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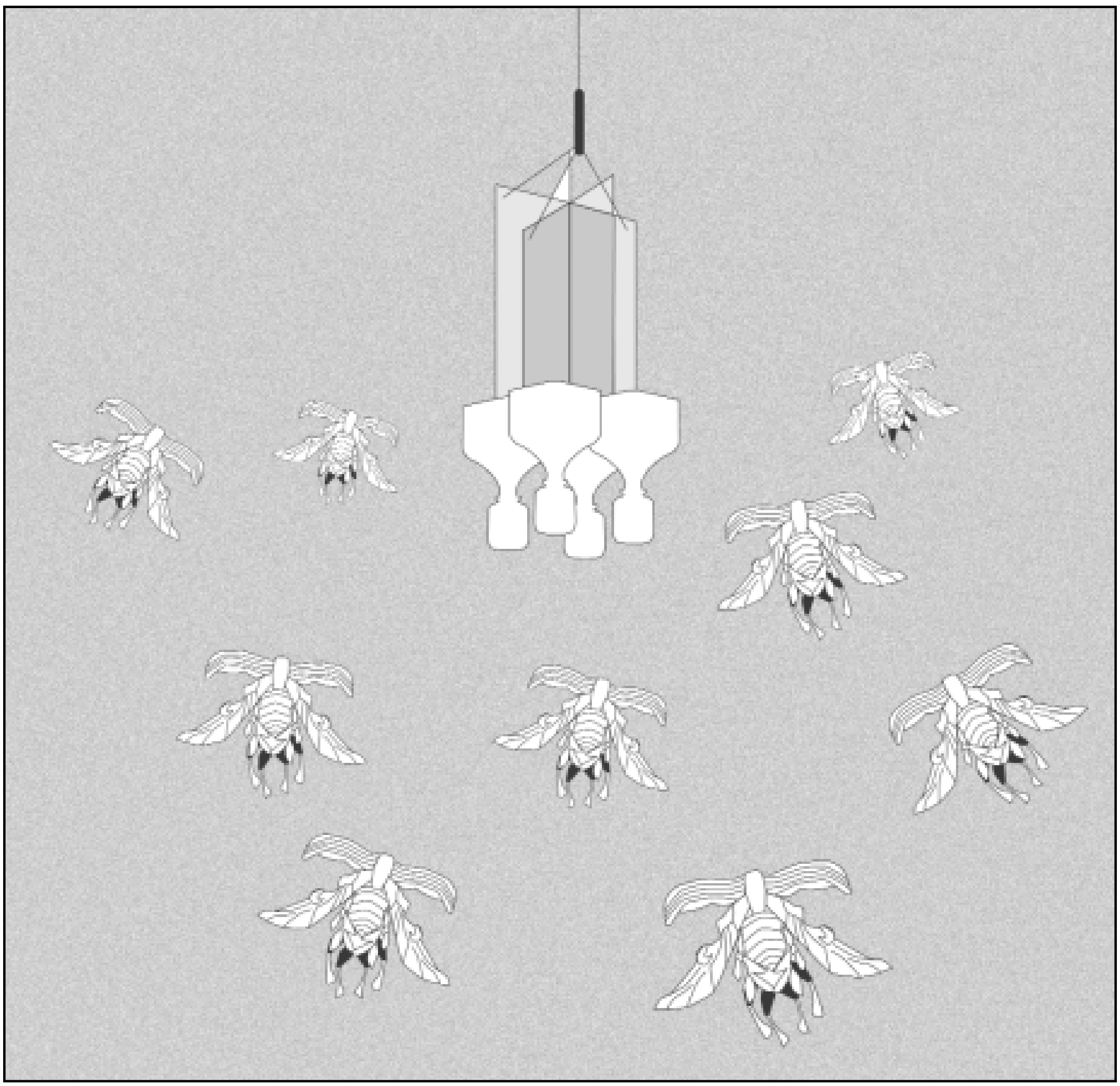
Dispersal Flight and Attack of the Spruce Beetle, *Dendroctonus rufipennis*, in South-Central Alaska

Edward H. Holsten and John S. Hard



Authors

Edward H. Holsten is a research entomologist and **John S. Hard** was a research entomologist (now retired), Forestry Sciences Laboratory, 3301 C Street, Suite 300, Anchorage, AK 99503.

Abstract

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Data from 1999 and 2000 field studies regarding the dispersal flight and initial attack behavior of the spruce beetle (*Dendroctonus rufipennis* Kirby) are summarized. More dispersing beetles were trapped in flight near the middle to upper tree bole than the lower bole. There were no significant differences between trap location and ambient temperatures. Initial attacks, however, were concentrated on the lower tree bole. Dispersal flight preceded initial attacks by 1 to 2 weeks.

Keywords: Bark beetles, *Dendroctonus rufipennis*, dispersal, flight, attack patterns, white spruce, *Picea glauca*, Lutz spruce, *Picea* X *lutzii*, Alaska (south-central), Kenai Peninsula.

Summary

Field tests regarding the dispersal flight and initial attack of the spruce beetle (*Dendroctonus rufipennis* Kirby) were conducted on the Kenai Peninsula in stands of Lutz (*Picea* X *lutzii* (Little)) and Sitka spruce (*P. sitchensis* (Bong.) Carr.). Adult beetles disperse more commonly in the area surrounding the upper clear bole of the tree and the lower live crown, although initial attacks were concentrated on the lower tree bole. Females outnumbered males, and twice as many adults were trapped during flight in unthinned vs. thinned stands regardless of initial population levels. The majority of adult dispersal occurred when temperatures approached and exceeded 16 °C. The lower limit of dispersal flight was 12.8 °C.

Contents

Introduction

The spruce beetle (*Dendroctonus rufipennis* Kirby) is the most significant natural mortality agent of mature spruce (*Picea* sp.) in the United States (Holsten and others 1999). At the peak of an ongoing outbreak in Alaska, more than 500 000 ha of spruce stands were infested in 1996 with about 30 million trees killed (Wittwer 2000).

