CATCHES IN AMBROSIA BEETLE TRAPS: WHAT DO THEY MEAN?

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Abstract

For the last decade, forestry operations, especially sawmills and dry land sorting areas, have been setting out pheromone-baited traps for ambrosia beetles. Although millions of beetles have been captured, the "problem" doesn't seem to go away. Data collected this summer has helped to show what the beetles are doing and what the message of a high trap catch really is.

Introduction

Ambrosia beetles have been a plague of logging operations in coastal operations in British Columbia ever since the first hand logger felled a tree and left the high stumps and the tops in the forest. One of the first colonizers of this newly dead tree tissue is the ambrosia beetle. Three of the major species are *Trypodendron lineatum* (Olivier), *Gnathotrichus sulcatus* (LeConte) *and G. retusus* (LeConte)(1). Control attempts have included aerial spraying of log booms with benzene hexachloride and methyl trithion in the late 1950's and the early 1960's (2). This method of control proved to be environmentally unacceptable. In the late sixties, Richmond and Nijholt (3) demonstrated that water misting of decks of logs would protect them against ambrosia beetle attack.

The main insect that will be discussed herein is the striped ambrosia beetle *T. lineatum.* This insect overwinters in the duff on the forest floor and on the first warm days in spring when the temperatures rise above 16C, the beetles fly from the duff to hawk through the forest and attack suitable logs and stumps (4). The suitability of logs is related to the presence of ethanol in the fermenting tissues (5,6). Once the pioneer beetles, in this case the females, have found suitable host log material, they bore into the log and as they do so, they produce a pheromone that attracts both male and female beetles. This aggregation pheromone has been identified as 3,3,7-trimethyl-2,9-dioxatricyclo[3.3.1.0^{4,7}]nonane and has been given the trivial name lineatin (7,8).

Lineatin-baited traps were first set out at the Chemainus sawmill on Vancouver Island in 1980 (9) and at the Shawnigan dry land sorting area (10). Facile syntheses of lineatin have provided sufficient pheromone to carry out extensive trapping programs in more than 55 locations during 1991[1]. The pheromone is attractive only to those adult

[1]E. Stokkink, Phero Tech Inc., Delta, B.C.

beetles which have overwintered. Beetles that emerge from logs for the first time in July/August are not attracted to pheromone-baited traps.

For the last year, an Ambrosia Beetle Task Force has been measuring the percentage of logs in booms produced in coastal B.C. that have been attacked by ambrosia beetles[2]. Two studies within this project are of particular interest in this discussion. The first followed the development of ambrosia beetle galleries in a spruce boom in the Alberni Canal. The objective here was to determine the phenology of life stage development. The second was a trapping study at the mouth of the Fraser River. Here the objective was to determine the areas where higher numbers of beetles were to be captured and thus identify areas where log booms in storage were at greatest risk of attack.

Methods

The boom for the first study was heavily attacked in mid-April. A sample was taken from each attacked log each week from April 19, 1991 to September 13, 1991. Each chip removed from the logs was dissected and the numbers of eggs, larvae, pupae, callow adults and parental adults were tallied.

In the second study at the mouth of the North Arm of the Fraser River, traps were set out on the North Arm Jetty, on each of 4 rows of dolphins (= set of piles used to tie the booms to), one row was one third of the way up the cliff of the Foreshore Park, another row was on top of the cliff and the last line was across Southwest Marine Drive in the Spirit of the Pacific Park. There were three traps in each line, one baited with lineatin (the others were baited with sulcatol or retusol).

Results

The Spruce Boom Study

The numbers of each life stage (adult, egg, larva, pupa, callow adult, pupal niches) were recorded from 28 logs each week. The variability in the sample "size" precludes a statistical analysis of these data but they are well represented by a kite diagram (Fig. 1) which shows the relative percentage of each life stage found throughout the year. It is of particular interest that the adult numbers started to decrease at the same time as the callow adult numbers reached their peak. New and old adults probably emerged from the gallery at the same time. The pheromone-sensitive beetles that were captured at this time in the pheromone-baited traps are those termed as "sister flight" beetles. These data also allowed us to develop a life stage development index which bounded the time taken to develop to each stage (Table 1).

