Not for publication

SPRUCE BEETLE LIFE CYCLE STUDIES AT HUSH LAKE PRINCE GEORGE FOREST DISTRICT, 1963 AND 1964

by

C. B. COTTRELL

FOREST INSECT AND DISEASE SURVEY

B. C. REGIONAL LABORATORY

VERNON, BRITISH COLUMBIA

INTERNAL REPORT BC-2

DEPARTMENT OF FORESTRY

JANUARY, 1966

Not for Publication

SPRUCE BEETLE LIFE CYCLE STUDIES AT HUSH LAKE, PRINCE GEORGE FOREST DISTRICT, 1963 AND 1964

by

C. B. COTTRELL

FOREST INSECT AND DISEASE SURVEY
B. C. REGIONAL LABORATORY
VERNON, BRITISH COLUMBIA
INTERNAL REPORT BC-2

DEPARTMENT OF FORESTRY
JANUARY, 1966

Spruce Beetle Life Cycle Studies at Hush Lake, Prince George Forest District, 1963 and 1964

C. B. Cottrell

Forest Insect and Disease Survey, Vernon, B. C.

March, 1964

INTRODUCTION

Late in 1962, a spruce beetle infestation was discovered in the Prince George Forest District. As there was little information available on the life cycle of the beetle, studies were carried out at Hush Lake, B. C., in 1963 and 1964 to provide data for determination of the trend of the outbreak.

METHODS

Early in May, 1963 two spruce beetle infested log sections from Kenny Lake (elev. 3000') were caged at Prince George (elev. 2000') to obtain information on adult emergence in order to provide prior warning of beetle flights in the forest. Emergence was recorded daily.

At Hush Lake (elev. 2900') four healthy mature white spruce were felled in mid-May of each year to attract spruce beetles. Four four-foot-long bolts were cut from the lower bole and left lying on the ground. An additional tree was felled in July, 1963 to absorb a possible later flight of beetles. Data on the number of attacks per log section and development of the broods were recorded weekly in 1963 and bi-weekly in 1964 from mid-May to early in October. An estimate of the number of eggs, a count of the number of larvae, pupae and adults, and the length of adult and larval galleries in one-square-foot bark samples were recorded at each examination. Late in June, two logs felled in May were caged in the forest and adult emergence was noted at irregular intervals. An additional freshly cut log was placed in each cage in July to absorb re-emerging beetles. A two-foot-long section from each bolt was examined in October.

RESULTS AND DISCUSSION

A few beetles emerged from caged logs at Prince George when the temperature reached a maximum of 80°F. on May 20, 1963. No other beetles emerged during May although the temperature was as high as 83°F. on May 21 and 22. The majority of beetles emerged between

June 2 and 18, even on days when the temperature did not exceed 60°F. (Figure 1).

Beetle attacks began on sample logs at Hush Lake before May 26 and continued sporadically, at least until July 10. Early in July, adult galleries averaged 6.6 inches in length; the longest was 10.7 inches. During August, parent adults often made one or two short galleries parallel to their original gallery.

Eggs were first observed on June 4 and larvae appeared on June 26. By mid-August larval galleries were up to six inches long. Fifty-five per cent of the eggs had hatched by July 4. Pupae were first recorded on August 6 and by August 23 composed 59% of the living brood. The first teneral adult was noted on August 23 and thereafter the percentage of pupae decreased until by September 28, the brood comprised 75% teneral adults and 25% larvae (See Appendix V). In the spring of 1964, the percentage of living larvae was higher than in the fall of 1963; this was attributed to higher winter mortality of adults than of larvae. By June 24, all larvae had pupated and the entire brood consisted of adults by July 12 (Figure 2).

A tree felled on July 9 was attacked by August 1, 1963 and eggs were laid. On August 6, 60% of the living brood consisted of larvae and by October 2, the entire living brood was in the larval stage. The first pupa was found on June 8, 1964 and teneral adults accounted for 62% of the brood by July 12. By September 25, all but 8% of the brood had reached the teneral adult stage.

On July 4, 1963, freshly cut log sections which had been placed in cages containing logs attacked in May were attacked by re-emerged, parent adults. The cages were taken to Prince George and left outdoors exposed to temperatures below -20°F. One of the logs attacked in July was examined in January when it contained 58 living larvae, two dead larvae and two dead parent adults; the other log contained 127 living larvae, three living and three dead pupae, and nine living teneral adults.