Silvicultural treatments, such as thinning, that can help maintain stand health and a moderate growth rate of residual trees are considered important factors in reducing risk of spruce beetle outbreaks in susceptible stands (Hard and Holsten 1985, Holsten and others 1999, Sartwell and Stevens 1975). Other strategies using semiochemicals to manage spruce beetle populations are being developed (Bentz and Munson 2000, Holsten 1994, Werner and Holsten 1995). Determining the relative abundance of inflight populations of the spruce beetle is one measure of the effectiveness of thinning to reduce tree killing in spruce stands. The dispersal and flight patterns of *D. rufipennis* adults are, however, probably the least understood aspects in the population dynamics of this bark beetle (Werner and Holsten 1997). Dispersal is one of the most important aspects of bark beetle population biology.

From 1999 through 2000, the following objectives were developed and tested through field studies:

1. Determine if numbers of dispersing spruce beetle adults differ between thinned and unthinned spruce stands.
2. Determine the height, with respect to the tree bole, of dispersing adult spruce beetles and their subsequent initial attacks on new host trees.
3. Determine the timing of new spruce beetle attacks with respect to adult dispersal.
4. Determine if height of dispersing adult spruce beetles depends on ambient temperature.

Materials and Methods

Field studies in 1999 were conducted in two pairs of stands having different characteristics but on generally level terrain.

Study Site Locations

Two adjoining mature Lutz spruce (*Picea* X *lutzii*) stands, 250 m in elevation in the Granite Creek area, 120 km south of Anchorage, Alaska, were about 148 years old. Spruce beetle activity in the area was moderate to low at about 2 to 10 attacked spruce per hectare (= endemic). The first stand was unthinned and had an average diameter of 26.6 cm, an average height of 17 m, and a stand density of about 945 trees per ha. Understory vegetation was sparse and consisted mostly of *Salix* sp. and blue-joint reedgrass (*Calamagrostis canadensis* (Michx.) Beauv.). The second stand was thinned from below in 1988 to about 420 trees per ha. Average diameter and height of these Lutz spruce were 25.6 cm and 14.6 m, respectively. Understory vegetation was abundant with blue-joint reedgrass, *Salix* sp., and fireweed (*Epilobium angustifolium* L.).

Two adjoining even-aged Lutz spruce stands, about 100 m in elevation near Centennial Lake, 300 km south of Anchorage on the Kenai Peninsula, were about 70 years old. Spruce beetle populations were high with more than 10 trees per ha attacked annually, and the outbreak had been ongoing in the study site for at least 3 years (= epidemic). The first stand was thinned from below in 1995 to about 300 stems per ha, with an average diameter and height of 21.8 cm and 15.8 m, respectively. Ground cover ran heavily to *C. canadensis* with scattered patches of alder (*Alnus* sp.) and willow (*Salix* sp.) The second stand was unthinned and had about 626 stems per ha. Average diameter and height of the Lutz spruce were 20.6 cm and 16.2 m, respectively. Ground cover was sparse and consisted of alder, willow, and scattered patches of blue-joint reedgrass.

Field studies were conducted in 2000 in a mature mixed (60 percent – 40 percent) Lutz/Sitka spruce (*P. sitchensis* (Bong.) Carr.) and mountain hemlock (*Tsuga mertensiana* (Bong.) Carr.) stand of about 550 stems per ha, which was at the base of a west-facing mountain slope about 170 km south of Anchorage near Moose Pass. Average diameter and height of the Lutz spruce and mountain hemlock were 47.3 cm and 30.7 m and 30.3 cm and 24.3 m, respectively. Ground cover was sparse and consisted of alder, willow, scattered patches of blue-joint reedgrass and Devil's club (*Echinopanax horridum* (Sm. Dece. and Planch)). This study site is referred to as Kenai Lake Work Center (KLWC). The spruce beetle dispersal flight was expected to be large in this area because heavy attacks occurred in the same general area in 1998. Mortality in the study site in 2000 was about 30 percent.

Passive Barrier Traps and Attack Monitoring

Before adult dispersal, five columns of nondirectional passive barrier traps were placed in each of the two thinned and two unthinned study plots in 1999. Trap columns were about 30 m apart and randomly distributed. Each three-trap column was suspended by a line running through a pulley suspended by rope between two spruce trees. Trap heights were approximately 0.6 m, 4 m, and 7 m aboveground to represent, respectively, the lower tree bole, middle tree bole, and lower live crown. The traps, used by Schmitz (1984), had two 30- by 30-cm clear Plexiglas barriers at right angles to each other.[1] Collection jars, containing 50 percent glycol and 50 percent water, were attached directly below each barrier trap. Each trap column could be individually lowered for inspection. Weekly trap collections were placed in labeled plastic bags and frozen for later identification and counting. Sex of all trapped spruce beetles was determined per Lyon (1958). Two unattacked Lutz spruce were randomly selected from each of the four study plots, and new spruce beetle attacks were recorded the same day as the trap collections from 0.5-m^2 bark sample bands located at roughly the same heights as the passive barrier traps.

Ten columns of nondirectional passive barrier traps were randomly distributed in the KLWC study plot in 2000. Five unattacked spruce trees were randomly selected to monitor spruce beetle attacks similarly to 1999 procedures. Ambient temperatures (°C) were recorded hourly between May 16 and July 25, 2000, by a Hobo® H8 data logger (Onset Computer Corporation, Pocasset, MA) from thermocouples attached to each of the three passive barrier traps in a trap column. Trap catches were collected weekly with the exception of June 5 and 6, when collections were made every 2 hours after peak emergence flight began a few days earlier. Trapped adult spruce beetles were processed as described for the 1999 study.

Experimental Design

Total numbers and sex of *D. rufipennis* caught from the different trap heights as well as number of attacks per 0.5 m^2 were compared by analysis of variance of data. For each replication at a given trap height, the average number of beetles trapped per collection date was calculated. Differences between means were tested by using Tukey's (1953) comparison of the means test alpha = 0.05. Analyses were with using "Statistix 7" software.[2]

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[1] The use of trade or firm names in this publication is for reader information and does not imply endorsement by the U.S. Department of Agriculture of any product or service.

