Host Adaptation in the European Satin Moth

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THE European satin moth was first reported in British Columbia in 1919. During the years 1920, 1921 and 1922 a study was made of its life-history and habits in order to obtain data as to the probable importance of the insect in the province.

During the first year of the study, viz. 1920, only the introduced poplars—silver, lombardy and carolina—were affected by this insect, and, therefore, no great concern was felt, as these trees are of little importance as shade trees on the Pacific Coast, being little used as such.

In 1921, however, a few larvae were found feeding on the native cottonwood, **Populus trichocarpa.** Attention was, therefore, directed to the possible menace to this tree on account of its economic value, the wood being in considerable demand for pulp and veneer. During the first year of native cottonwood infestation, egg masses were found freely on this tree when adjacent to totally or partially defoliated trees of the introduced species, but the cottonwoods were only slightly infested, a dozen or so larvae only being found on any one tree.

During the next year, 1922, an important increase was noted in the amount of infestation on cottonwood in New Westminster. Notes made at that time recorded a 20% defoliation in some cases, and it appeared, therefore, that a gradual adaptation to that host was developing.

To test this, two experiments were conducted in the autumn of 1922, the immediate objective being to ascertain if larvae whose parents had fed upon cottonwood were better adapted to survive on this leathery-leaved host than larvae whose parents had fed upon lombardy popular.

The experiments were as follows: A number of fully fed larvae were collected from an isolated cottonwood tree in New Westminster which was known to have been infested the previous year. These larvae were retained in Fiske trays and allowed to finish their feeding and pupate. The resultant moths were confined in cages where they mated, and the females subsequently deposited their egg masses. From the eggs deposited by these moths 50 larvae were taken and placed on

cottonwood shoots. For comparison, a further batch of lavae were reared similarly from lombardy poplar feeding parents and placed, under identical conditions, on cottonwood foliage in another Fiske tray alongside.

It is well to state here that the eggs of the satin moth hatch during August and the young larvae feed for about one month before going into hibernation in the middle of September. They moult twice before spinning up for the winter as third stage larvae in crevices in the trunks.

The trays were examined daily and the food changed, notes being taken of the number of dead found each day. It was soon seen that great numbers of the larvae from the lombardy poplar fed parents were unable to assimilate the new food. They fed sparingly and soon curled up and died. This experiment was performed in duplicate, the second commencing about ten days after the first. The results are shown in the following table and on the accompanying graph.