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[2]Research funding for the 1990-1992 Ambrosia Beetle Task Force provided by MacMillan Bloedel Ltd, the Science Council of B.C. and the Natural Sciences and Engineering Research Council of Canada.

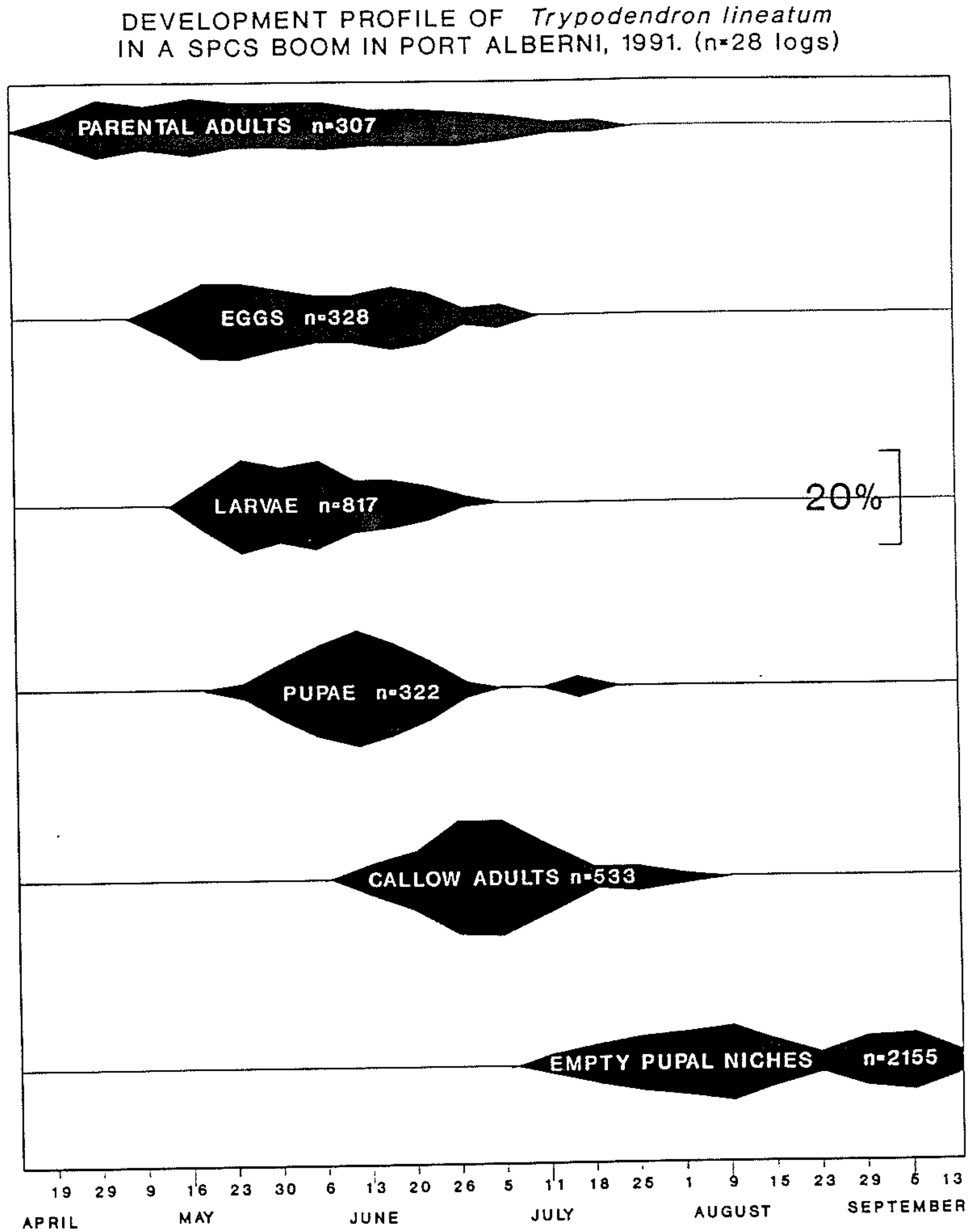

Figure 1. Kite diagrams to show the relative abundance of the life stages of the ambrosia beetle *Trypodendron lineatum* in a spruce boom in the Alberni Canal, British Columbia, during the summer of 1991.

Table 1. A life stage development index for the ambrosia beetle *Trypodendron lineatum* as developed from the data presented in Figure 1.

