 drops were placed on each strip.

Tubed larvae were stacked in jars, and a wad of wet cotton wool was added to each jar to maintain humidity. Tubes were incubated at 21°c., and tilted at an angle of 30° to keep larvae at the bottom of the tubes. Tubes were examined weekly and any dead larvae removed. Tubes containing pupae were placed together in one jar, where they were left for three weeks, after which the cotton-wool plugs were removed and the inner tubes pulled back to allow the adults to chew their way out through the blotting-paper. Adults were removed daily on emergence, and liberated in the oviposition room.

The Symbiotic Fungus

A most critical part of the work was to ensure that the fungus was carried through from the hypopleural organs of the larvae to the sacs at the base of the ovipositor in the adult female. Attempts to ensure this by inoculation of the blotting-paper and by washing pupae and adults with spore suspensions were not successful. In the tree, the larva fits tightly into the pupal chamber, and the last larval and pupal skins are not completely shed until the adult commences boring its way out. In the pupa are small pouches in the same position as the hypopleural organs in the larvae. These pouches contain no fungus and are simply empty sacs evaginated in the ecdysis. It appears necessary that the larval and pupal skins should remain attached to the adults during the week before they commence to bore out. It is thought that during this period the fungus grows and occupies the sacs at the base of the ovipositor.

By careful handling, maintaining correct humidity and slope of tubes, the fungus was successfully carried through.

Parthenogenesis

Attempts to develop a smear technique for examination of chromosomes were unsuccessful, and were abandoned when males emerged from logs in which eggs had been laid by virgin test-tube-reared females, proving *Sirex* to be facultatively parthenogenetic, producing

males from unfertilized eggs. Thus males were not necessary in the provision of eggs for *Ibalia* oviposition.

Biotic Potential

As some of the larvae used for rearing adult female *Sirex* were small, the possibility of some laying less than the estimated 400 eggs was recognized. A number of larvae were therefore weighed before incubation in order to obtain the relationship, if any, between weight of larva, weight of adult, and number of eggs. Nearly all the first series died owing to infection by *Beauveria* during weighing. Adults reared from more carefully handled larvae were weighed and dissected. It was found that loss of weight from adult to larva was 40 to 45 per cent. and that a close correlation existed between weight and number of eggs produced, and a formula was obtained to estimate eggs resultant from weight of larva or adult.

The heaviest larva weighed 1.71 g. and yielded 515 eggs. A larva of 1.15 g. yielded 536 eggs, whilst the heaviest adult (0.62 g.) contained 591 eggs. Small larvae of 0.05 g. yielded only 50 eggs.

Oviposition

To receive *Sirex* eggs, logs were obtained from trees felled in a young *P. radiata* stand. *Sirex* larva and fungus cannot develop in logs with a high moisture content, hence trees were felled two or three weeks before required, and were left untrimmed.

To avoid sap stain fungi, bruising and bark damage were avoided as far as possible in cutting logs. The oviposition room was maintained at 21°C., the logs being stood on end and exposed to *Sirex* attack for about a week, the exact time depending on supplies of *Ibalia*. Logs were removed to a similar room where *Ibalia* were liberated to oviposit on the *Sirex* eggs. Both *Sirex* and *Ibalia* proved very accommodating in their oviposition behaviour.

Importations of *Ibalia* in 1951

Between August 17 and December 6, 92 male and 107 female adult *Ibalia* were forwarded by air from England, duration of transit being from 7 to 9 days. The mortality was 19.5 per cent. for males and 12.2 per cent. for females, leaving 74 males and 95 females alive on arrival. Females were received between August 27 and October 23, a much shorter period than had been expected.

Ibalia were fed on sugar solution on arrival, and liberated on the logs containing *Sirex* eggs. During transit, the parasites were packed in pill-boxes, at first one per box, and later a pair per box. In the latter case, mortality appeared to be somewhat higher.

In addition to the above adults, 20 larvae were received on November 26, 12 appearing healthy. From these, 4 adults emerged in February.

The First New Zealand Generation

During February and March 1952, 16 male and 6 female *Ibalia* emerged from logs exposed to oviposition between October and December, 1950. A further female emerged on April 15. These, the first *Ibalia* reared in New Zealand, took sixteen months to reach the adult stage; that is, two summers instead of three years as recorded in England. As a result of this emergence, no further importations should be necessary, as there should be no difficulty in maintaining a large insectary population in phase with *Sirex*, from which liberations can be made. The progeny of these 6 females should number about 4,000, of which 1,000 may be expected to be females.

The Parasitic Fungus

Many *Sirex* larvae were killed by a parasitic fungus, *Beauveria* sp., which attacks both *Sirex* and its larval parasite *Rhyssa* in both larval and pupal stages. The fungus appears to gain entry through *Sirex* exit holes and so cannot attack first-year larvae.

Thirteen *Sirex* larvae experimentally infected with *Beauveria* spores were noted to develop pink areas which spread from one or both ends. Seven were visibly attacked in 5 days, three in 6 days, two in 7 days, and one in 9 days. All larvae died.

Mutations and Gynandromorphs in *Sirex*

There is always the danger that, when the population reverts to normal following an epidemic, a new strain will have replaced the original one owing to the survival of a mutation produced among the vast numbers of individuals. With *Sirex* there is probably less danger of this being significant, owing to the overriding importance of the fungus symbiont.

All specimens were examined, but no mutations were noted in the females, although four male larvae from the same tree were found to have external wing buds, two being reared to produce normal male adults.

Several gynandromorphs were reared from larvae classed as female on the presence of the hypopleural organ. Only the hind legs and abdomen were affected, and many gradations were obtained.

NOTES ON *Nysius huttoni* F. B. WHITE A Pest of Wheat in New Zealand*

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AFTER a preliminary survey and a series of experiments carried out on screened wheat plots at Lincoln, Morrison (1939) established the fact that *Nysius huttoni* was one of the bugs occurring in New Zealand capable of attacking the grains and producing "sticky dough." The bug attacks the wheat in the milk ripe stage, piercing the grain and sucking from it some of the plant juices. In the process, a proteolytic enzyme is injected into the grain to facilitate ingestion of the plant juices. It is the residue of this substance remaining in the damaged grain which interferes with the normal behaviour of the glutin when an attempt is made to bake with flour made from bugged wheat. As little as 1 per cent. of bugged wheat used in the production of a flour has made it unusable for baking. Of 1,400 samples tested in 1950 at the Wheat Research Institute, Christchurch, 98, or 7 per cent. were definitely "bug wheat."

Bug-damaged wheat is easily recognized in the hand. The grain shows an oval or round whitish patch, very conspicuous in dark-coloured wheats, with frequently a dark pin-prick

*Abstract only.