RECORD OF MORTALITY

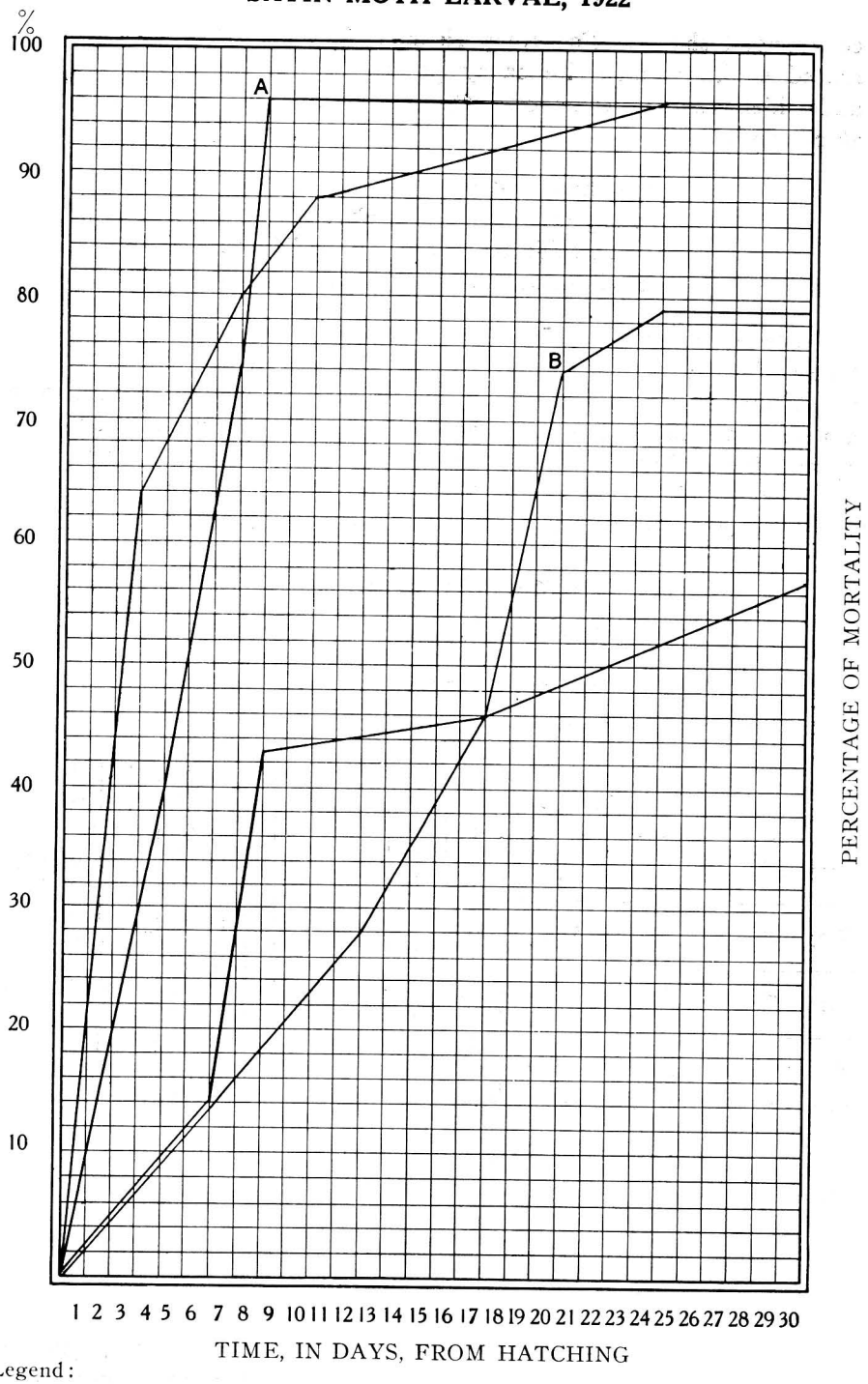
Satin Moth Larval Feeding Experiments

NUMBER OF LARVAE ALIVE

	AUGUST									SEPTEMBER										
	15	17	19	21	23	25	27	29	31	1	3	5	7	9	11	13	15	17	19	
Tray "A"	50	46	40	28	27	27	26	26	26	26	24	24	24	24	24	22 Hibernated	....	....	....	= 44%
Tray "B"	50	41	24	13	2	2	2	2	2	2	2	2	2	2	.... Hibernated	....	....	....	....	= 4%
Tray "C"						50	48	45	40	39	39	35	27	27	27	20	13	12	12 Hibernated	= 24%
Tray "D"					50	41	18	18	10	6	6	4	4	3	2	2	2	....	.... Hibernated	= 4%

Examination of the table and graph will show that there was a steady mortality of larvae from the commencement of feeding, with a very distinct rise in the rate at the time of the first moult. In trays A and C, which contained the supposedly partially adapted larvae from cottonwood-feeding parents, 22 and 12 respectively survived and spun up as healthy third-stage larvae, a percentage of 44 and 24 respectively. In the trays B and D, which contained the larvae from poplar fed parents, only two individuals in each case survived, giving a percentage of 4 that had managed to assimilate the new food.