[2] Analytical Software. 2000. Statistix 7. Tallahassee, FL.

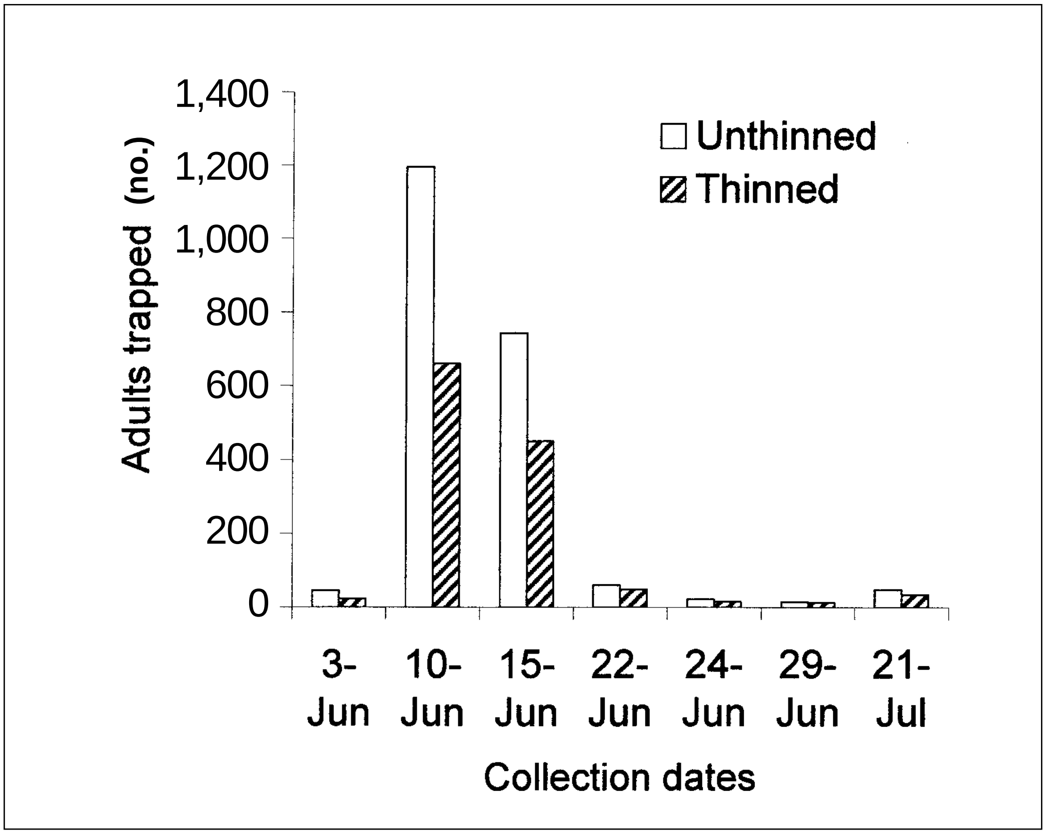

Figure 1—Total number of dispersing adult spruce beetles from five columns of traps each, from unthinned and thinned stands, Centennial Lake, Alaska, 1999.

Results and Discussion

Vertical Distribution of Flight

Spruce beetle dispersal flights in 1999 and 2000 began by the first week of June (figs.1, 2, and 3b). There were no significant differences in the number of beetles trapped by trap height in either the thinned or unthinned Centennial Lake sites (table 1). At both sites, however, about 37 percent of the dispersing adults were captured in the upper traps, 39 percent in the middle traps, and 25 percent in the bottom traps. At the Granite Creek thinned site, significantly more beetles were captured in the middle trap than in the top or bottom traps. At the Granite Creek unthinned site, there also were no significant differences by trap height in number of beetles captured. Significantly more beetles were trapped at KLWC in 2000 in the upper and middle traps than in the bottom traps (table 1). These trends are similar to trap catches of the mountain pine beetle (*D. ponderosae* Hopkins) (Safranyik and others 1989, Schmitz 1984). Height at which mountain pine beetles flew under the canopy was affected by density and height of the understory cover, the depth of the clear bole zone, and weather factors, especially temperature (Safranyik and others 1989). Safranyik and others (1989) demonstrated that 1.74 times as many mountain pine beetles were trapped at 4 m aboveground than at 2.5 m. Safranyik and others (1992) estimated, however, that only 0.2 percent of the marked mountain pine beetles dispersed above the stand canopy in a Canadian study.