LIFE STAGE	ESTIMATED AGE OF ATTACK (days)
Adults only present (no niches)	0 - 10
Adults and/or eggs present (light brown staining of gallery)	11 - 20
Adults, eggs and larvae (galleries now darkly stained)	20 - 42
Late instar larvae and pupae	43 - 53
Larvae, pupae and callow adults	54 - 70
No life stages, old pupal niches	>70

These time intervals enabled us to age the period WHEN any particular log was attacked and by reference to the towing record for a boom we could estimate WHERE each log was attacked. In many cases, it could be shown that the logs were attacked before they entered the water.

The North Arm of the Fraser Transect

The total seasonal catches, in relation to the transect are shown in Figs. 2A,B. The highest catches of beetles were recorded in the forested margin. Low catches were recorded on the North Arm Jetty and very few beetles were caught on the outer rows of dolphins. Of concern, was the large numbers of beetles captured in the traps on the first row of dolphins which were about 50 m off shore. High value booms should not be stored close to an apparently highly suitable overwintering site as the Foreshore Park area.

The seasonal catch of *T. lineatum* (Figure 3) shows that the greatest catches were made during the week ending April 26, 1991. The sister flight was recorded in late June and early July. It is during these flight periods that there is the greatest chance for attacks on logs.

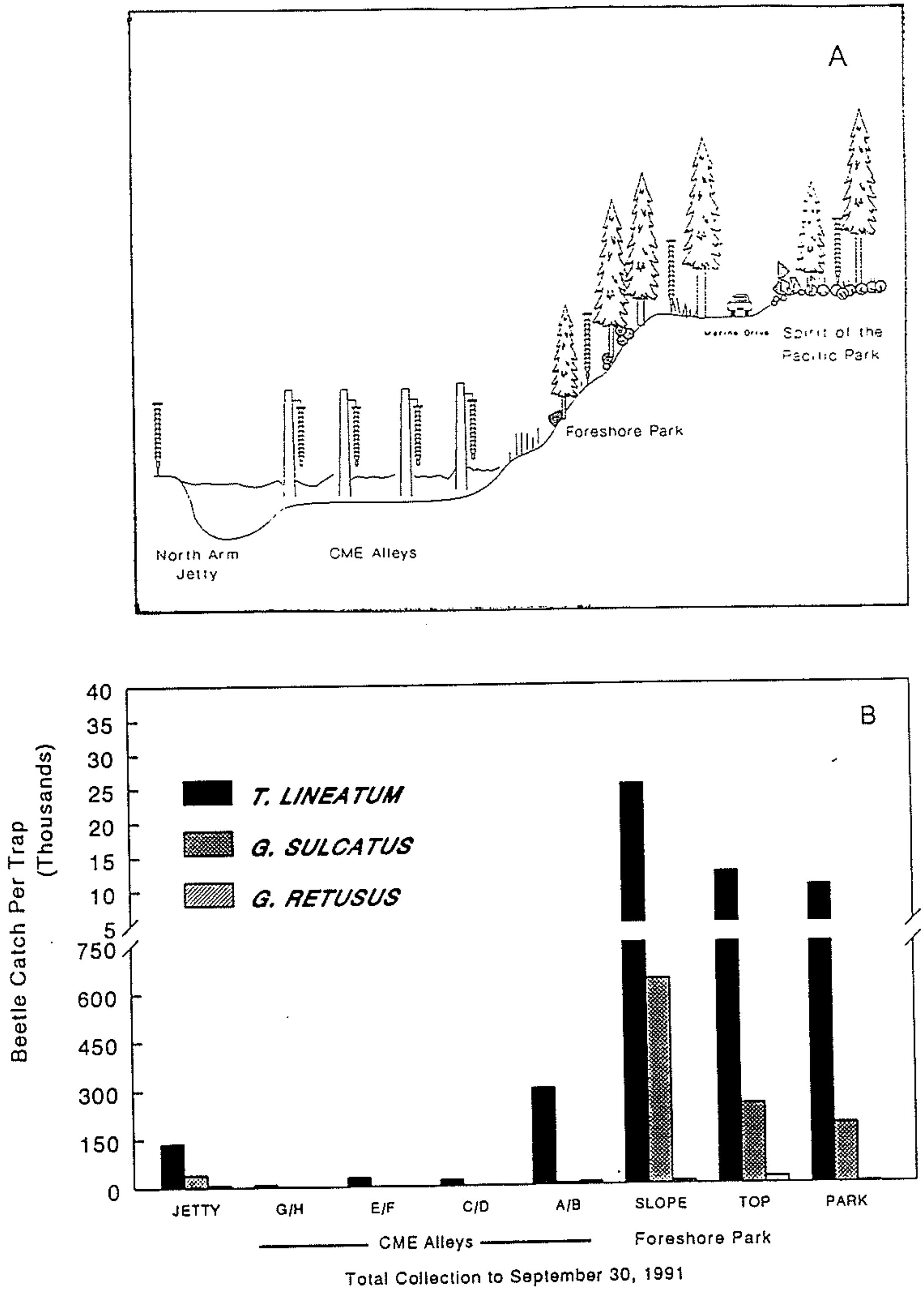

Figure 2. Trapping in the Point Grey booming grounds at the mouth of the North Arm of the Fraser River near Vancouver, British Columbia. A. Diagrammatic representation of the trapping transect across the booming ground into the Foreshore Park area and Spirit of the Pacific Park. B. Total catches of ambrosia beetles during the period 1 April 1991 to 30 September 1991.

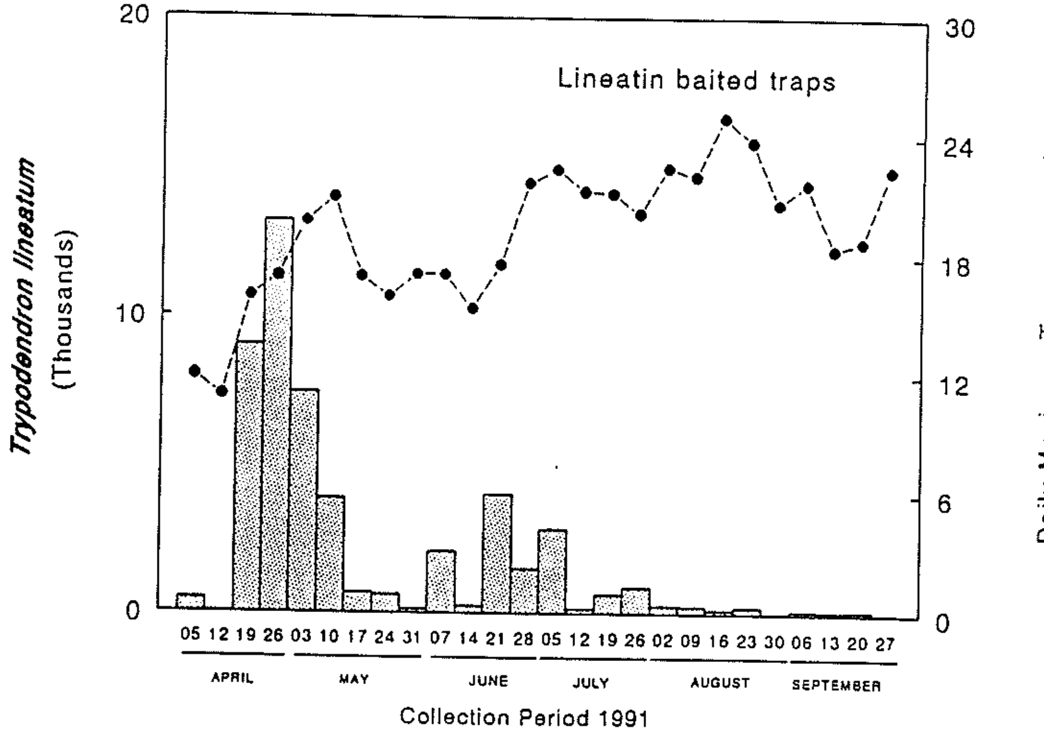

Figure 3. Weekly catches of the ambrosia beetle *Trypodendron lineatum* in pheromone-baited traps in the booming ground area at the mouth of the North Arm of the Fraser River. The dotted line indicates the daily maximum temperature as recorded at the nearby Vancouver International Airport.

