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Observations on *Platypus flavicornis* (Coleoptera: Platypodidae) in Southern Pine Beetle Infestations[1]

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ABSTRACT

The flight and attack pattern of the ambrosia beetle *P. flavicornis* (F.) was studied in southern pine beetle, *Dendroctonus frontalis* (Zimmermann) infestations in eastern Texas. The ambrosia beetle flew mostly within 9 feet of the ground and attacked the lower stems of pines which had been mass-attacked previously by the southern pine beetle. Four to six days elapsed from the time of *D. frontalis* mass-attack until *P. flavicornis* began to land on the trees. The rate of landing increased until the 10th day and then declined slowly. The slow accumulation of attacks suggests the orientation primarily to odors originating from the host, as opposed to insect-produced volatiles.

The family Platypodidae is represented in the United States by 7 species of the genus *Platypus* Herbst (Arnett 1963). Of these, only *P. flavicornis* (F.) is known to be a pest of southern pines. This ambrosia beetle is found from Texas east to Florida and north to New Jersey (Chamberlin 1939). In spite of its widespread occurrence as a forest pest, little is known of its ecology and behavior.

Under normal conditions, *P. flavicornis* is found only in widely scattered dead or dying trees. Certain conditions, such as the current southern pine beetle, *Dendroctonus frontalis* Zimmerman, epidemic in eastern Texas, provide an abundance of host material for the ambrosia beetles. The following observations were made in 1966–67 in conjunction with studies on southern pine beetle behavior.

MATERIALS AND METHODS

Trees infested by *P. flavicornis* are easily detected by the piles of fluffy, white boring dust around their bases. Southern pine beetle infestations in Hardin County, Tex., exhibiting ambrosia beetle activity were chosen as the sites for observations. The infestations were typically in loblolly pine sawtimber stands containing an admixture of magnolia, sweetgum, beech, and oaks.

Vertical flight distribution was sampled using 18× 18-in. polyethylene sheets coated with an adhesive. A flight-panel set consisted of 4 such sheets fastened to a cord and suspended from a crossarm nailed to a hardwood tree. The sticky sheets were positioned on the cord so that the tops of the sheets were 3, 6, 9, and 12 ft above the ground. The flight-panel sets were positioned at least 30 ft from trees attacked by the southern pine beetle, to lessen any possible artifact caused by visual and olfactory orientation to the pines. Five such sets were operated for about 3 weeks each at various times during the summers of 1966 and 1967.

Attack density was sampled on 8 trees in 1966. A 6-in. × 8-ft section of tree bark was removed to expose the wood surface, and the number of *Platypus* pinholes was tallied at 1-ft-height intervals above the ground. *P. flavicornis* pinholes are noticeably larger than the tunnels of associated scolytid ambrosia beetles (viz. *Gnathotrichus* and *Xyleborus*).

The vertical distribution of *P. flavicornis* landings on trees killed by southern pine beetles was determined by use of adhesive-coated plastic strips stapled to the standing trees. Since the attack density counts had shown no attacks above 8 ft, sticky traps longer than 8 ft were not used. Two strips were placed on each tree, one extending from ground level to 8 ft on the north side of the tree and a similar strip on the south side of the tree. Beetles were removed and tallied by 1-ft height classes above the ground every 1–3 day period.

Two sleeve olfactometers (Gara 1967) were installed on loblolly pines immediately after they had been mass-attacked by southern pine beetles (Fig. 1). Another olfactometer was placed on a nearby but unattacked pine. The olfactometers were operated for 3–4 hr between 8:00 AM and 12 M and once again for 3–4 hr in the late afternoon from ca. 4:00 to 8:00 PM. Beetles caught in the olfactometers were collected and counted daily.

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FIG. 1.—Sleeve olfactometer being installed on loblolly pine stump.

The sex of beetles collected in rotary nets (Vité and Gara 1962) and from various sticky traps was determined using the characteristics described by Blackman (1922).

RESULTS AND DISCUSSION

Flight Behavior.—The total numbers of *P. flavicornis* intercepted by the flight panels are shown in Table 1. More than ½ the beetles in flight were within 3 ft of the ground and about ¾ were below 6 ft. Beetles landing on trees showed a different distribution (Table 2). About 80% of the beetles landed on the lower 3 ft of the trees. Although tree sticky traps were not used to sample landings higher than 8 ft on the tree stems, it is reasonable to assume that very little landing took place at the higher levels, because of the rapid decrease in number of trapped beetles up to the 8-ft level. Thus, the data not only corroborate observations of foresters and entomologists on the distribution of ambrosia beetle attacks in the lower stems of pines, but they also indicate that the major flight activity of *P. flavicornis* in forest stands with little undergrowth is probably restricted to within 6 ft of the ground. Furthermore, flying beetles show a strong preference for alighting on the bottom 2 ft of the stem.

Table 1. — Number of *P. flavicornis* caught on sticky flight panels placed in loblolly pine stands.