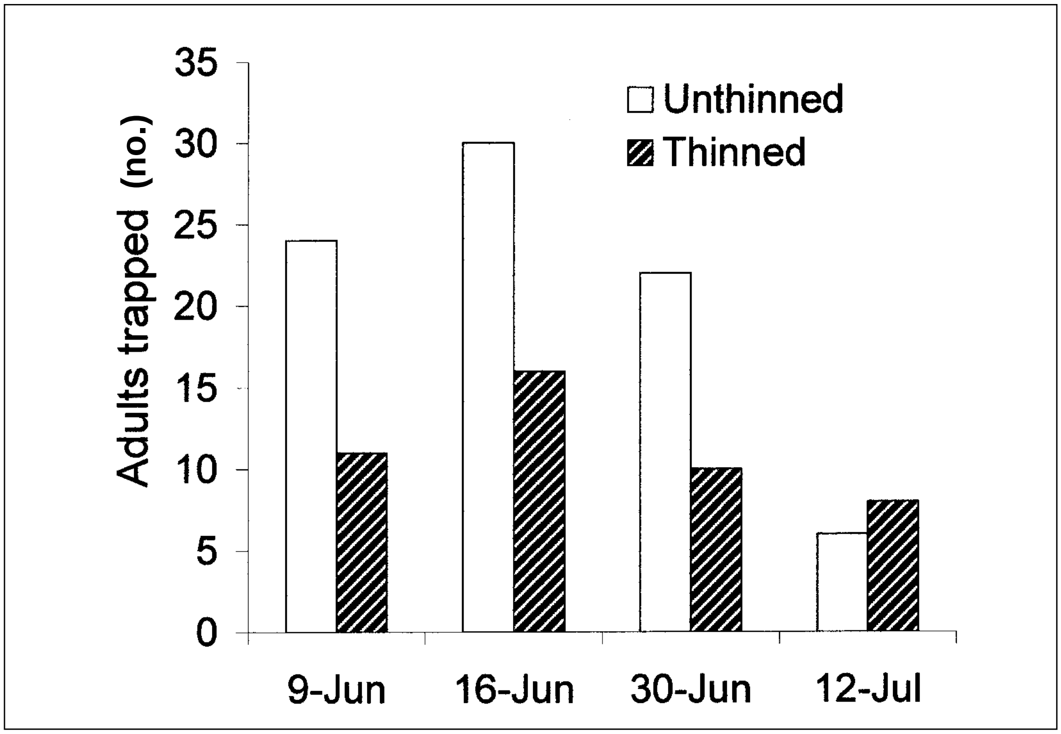

Figure 2—Total number of dispersing adult spruce beetles from five columns of traps each, from thinned and unthinned stands, Granite Creek, Alaska, 1999.

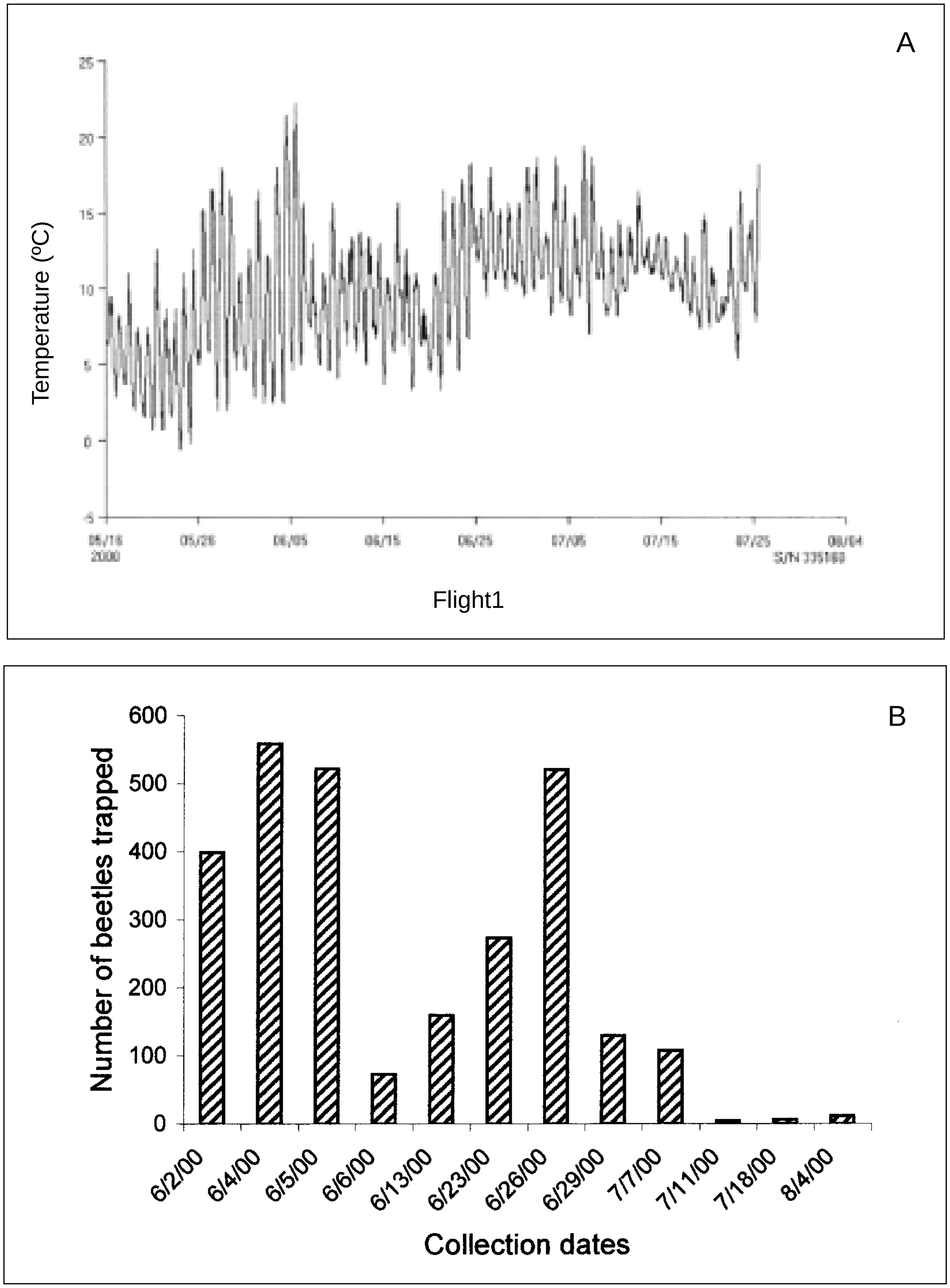

Figure 3—Relation between average ambient temperature from three probes (**A**) and total number of dispersing spruce beetle adults from 10 columns of traps (**B**), KLWC, Alaska, 2000.

Table 1—Collections of dispersing spruce beetle adults, Centennial Lake, Granite Creek, and KLWC,[1] Alaska, 1999 and 2000

Item	Centennial Lake		Granite Creek		KLWC
	Thinned	Unthinned	Thinned	Unthinned	
Top trap[2 3]	16.4(2.6)[a]	28.3(6.7)[a]	1.8(0.4)[a]	2.7(0.7)[a]	11.5(0.9)[a]
Middle trap	18.8(1.2)[a]	26.8(4.4)[a]	2.2(0.2)[b]	2.5(0.5)[a]	13.7(2.8)[a]
Bottom trap	12.9(3.4)[a]	15.2(4.3)[a]	1.0(0.0)[a]	2.3(0.4)[a]	5.0(0.9)[b]
Sex ratio (female:male)	1.5:1	1.7:1	2.3:1	1.6:1	2.2:1
Total beetles trapped	1,244	2,125	45	82	2,742

[1] KLWC = Kenai Lake Work Center.
[2] Top trap = 7 m, middle trap = 4 m, bottom trap = 0.6 m.
[3] Average number of adults per trap. Number in parenthesis is S.E. Values followed by the same letter within the same column are not significantly different ($P < 0.05$), Tukey's (1953) studentized range test.