HOST PLANT FEEDING EXPERIMENTS WITH SATIN MOTH LARVAE, 1922



Legend:

A. Larvae from poplar feeding parents.
B. Larvae from cottonwood feeding parents.

As far as is known the cottonwood-feeding race had not been using this host for more than two generations, possibly less, and it appeared, therefore, that a very rapid adaptation to new food habits was taking place with the probable result that in a very few years severe defoliation of native cottonwood would take place. In my report for 1922, the following comment is made: "Should this adaptation continue (and I see no reason why it should not), the great stands of cottonwood along the river bottoms will become affected in a few years and severe damage would result." These fears were fully justified, for in 1928 large areas of cottonwoods, acres in extent, at several points in the lower Fraser valley, were totally defoliated by this insect, while in 1929 thousands of acres of this tree over an area of approximately three hundred square miles were defoliated to the extent of from 80 to 100 per cent.

From the above statements it will be seen that complete adaptation to the cottonwood has taken place, and that the mortality of the early stages must now be very small, if any.

Although the close study of this insect was relinquished in 1922, its progress and spread have been noted from year to year, and it now ranges all over the lower Fraser valley and is spreading eastward through the mountains by means of the river valleys bordered with cottonwood, and by accidental transportation on trains. It is also prevalent on the east coast of Vancouver Island, and has spread up the coast of the mainland as far as Powell River.

A similar phase of this subject is seen in connection with willows.

In Europe this insect is recorded as a willow pest, injuring to a serious extent the basket willow in Germany, but up to 1923 only a few larvae had been found on one species of native willow, viz., **Salix lasiandra,** and my manuscript for 1922 says: "It does not seem to have accepted the great mass of willow species common to this coast, though plenty are close to present outbreaks on poplar. This is somewhat peculiar, as it is a frequent pest on willows in Europe though of different species to those in British Columbia.."

However, in 1928, acres of willows were noted to have been defoliated, and it may now be found quite frequently on three native species and abundantly in certain areas.

Evidently a similar adaptation has taken place in the case of the willows as with the cottonwood, and exactly the same course has been noted with the native aspen, **Populus vancouverense** Piper, as up to 1922 it remained untouched, but since, totally defoliated trees of this species have often been found.

During the last three years, while traversing the area of infestation in the lower Fraser valley, one characteristic was noticed that also bore on this subject of adaptation, namely, that a severe infestation of cottonwood in one locality would not necessarily be accompanied by a similar infestation of adjacent lombardy poplar or willow, or again that a large willow outbreak would not necessarily be accompanied by an infestation of the neighbouring cottonwoods or poplars. This phenomenon was duplicated in various combinations, and even an outbreak on carolina poplar was often not accompanied by a similar infestation on nearby lombardys. This latter phenomenon was noticed as early as 1923. The reason for these separate outbreaks is not understood at present, but may possibly be due to the differentiation of strains or races; further experimentation is needed upon this point.

This subject has been studied by several workers, namely, Brues, Craighead and, latterly, Twinn, but these authors have approached it more from the aspect of the selection of the host by the parent insect than from the aspect of the adaptation of the feeding stages. Craighead found that cerambycid beetles in ovipositing had a marked predilection for the host in which they had fed as larvae, and Twinn found the same thing with the imported cabbage worm **(Pieris rape)** using cabbage, radish, mignonette and nasturtium as food plants. In the case of the satin moth, I think it would be unlikely that this phase, i.e., host selection by the ovipositing moths, would be an important factor, as the female satin moth is very stupid or careless about egg laying. The egg masses may be found in all sorts of locations—on iron fences, wooden fences, concrete walls, juniper bushes, laurel hedges, and other totally unsuitable hosts and inconceivable places, even on the clock face on a building two hundred feet high in the centre of the city of Vancouver. It would appear, therefore, that host selection by the moths is unlikely, or at most, but slightly operative when apparently they do not distinguish a concrete wall from a deciduous tree.

In the case of the satin moth we have been exceptionally fortunate in being able to study the life-history and natural development of this insect in a new environment under conditions that probably seldom occur; its future development, of course, will still be of interest.