Flight-panel set no.[a]	No. beetles at indicated distances above ground (ft)			
	1.5–3.0	4.5–6.0	7.5–9.0	10.5–12.0
1	2	4	1	1
2	4	5	7	1
3	0	0	2	0
4	20	5	3	1
5	16	3	0	0
Totals	42	17	13	3
Percent	56.0	22.7	17.3	4.0

[a] Flight-panel sets 1–4 observed for 16 days; set 5 observed for 12 days.

Response to Susceptible Host Trees.—During the 1st 4–6 days following mass-attack by southern pine beetle, *P. flavicornis* was not captured in either sticky traps or sleeve olfactometers. After that time, the number of platypodids trapped at attacked trees increased slowly until the 10th day after southern pine beetle invasion and then declined (Fig. 2). Continued small flights at sticky traps and sleeve olfactometers were evident after 18 days. Catches at the tree sticky traps were less erratic and consisted of more beetles than at the olfactometers. These differences are most likely explained by the continuous sampling by sticky traps as opposed to the 6- to 8-hr sample of the sleeve olfactometers. Vité et al. (1964) found *P. flavicornis* in flight during the summer only from 6:00 to 9:00 AM, but in the present study olfactometers usually were not operated to take maximum advantage of this early morning flight period.

The gradual increase in number of attacking beetles followed by a slow decline suggests a response to odors from the host rather than to insect-produced attractants. A similar buildup of attacks has been observed for the scolytid ambrosia beetles *Xyleborus ferrugineus* (F.) and *X. posticus* Eichhoff (Norris et al. 1968).

The mass-attacks of southern pine beetle would appear to hasten conditions that are favorable to ambrosia beetle attraction. The sleeve olfactometer that was placed around a pine severed in the same man-

Table 2. — Number of *P. flavicornis* caught on sticky strips attached to loblolly pines recently attacked by southern pine beetles.

Trap no.[a]	No. beetles/ft² at indicated distances above ground (ft)							
	0–1	1–2	2–3	3–4	4–5	5–6	6–7	7–8
1	160	108	72	48	22	4	2	0
2	181	56	19	28	16	14	0	0
Totals	341	164	91	76	38	18	2	0
Percent	46.7	22.5	12.6	10.4	5.2	2.5	0.1	0

[a] Trap 1 observed for 13 days; trap 2 for 15 days. Total area sampled at each level; trap 1, 0.5 ft²; trap 2, 1.0 ft². The numbers shown for trap 1 were adjusted to ft² basis.

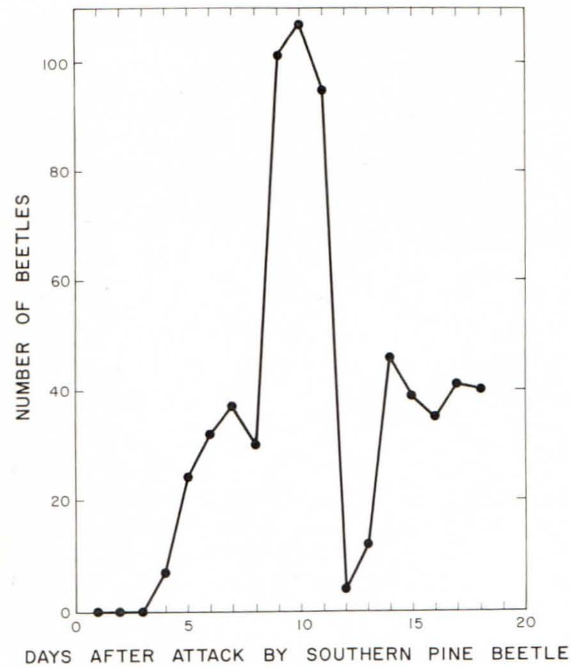

Fig. 2.—Number of *P. flavicornis* caught each day on sticky traps placed on 2 loblolly pines attacked by southern pine beetle.

ner as the *D. frontalis*-infested trees caught only 11 *P. flavicornis* in the 30 days it was in operation. During the same time ambrosia beetles were caught regularly on trees infested with southern pine beetles. The aggregation pheromone of southern pine beetle does not seem to be primarily responsible for *P. flavicornis* response because it was not attracted to trees during the first 2–3 days after southern pine beetle mass-attack, the time period when southern pine beetle pheromone is at its highest level. Resinous odors may play a role in olfactory orientation, but once again, resin exudes from southern pine beetle-infested trees largely during the 1st few days after attack. Batra and Batra (1967) reported that ambrosia beetles are attracted by yeasty odors. Several yeasts and fungi are introduced into pines after attack by *D. frontalis* (Bramble and Holst 1940), and it may be that odors from these organisms are a source of attraction for *P. flavicornis*.

Attack Density.—The vertical distribution of attacks on standing trees (Table 3) was very similar to the vertical distribution of landing beetles (Table 2). By comparing the 2 distributions, there appears to be a slight downward movement of beetles after they land.

Although not conclusive, the data in Table 3 indicate that ambrosia beetle attack extends higher on the trunk in trees of larger diameter. Attack on trees less than 10 in. DBH was restricted to within 3 ft of the ground. Likewise, attack density seems to be greater in the larger trees. The data in Table 3 show that attack density in the lower 3 ft of trees less than 13 in. DBH averaged 11.4/ft^2, while in trees greater than 13 in. DBH the average attack density was 21.2/ft^2. However, a direct cause-and-effect relationship between tree size and attack density should not be inferred. Tree diameter may reflect differences in host moisture content which in turn would affect the success of ambrosia beetle attacks.