Distribution of Attacks

New attacks in the Centennial Lake area began on June 16 and June 22, 1999, in the unthinned and thinned stands, respectively (figs. 4 and 5). In both areas, beetle attacks began about 1 to 2 weeks after peak adult spruce beetle dispersal flight. We hypothesize that the trapped spruce beetles were part of a dispersing population from outside the study area and that perhaps the attacks were initiated by these beetles immigrating to the study sites. This is supposition on our part because we do not have data on where dispersing beetles go. Perhaps spruce beetles are not physiologically ready for attack during the early stages of their dispersal flights. This same relation held true for the 2000 KLWC flight study, wherein attacks began from 1 to 2 weeks after peak dispersal flight (fig. 6). We had, however, few sample trees for monitoring attacks. New attacks may have occurred elsewhere in the study sites during dispersal flight. There were too few new attacks in the Granite Creek area in 1999 to compare timing of attacks against timing of dispersal. Many bark beetles disperse by flight before attacks start (Atkins 1959). Safranyik and others (1995) demonstrated that 39 percent of emerging spruce beetles from experimental log decks attacked nearby host material. The remainder dispersed outside the test area.

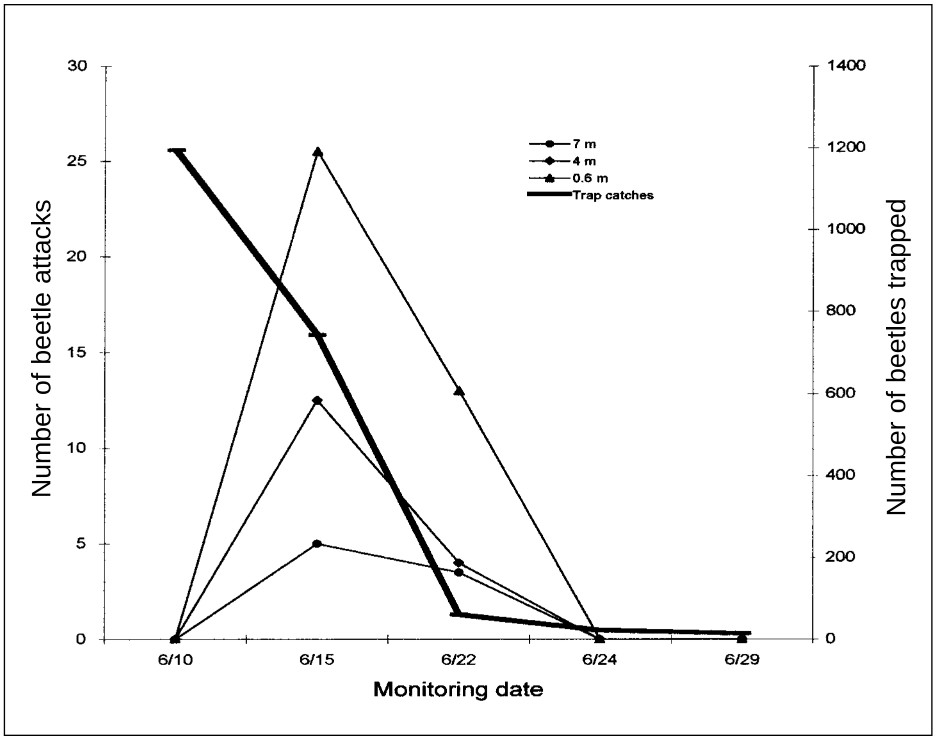

Figure 4—Timing of peak spruce beetle flight and number of beetle attacks/0.5 m^2 at three trap heights (0.6, 4, and 7 m) in an unthinned stand, Centennial Lake, Alaska, 1999.

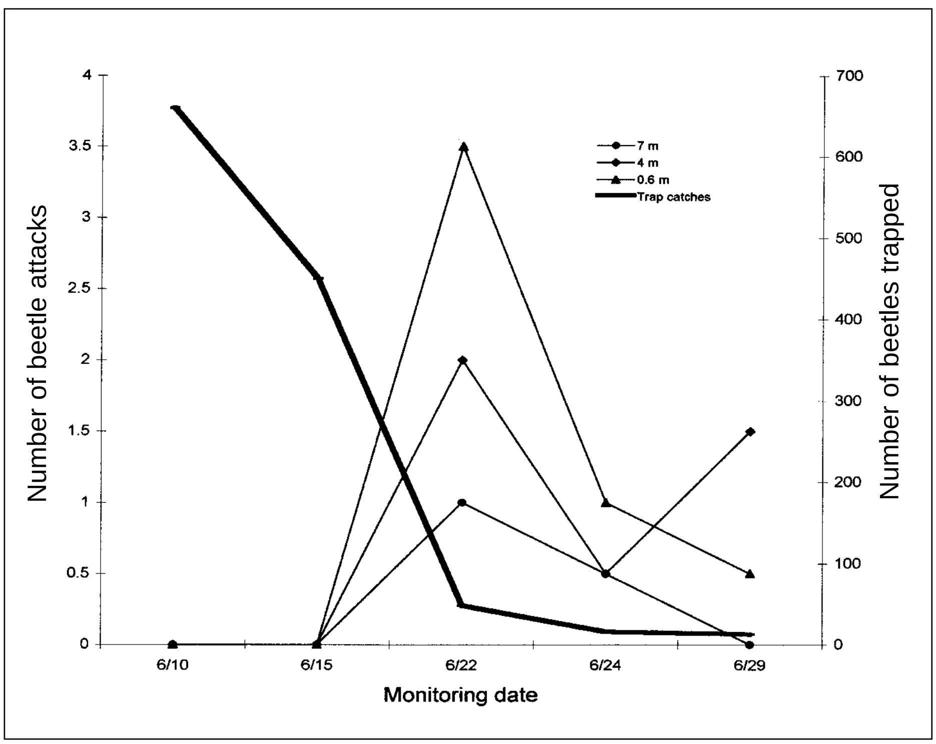

Figure 5—Timing of peak spruce beetle flight and number of beetle attacks/0.5 m^2 at three trap heights (0.6, 4, and 7 m) in a thinned stand, Centennial Lake, Alaska, 1999.