When we review these two studies we see that beetles which successfully overwinter in the duff emerge in a relatively small period in late April and early May as soon as there are suitably warm days. The boom study shows that the progeny from these attacks can be expected to emerge in July. It is this July flight of brood adults that goes into the forest to overwinter in the duff and emerge the following spring to attack seasoned logs. For the 14 weeks that adults were found in the galleries, the average number found was 21.9/week. For the 10 weeks when empty pupal niches were found, the average number was 215.5/week. This shows that there is an order of magnitude increase in the numbers of beetles from generation to generation.

This separation of cause and effect by 9 months has led to difficulties in realizing just what trap catches mean. At a sawmill or a dry land sort, they represent the beetles that were able to emerge the previous July and overwinter successfully in nearby forested areas. Log booms with large infestations on them in July are almost certainly attacked in the woods during the spring flight.

Thus the ambrosia beetle *T. lineatum* plagues the industrial forester twice. The first time is when the flight occurs in the forest in late April when the beetles disperse to find new logs. The second occasion is when that cycle is unwittingly perpetuated at dry land sorting areas and at boom storage areas. New brood beetles emerge from infested logs in July and August and are transported in the prevailing winds (11,12) to the closest forested margin where they overwinter in the duff. The following April, the overwintered beetles emerge to attack logs in the storage areas.

Pheromone-baited traps are very useful for mass-trapping. Wise interpretation of trap catches in the light of the knowledge presented above will give the industrial forester a measure of the problem encountered in failing to move felled logs in time from the forest. The infestations can be transported widely throughout the system on log booms and create centres of infestation that will attack clean logs moved through those areas the following spring.

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References

1. Furniss, R.R. and V.M. Carolin. 1977. Western Forest Insects. Misc. Publ. #1339 USDA Forest Service. 654 pp.

2. Richmond, H.A. 1986. Forest Entomology:From packhorse to helicopter. Pest Management Report No. 8. B.C. Ministry of Forests. 44 pp.

3. Richmond, H.A. and W.W. Nijholt. 1972. Water misting for log protection from ambrosia beetles in B.C. Can. For. Serv., Pac. For. Res. Cent. Inform. Rep. B.C. P-4-72.

4. Chapman, J.A. and J.M. Kinghorn. 1958. Studies of flight and attack activity of the ambrosia beetle, *Trypodendron lineatum* (Oliv.) and other scolytids. Can. Ent. 90:362-372..

5. Graham, K. 1968. Anaerobic induction of primary chemical attractancy for ambrosia beetles. Can. J. Zool. 46:905-908.

6. Moeck, H.A. 1970. Ethanol as the primary attractant for the ambrosia beetle *Trypodendron lineatum* (Coleoptera: Scolytidae). Can. Ent. 102:985-995.

7. MacConnell, J.G., J.H. Borden, R.M. Silverstein and E. Stokkink. 1977. Isolation and tentative identification of lineatin, a pheromone from the frass of *Trypodendron lineatum* (Coleoptera:Scolytidae). J. Chem. Ecol. 3:549-561.

8. Borden, J.H., J.R. Handley, B.D. Johnston, J.G. MacConnell, R.M. Silverstein, K.N. Slessor, A.A. Swigar and D.T.W. Wong. 1979. Synthesis and field testing of 4,6,6-lineatin, the aggregation pheromone of *Trypodendron lineatum* (Coleoptera:Scolytidae). J. Chem. Ecol. 5:681-689.

9. Shore, T.L. and J.A. McLean. 1985. A survey for the ambrosia beetles *Trypodendron lineatum* and *Gnathotrichus retusus* (Coleoptera: Scolytidae) in a sawmill using pheromone baited traps. Can. Ent. 117:49-55.

10. Lindgren, B.S. and J.H. Borden. 1983. Survey and mass trapping of ambrosia beetles (Coleoptera:Scolytidae) in timber processing areas on Vancouver Island. Can. J. For. Res. 13:481-493.

11. Salom, S.M. and J.A. McLean. 1989. Influence of wind on the spring flight of *Trypodendron lineatum* (Olivier) (Coleoptera:Scolytidae) in a second growth coniferous forest. Can. Ent. 121:109-119.

12. Salom, S.M. and J.A. McLean. 1991. Environmental influences on dispersal of *Trypodendron lineatum* (Coleoptera:Scolytidae). Environ. Entomol. 20:565-576.