Trees felled in mid-May, 1964 were attacked by May 28, but most of the attacks occurred during June. The rate of development was slower than in 1963 (Table 1); as a result, fewer adults were produced in 1964 (Table 2).

Table 1

Dates of First Spruce Beetle Attacks and
Life Cycle Observations in 1963 and 1964, Hush Lake

Year	Date first observed				
	Beetle attack	Egg	Larva	Pupa	Teneral adult
1963	May 25	June 3	June 26	Aug. 6	Aug. 23
1964	May 28	June 10	July 2	Aug. 25	Sept.16

Table 2

Percentage of 1963 and 1964 Broods Which Entered the Winter as Larvae, Pupae and Teneral Adults, Hush Lake

Year	Larvae	Pupae	Teneral adults
1963	64	2	34
1964	84	1	15

The life cycle of the spruce beetle at Hush Lake in 1963 and 1964 is shown in Figure 3. In 1963, many adults which attacked logs in May, deposited eggs, emerged in July and established a second brood. Some of the first brood became teneral adults (II), in the fall of 1963 and attacked in the spring of 1964. The remainder of the brood overwintered as large larvae, reached the teneral adult stage (I), in the summer of 1964 and should attack in the spring of 1965. All of the second brood overwintered in 1963-64 as small or medium-sized larvae and their adults (III), should also attack in 1965. Adults which made two attacks in 1963 were dead by fall, while those that did not re-emerge for a second attack remained with their broods and many were still alive entering the winter.

Another group of spruce beetles at Hush Lake overwintered in 1962-1963 in the larval stage, pupated during the summer and spent the winter of 1963-64 as adults (IV). These emerged and attacked in the spring of 1964 but it is not known whether they made a second attack. If not, they may make a second attack in the spring of 1965 provided they survive the winter. Brood development was slower in 1964 than in 1963 with the result that fewer individuals reached the adult stage in one year. Under favorable conditions, such as those experienced by caged insects at Prince George in 1963, it is possible for a portion of the broods from a first and second flight to reach the adult stage in one year.

SUMMARY

Beetles entering their first winter in the larval stage may complete their life cycle in two years while those entering their first winter as adults may be expected to fly the following spring, thus completing their life cycle in one year. Spruce beetles entering the winter in the pupal stage usually do not survive.

At Hush Lake in 1963 and 1964, rearing experiments showed that the spruce beetle had a predominantly two-year life cycle with part of the brood developing in one year. Under favourable conditions,

parent beetles produced two broods per year, some of each developing into adults. Parent adults which produced one brood only, remained alive at the approach of winter. Beetles survived in logs caged outdoors and exposed to -20°F. The 1965 attack should consist of two groups of beetles which overwintered as teneral adults, and in addition, beetles which overwintered as parent adults.

APPENDIX I

Maximum and Minimum Daily Temperature[1/] and Spruce Beetle Emergence from a Log Section Caged at Prince George, May 15 to June 30, 1963

Date	Max. temp.	Min. temp.	No. of beetles	Date	Max. temp.	Min. temp.	No. of beetles
May 15	53	36	0	June 8	60	39	90
16	59	33	0	9	68	44	180
17	64	28	0	10	70	39	221
18	68	40	0	11	62	52	1
19	74	33	0	12	60	36	4
20	79	35	3	13	67	34	98
21	81	49	1	14	74	34	181
22	83	40	0	15	82	44	44
23	67	42	0	16	77	53	74
24	65	36	0	17	73	44	13
25	55	39	0	18	78	46	8
26	61	28	0	19	64	46	0
27	64	34	0	20	64	41	0
28	71	33	0	21	65	44	0
29	64	46	0	22	69	46	0
30	60	46	0	23	75	41	0
31	61	39	0	24	61	47	0
June 1	60	43	0	25	55	35	1
2	62	43	32	26	58	42	4
3	70	35	50	27	65	36	3
4	62	45	18	28	70	39	1
5	63	42	10	29	67	44	0
6	64	30	94	30	71	46	0 [2/]
7	67	43	121				

[1/] Prince George Airport, Monthly Record, Meteorological observations, May and June, 1963.

[2/] Bark peeled on June 30, 32 living adults remained in 15.5 sq. ft. of bark.