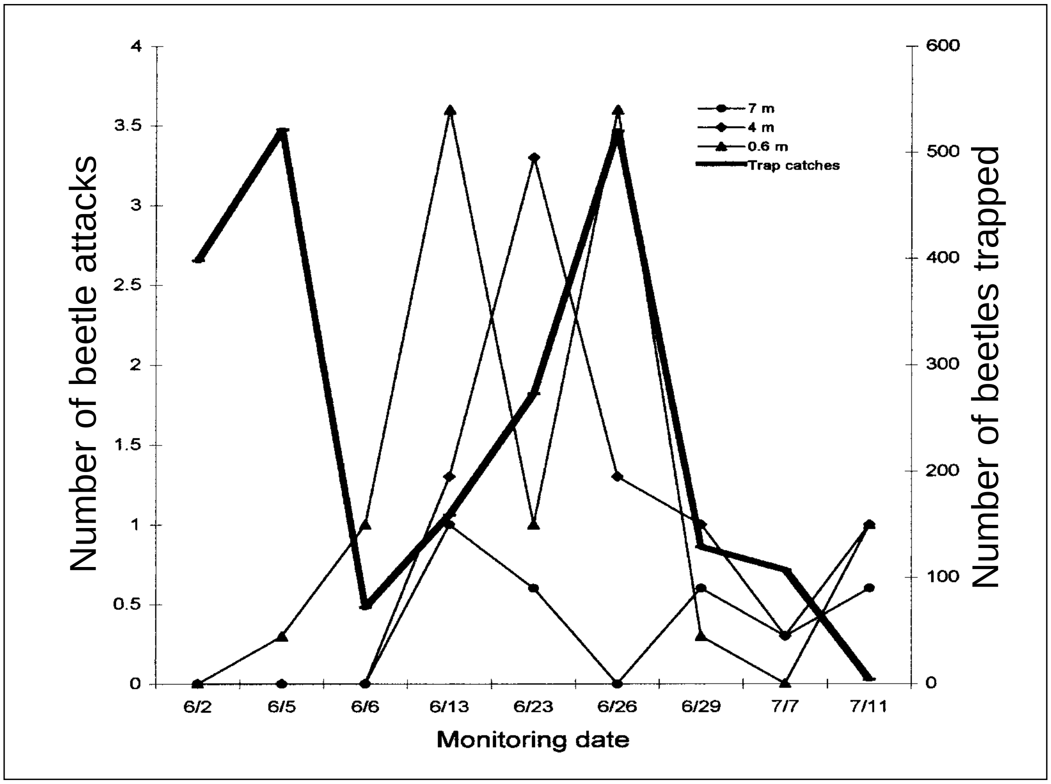

Figure 6—Timing of peak spruce beetle flight and number of beetle attacks/0.5 m^2 at three trap heights (0.6, 4, and 7 m) in an unthinned stand, KLWC, Alaska, 2000.

In 1999 and 2000, in both thinned and unthinned areas, new attacks were first noticed and were most numerous on the lower tree bole (figs. 4, 5, and 6). This is in agreement with earlier studies showing that spruce beetles concentrate their attacks on the lower tree bole (Hard 1987, Hard and Holsten 1985, Knight 1960, Watson 1928). The lower tree bole can be considered the "Achilles heel," especially on slowly growing spruce, because attacking beetles may have less chance of being repelled there by defensive reactions of the host (Hard and Holsten 1985). Other species of scolytids show similar attack patterns. For example, most marked mountain pine beetles are trapped at a height of 3 m; captures decline above and below this point (Berryman 1982, Safranyik and Linton 1987, Safranyik and others 1992).

Table 2—Flight temperatures by trap height, KLWC,[1] Alaska, 2000

Trap	Freq. of minimum temp.[2]	Freq. of optimal temp.[3]
Top[4]	199[a]	74[a]
Middle	197[a]	76[a]
Bottom	195[a]	82[a]

[1] KLWC = Kenai Lake Work Center.
[2] Number of times temperature exceeded flight threshold temperature (14.5 °C).
[3] Number of times temperature exceeded optimal flight temperature (16 °C).
[4] Values followed by the same letter within columns are not significantly different ($P < 0.05$), Tukey's (1953) studentized range test [HSD].

Relation Between Endemic and Epidemic Spruce Beetle Populations and Thinned Vs. Unthinned Stands

There were no significant differences between endemic and epidemic spruce beetle populations or males and females with respect to flight preference by height (table 1). In all studies, there were more females trapped than males, with female to male ratios ranging from 1.5:1 to 2.3:1 (table 1). These sex ratios are in agreement with other spruce beetle studies (Holsten and Werner 1990, Massey and Wygant 1954). The primary difference between sites with epidemic spruce beetle populations (Centennial Lake, KLWC) and those with endemic levels (Granite Creek) was, as expected, the number of dispersing spruce beetles (table 1). At Centennial Lake and KLWC, 3,369 and 2,742 adult beetles were trapped, respectively, vs. 127 adults at Granite Creek; a greater than twentyfold difference. Overall, almost twice as many adult beetles were trapped in unthinned stands vs. thinned stands regardless of population levels (table 1). An earlier study conducted in white spruce (*P. glauca* (Moench) Voss) stands in interior Alaska showed that the total number of scolytids trapped in a thinned stand to be one-seventh that of an unthinned stand (Beckwith 1972).

Relation Between Ambient Temperature and Dispersal Flight

Spring and summer weather conditions in south-central Alaska were cooler than normal in 2000. The highest temperature recorded, 24.4 °C on June 5, was from the bottom probe (0.6 m) during peak beetle dispersal flight (fig. 3). This temperature was at least 2 °C higher than temperatures recorded at the middle (4 m) and upper traps (7 m). There were no significant differences in the number of hours above flight threshold (14.5 °C) among probe heights (table 2), and there were no significant differences in the number of hours above optimal flight dispersal temperatures (16 °C) by probe height. On June 5, when temperatures warmed above 14.5 °C, the number of beetles caught in traps increased as temperatures increased until the study was terminated at 8 p.m. (figs. 7 and 8). The following day was significantly cooler, with the temperature reaching a high of only 15 °C, and few adults were trapped. Some dispersing adults, however, were trapped when the ambient temperature was as low as 12.8 °C. This is a lower flight threshold than previously documented (14.5 °C) by Werner and Holsten (1985). Most spruce beetles dispersed when temperatures approached and exceeded 16 °C.

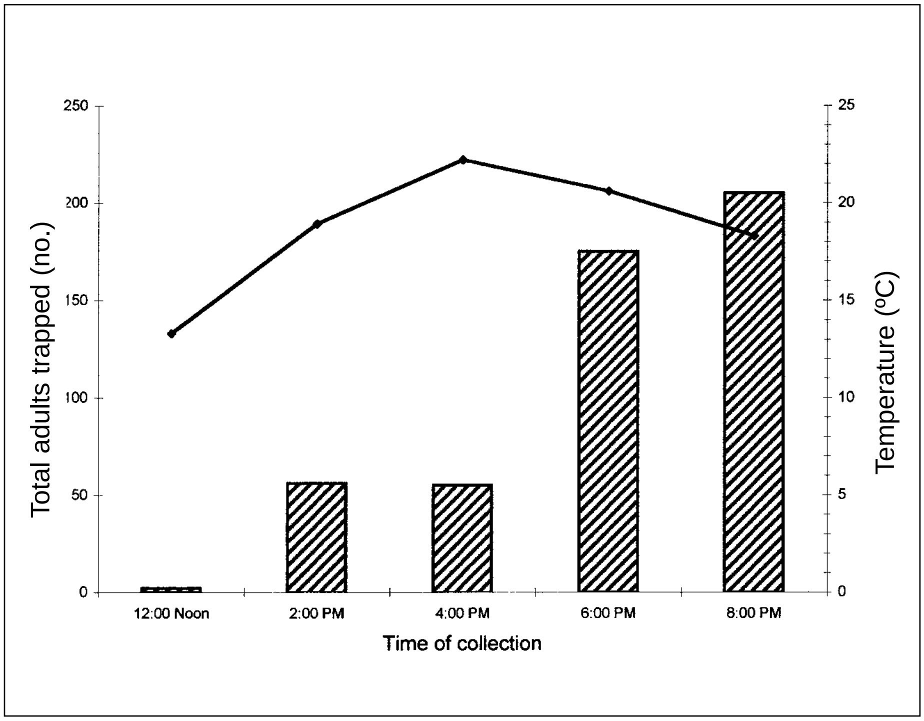

Figure 7—Collections of dispersing spruce beetles and ambient temperature, June 5, 2000, KLWC, Alaska, 2000.

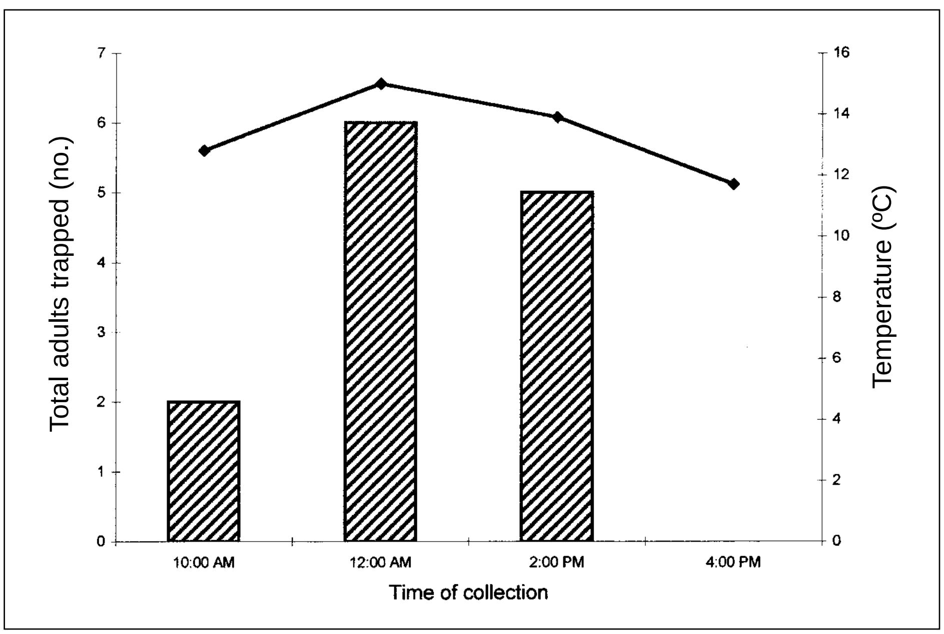

Figure 8—Collections of dispersing spruce beetles and ambient temperature, June 6, 2000, KLWC, Alaska.

Conclusions

Two years of field testing demonstrated that spruce beetle dispersal flights began when the temperature increased above a threshold of 12.8 °C. Fewer dispersing beetles were trapped in thinned stands compared to adjoining unthinned stands. The majority of dispersing spruce beetle adults were trapped at the height of the upper portions of the clear tree bole and lower live crown region. Differences in trap catches of dispersing adults by trap height were not related to differences in ambient temperatures by sample probe height. Initiation of attack lagged initial dispersal flight by a week or more. It is possible that adult beetles trapped during peak dispersal emerged from the study site and were dispersing out of the study site before initiating attack. New attacks within the study sites were possibly initiated by beetles moving into the study sites after a dispersal flight from outlying areas. Initial attacks always occurred on the lower tree bole. As the attack phase continued, more attacks appeared on the middle and upper tree bole.