APPENDIX II

Number of Spruce Beetle Attacks per 4-foot Log Section, Hush Lake, 1963

Log no.	May 15	May 26	May 29	June 4	June 10	June 20	June 26	July 4	July 10	Remarks
01-1	0	0	31	25	1	15	39	14	1	
01-2	0	0	22	32	1	14	45	15	0	
01-3	0	0	37	33	6	6	43	-	-	caged on June 26, 1963
01-4	0	0	31	19	2	30	14	9	0	
02-1	0	0	0	0	1	4	8	9	0	thin-barked
02-2	0	0	0	1	5	5	10	11	0	thin-barked
02-3	0	0	0	0	1	4	11	15	0	thin-barked
02-4	0	0	0	0	0	6	6	7	0	thin-barked
S1-1	0	6	11	21	1	28	2	2	1	
S1-2	0	2	4	15	12	28	30	-	-	caged on June 26, 1963
S1-3	0	2	4	9	10	21	10	3	3	
S1-4	0	8	17	20	24	25	27	4	1	
S2-1	0	0	19	0	8	7	9	1	1	
S2-2	0	0	8	5	5	4	22	1	0	
S2-3	0	0	2	3	4	8	10	2	0	
S2-4	0	0	1	4	2	7	8	2	1	

APPENDIX III

Length in Inches of Spruce Beetle Egg Galleries in 10-gallery Samples, Hush Lake, 1963

Date	Average	Range
May 29	0.9	0.5 - 1.5
June 4	1.3	0.5 - 2.5
10	2.4	1.0 - 5.7
20	3.6	1.7 - 7.8
26	4.9	3.0 - 7.6
July 4	6.6	2.0 - 10.7
9	6.6	3.2 - 10.2
18	5.4	4.3 - 8.0
25	6.2	3.4 - 8.4
Aug. 1	5.6	2.6 - 7.9
6	6.4	4.2 - 8.2
12	6.8	3.1 - 10.5
16	7.0	4.7 - 9.6
23	5.7	3.7 - 8.0
29	5.9	4.4 - 7.4

APPENDIX IV

Length in Inches of Spruce Beetle Larval Galleries in 10-gallery Samples, Hush Lake, 1963

Date	Average	Range
June 4	-	first eggs
26	0.5	0.5 - 0.5
July 4	1.1	0.5 - 1.5
9	1.6	0.7 - 2.8
18	2.3	0.9 - 3.4
25	3.1	2.3 - 4.5
Aug. 1	4.6	4.1 - 5.1
6	3.5	2.6 - 4.5
12	4.6	4.2 - 5.0
16	4.0	1.5 - 5.9

APPENDIX V

Percentage of Living Spruce Beetle Brood by Life Cycle Stages in Spruce Felled and Attacked in May, 1963 at Hush Lake.

Date	Eggs 1/	Larvae	Pupae	Adults
1963 June 20	100	0	0	0
26	95	5	0	0
July 4	45	55	0	0
9	30	70	0	0
18	10	90	0	0
25	0	100	0	0
Aug. 1	0	100	0	0
6	0	99	1	0
12	0	80	20	0
16	0	70	30	0
23	0	40	59	1
29	0	39	49	12
Sept. 6	0	21	17	62
12	0	27	6	67
17	0	36	8	56
28	0	25	0	75
Oct. 2	0	31	0	69
1964 May 28	0	42	0	58
June 8	0	23	26	51
24	0	0	81	19
July 12	0	0	0	100
30	0	0	0	100
Aug. 25	0	0	0	100
Sept. 25	0	0	0	100
1965 May 11	0	0	0	100

1/ The percentage of eggs is estimated.

APPENDIX VI

Percentage of Living Spruce Beetle Brood by Stage in Spruce Felled and Attacked in July, 1963 at Hush Lake

Date	Egg	Larva	Pupa	Adult
1963 Aug. 1	100	0	0	0
12	40	60	0	0
29	5	95	0	0
Oct. 2	0	100	0	0
1964 May 26	0	88	12	0
June 24	0	29	71	0
July 12	0	3	35	62
30	0	15	49	36
Aug. 25	0	14	32	54
Sept. 25	0	5	3	92
1965 May 11	0	4	0	96

APPENDIX VII

Number of Spruce Beetle Attacks per 4-foot Log Section, Hush Lake, 1964

Log no.	May	June		July
	28	8	24	12
1	12	51	29	0
2	11	41	43	0
3	3	42	18	2
4	2	32	15	4
5	4	32	6	3
6	6	59	20	0
7	12	26	6	3
8	2	47	7	2