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English Equivalents

When you know:	**Multiply by:**	**To find:**
Celsius (°C)	1.8 and add 32	Fahrenheit
Centimeters (cm)	2.54	Inches
Hectares (ha)	2.47	Acres
Kilometers (km)	0.621	Miles
Meters (m)	3.281	Feet
Square meters (m^2)	1.20	Square yards
Millimeters (mm)	0.254	Inches

References

Atkins, M.D. 1959. A study of the flight of the Douglas-fir beetle *Dendroctonus pseudotsugae* Hopkins (Coleoptera: Scolytidae). I: Flight preparation and response. Canadian Entomologist. 91: 283-291.

Beckwith, R.C. 1972. Scolytid flight in white spruce stands in Alaska. Canadian Entomologist. 104: 1977-1983.

Bentz, B.J.; Munson, A.S. 2000. Spruce beetle population suppression in northern Utah. Western Journal of Applied Forestry. 15(3): 122-128.

Berryman, A.A. 1982. Population dynamics of bark beetles. In: Mitton, J.B.; Sturgeon, K.B., eds. Bark beetles in North American conifers: a system for the study of evolutionary biology. Austin, TX: University of Texas Press: 264-314.

Hard, J.S. 1987. Vulnerability of white spruce with slowly expanding lower boles on dry cold sites to early seasonal attack by spruce beetles in south-central Alaska. Canadian Journal of Forest Research. 17: 428-435.

Hard, J.S.; Holsten, E.H. 1985. Managing white and Lutz spruce stands in south-central Alaska. Gen. Tech. Rep. PNW-188. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 21 p.

Holsten, E.H. 1994. The role of spruce beetle pheromones as management strategies in Alaska. In: Shea, P.J., tech. coord. Proceedings of the symposium on management of western bark beetles with pheromones: research and development. Gen. Tech. Rep. PSW-GTR-150. Albany, CA: U.S. Department of Agriculture, Forest Service, Pacific Southwest Research Station: 11-14.

Holsten, E.H.; Their, R.W.; Munson, A.S.; Gibson, K.E. 1999. The spruce beetle. For. Insect Disease Leafl. 127. [Washington, DC]: U.S. Department of Agriculture, Forest Service. 12 p.

Holsten, E.H.; Werner, R.A. 1990. Comparison of white, Sitka, and Lutz spruce as hosts of the spruce beetle in Alaska. Canadian Journal of Forest Research. 20(3): 292-297.

Knight, F.B. 1960. Measurement of Englemann [sic] spruce beetle populations. Ecology. 41(2): 249-252.

Lyon, R.L. 1958. A useful secondary sex character in *Dendroctonus* bark beetles. Canadian Entomologist. 90: 582-584.

Massey, C.L.; Wygant, N.D. 1954. Biology and control of the Englemann [sic] spruce beetle in Colorado. Circ. 944. [Location of publisher unknown]: U.S. Department of Agriculture, Forest Service. 35 p.

Safranyik, L.; Linton, D.A. 1987. Patterns of landing of spruce beetles, *Dendroctonus rufipennis* (Coleoptera: Scolytidae), on baited lethal trap trees. Journal of the Entomological Society of British Columbia. 84: 21-32.

Safranyik, L.; Linton, D.A.; Silversides, R.; McMullen, L.H. 1992. Dispersal of released mountain pine beetles under the canopy of a mature lodgepole pine stand. Journal of Applied Entomology. 113: 441-450.

Safranyik, L.; Shore, T.L.; Linton, D.A.; Taylor, S.P. 1995. Dispersal of the spruce beetle, *Dendroctonus rufipennis* Kirby (Col., Scolytidae) from an experimental log deck. Journal of Applied Entomology. 119: 335-340.

Safranyik, L.; Silversides, R.; McMullen, L.H.; Linton, D.A. 1989. An empirical approach to modeling the local dispersal of the mountain pine beetle (*Dendroctonus ponderosae* Hopkins) (Coleoptera: Scolytidae) in relation to sources of attraction, wind direction and speed. Journal of Applied Entomology. 108: 498-511.

Sartwell, C.; Stevens, R.E. 1975. Mountain pine beetle in ponderosa pine: prospects for silvicultural control in second growth stands. Journal of Forestry. March: 136-140.

Schmitz, R.F. 1984. A passive aerial barrier trap suitable for sampling flying bark beetles. Res. Note INT-348. [Ogden, UT]: U.S. Department of Agriculture, Forest Service, Intermountain Research Station. 8 p.

Tukey, J.W. 1953. The problem of multiple comparisons. Princeton, NJ: Princeton University. 396 p. Unpublished manuscript. On file with: Princeton University, Firestone Library, Princeton, NJ 08544.

Watson, E.B. 1928. The bionomics of the spruce bark beetle, *Dendroctonus picaperda* Hopkins. Scientific Agriculture. 8(10): 613-635.

Werner, R.A.; Holsten, E.H. 1985. Factors influencing generation times of spruce beetles in Alaska. Canadian Journal of Forest Research. 15: 438-443.

Werner, R.A.; Holsten, E.H. 1995. Current status of research with the spruce beetle, *Dendroctonus rufipennis*. In: Salom, S.M.; Hobson, K.R., eds. Proceedings of the National Entomological Society meeting: application of semiochemicals for management of bark beetle infestations. Gen. Tech. Rep. INT-GTR-318. Ogden, UT: U.S. Department of Agriculture, Forest Service, Intermountain Research Station: 34-42.

Werner, R.A.; Holsten, E.H. 1997. Dispersal of the spruce beetle, *Dendroctonus rufipennis*, and the engraver beetle, *Ips perturbatus*, in Alaska. Res. Pap. PNW-RP-501. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 8 p.

Wittwer, D. 2000. Forest insect and disease conditions in Alaska—1999. R10-TP-82. Juneau, AK: U.S. Department of Agriculture, Forest Service, Alaska Region. 55 p.

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