APPENDIX VIII

Length of Spruce Beetle Egg Galleries in 10-gallery Samples, Hush Lake, 1964

Date	Variation in length (ins.)	Average length (ins.)
June 24	2.1 - 4.0	3.1
July 12	2.5 - 6.3	4.4
30	2.1 - 5.4	3.7
Aug. 25	3.6 - 7.2	5.8

APPENDIX IX

Length of Spruce Beetle Larval Galleries in 10-gallery Samples, Hush Lake, 1964

Date	Variation in length (ins.)	Average length (ins.)
July 12	0.4 - 1.4	0.9
30	1.7 - 3.4	2.4
Aug. 25	3.5 - 5.2	4.5

APPENDIX X

Percentage of Living Spruce Beetle Brood by Life Cycle in Spruce Felled and Attacked in May, 1964 at Hush Lake

Date	Life cycle stage			
	egg	larva	pupa	adult
1964 June 24	100	0	0	0
July 12	33	67	0	0
30	0	100	0	0
Aug. 25	0	99	1	0
Sept. 25	0	84	1	15
1965 May 11	0	35	0	65

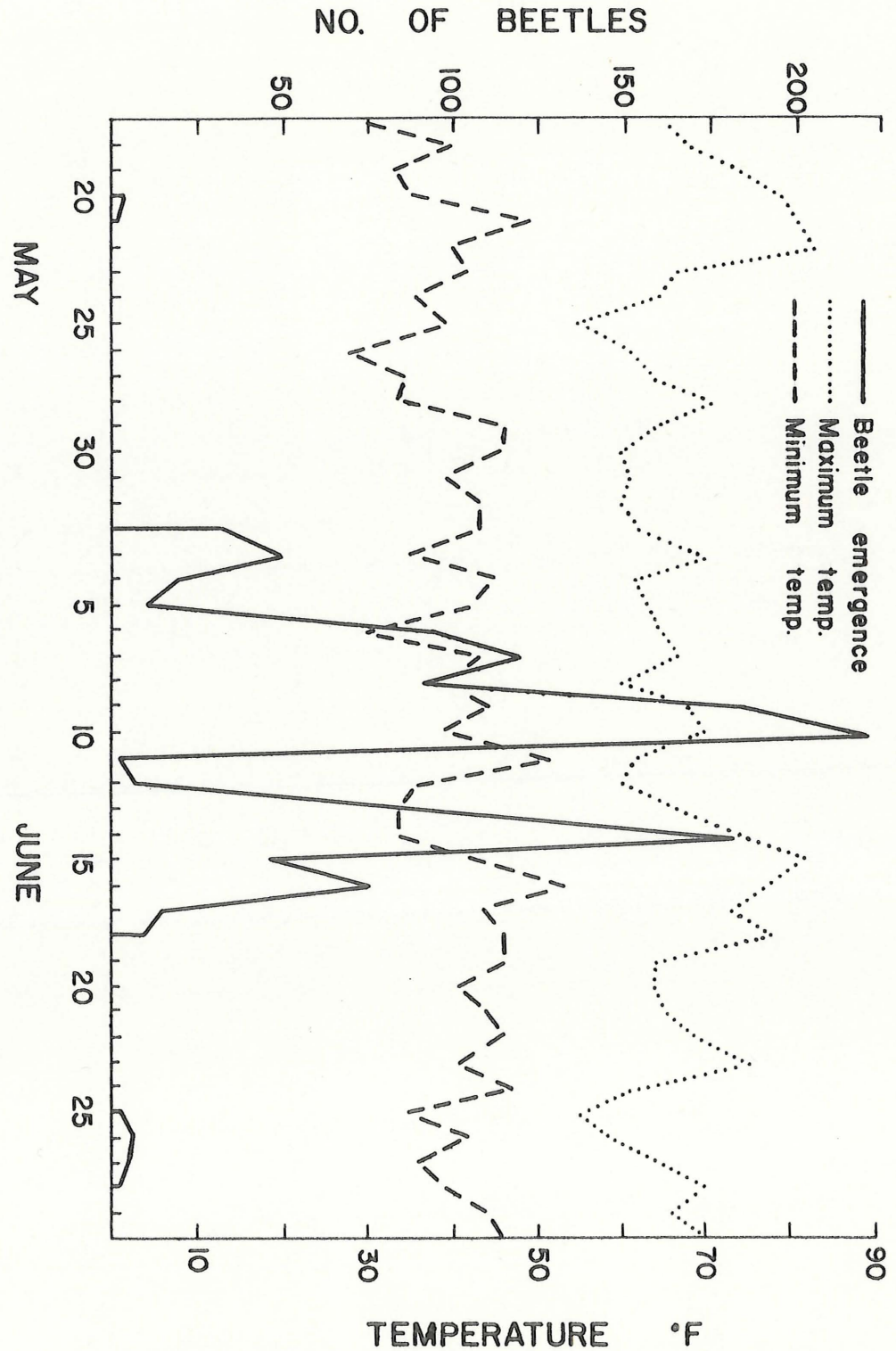

Fig. 1. Daily maximum and minimum temperatures and daily emergence of spruce beetles in logs caged at Prince George, May and June, 1964.

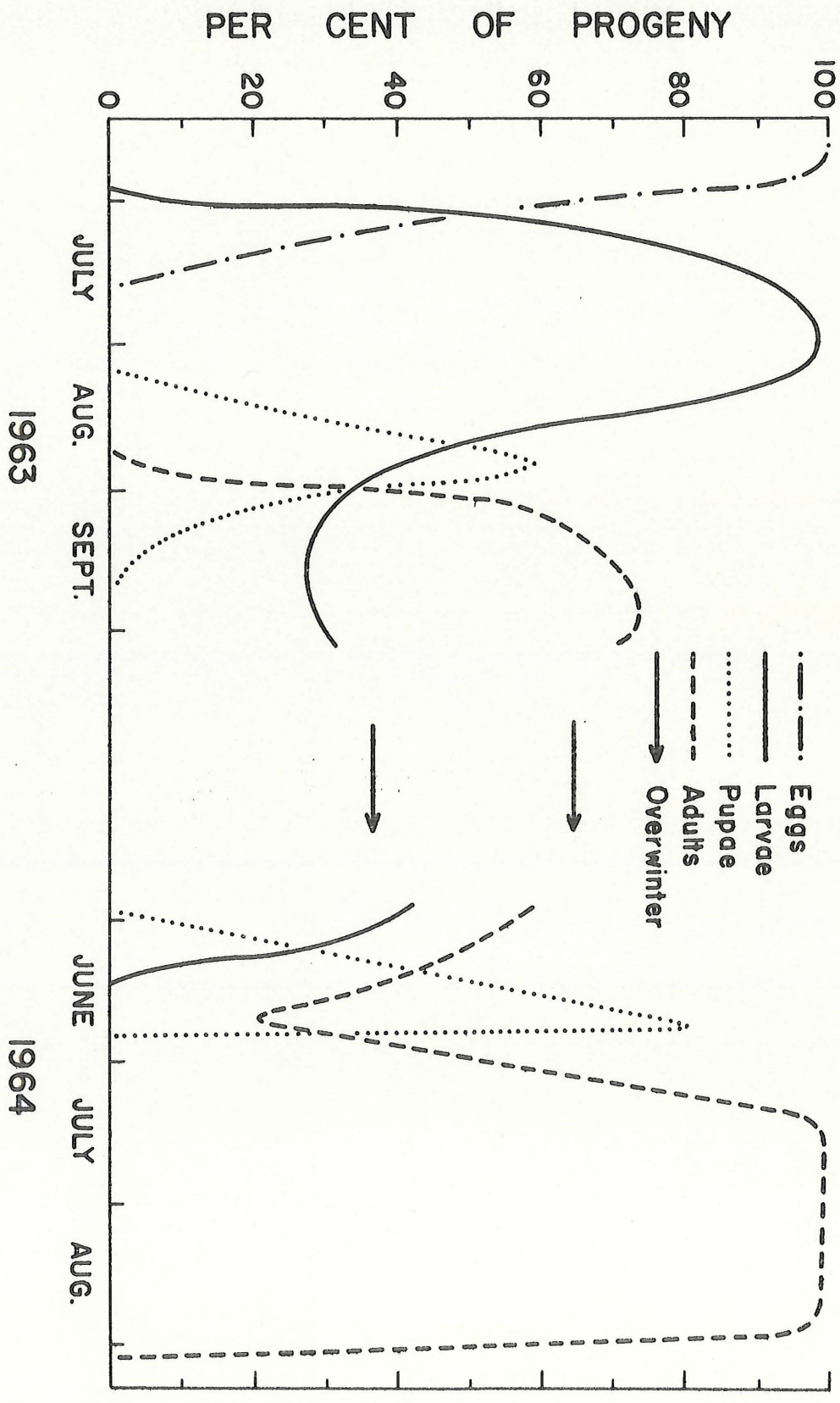

Fig. 2. Brood development of the spruce beetle in 1963 and 1964 at Hush Lake, Prince George Forest District.

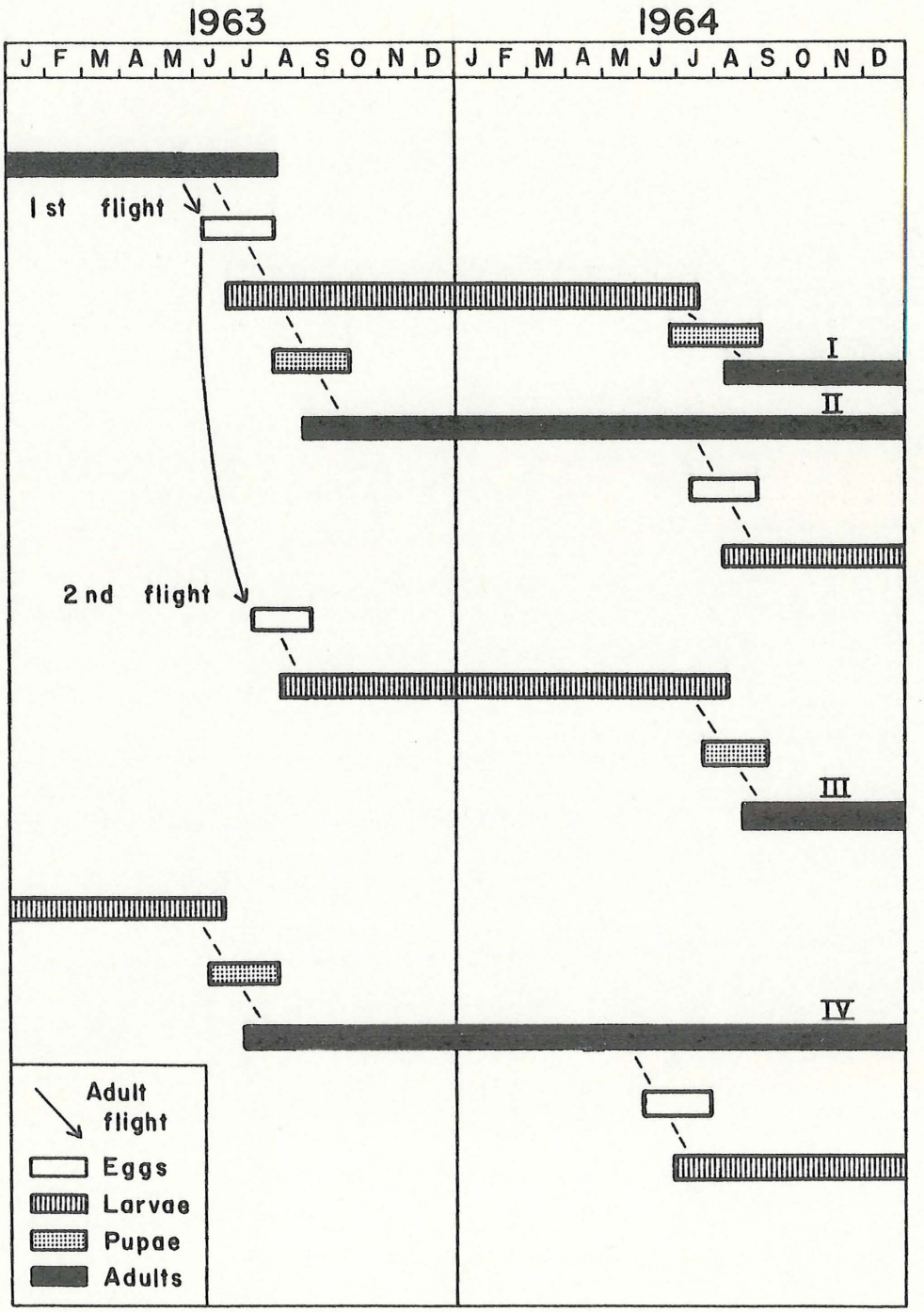

Fig. 3. Life cycle of the spruce beetle for 1963 and 1964 at Hush Lake, Prince George Forest District.