Table 3. — Number of *P. flavicornis* attacks on standing loblolly pine trees. Sample unit on each tree was a 6-in. × 8-ft area.

Tree no.	DBH (in.)	No. attacks at indicated distances above ground (ft) 0–1	1–2	2–3	3–4	4–5	5–6	6–7	7–8
1	9.5	24	10	1	0	0	0	0	0
2	9.5	26	10	4	0	0	0	0	0
3	12.0	16	8	1	0	2	0	0	0
4	12.0	29	11	8	1	0	0	0	0
5	12.5	18	4	1	1	2	2	2	0
6	16.5	39	19	4	1	0	0	0	0
7	19.5	31	19	5	4	1	0	0	0
8	20.0	31	33	11	6	2	3	0	1
Totals		214	114	35	13	7	5	2	1
Percent		54.7	29.1	9.0	3.3	1.8	1.3	0.5	0.3

Sex Ratios.—*P. flavicornis* removed from sticky traps placed on trees in varying stages of attack were found in the ratio of 0.85 ♂ :1 ♀. Hetrick (1967) captured this insect at UV light traps in the ratio of 0.6 ♂ :1 ♀. Very few *P. flavicornis* were caught in the rotating nets, but on several occasions the hardwood pest *P. compositus* (Say) was caught in appreciable numbers. During early August 1967, this insect was found in flight only between 7:45 and 9:00 PM (CDST). Peak flight was observed to occur from 8:15 to 8:30 PM at temperatures down to 21°C. Lower temperatures did not occur during the rotating net studies. *P. compositus* was captured in the ratio of 1.5 ♂ :1 ♀, which figure agrees well with the 1.4 ♂ :1 ♀ ratio reported for this insect at light traps (Hetrick 1967).

Attempts to control losses caused by *P. flavicornis* in pine trees killed by southern pine beetle are rarely undertaken, because under forest conditions such losses are not significant compared with the added control costs. Economic loss that results from quality reduction in beetle-infested timber stands managed for pulpwood production would not be expected to be serious. In these smaller trees, nearly half the total damage would be left in a 1-ft stump. However, in sawtimber stands, value loss could be significant. While a 1-ft stump would still contain about ½ the beetle tunnels, the remaining pinholes would be found in a greater length of the lower log. Also, attack density in the larger timber is higher.

The importance of *P. flavicornis* as a secondary pest following southern pine beetle attacks is primarily in stands managed for sawtimber production. Use of trees within 1–2 weeks after southern pine beetle attack would seem to be necessary to limit loss to the outer 1–2 in. of tree sapwood. If trees are left longer, the tunnels eventually are extended to the heartwood of the tree.

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Reproduction of Stored-Grain Insects on Varieties of Wheat, Oats, and Barley[1]

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ABSTRACT

Reproduction of 5 cosmopolitan species of stored-grain insects on as many as 39 varieties of cereal grain grown in western Canada in 1965–66 was determined. Resistance of a cereal to an insect was assumed to be inversely related to reproduction of that insect. The granary weevil, *Sitophilus granarius* (L.), and the lesser grain borer *Rhyzopertha dominica* (F.), did not multiply on unbroken seeds of hulled oats, but *S. granarius* multiplied on the hulless variety 'Vicar.' The rusty grain beetle, *Cryptolestes ferrugineus* (Stephens); the red flour beetle, *Tribolium castaneum* (Herbst); and the confused flour beetle, *T. confusum* Jacquelin duVal, developed and reproduced best on crushed oats. Differences ($P<0.05$) in rates of multiplication of the insect species were observed among varieties of 2 cereals. *Triticum dicoccum* Schübl. was the most resistant of the cereals tested to whole-grain feeding insects and most susceptible to broken-grain feeders. The extent of resistance by a variety to whole-grain feeding insects may be related to the presence and nature of the hull on the cereal.

The quality of stored cereals is often greatly reduced by insect infestation. Notwithstanding recent advances in chemical control of insects and improvement in grain storage practices, the problem of low-cost storage of cereals without danger from insecticidal residues remains unsolved. Search for and subsequent incorporation of insect resistance as 1 of the desirable varietal characters in the breeding of cereals might help solve this problem. So far, studies to identify insect-resistant varieties of stored cereals and to determine the factors responsible for resistance have been done largely with sorghum (Samuel and Chatterji 1953, Doggett 1957, Russell 1962), and to a lesser extent with corn (Kempton 1917, Cartwright 1930, Warren 1956, Soderstrom 1962, Pant et al. 1964), and teosinte (*Euchlaena* sp.) (Warren 1954).

In Canada, more than a billion bushels of grain are produced annually. Of this amount, about ⅓ is consumed domestically and the remainder is stored on farms or in elevators and is gradually exported. The relatively insect-free grain exported from Canada to Europe, Africa, and Asia is exposed on arrival to stored-grain insects prevalent in the region such as weevils of the genus *Sitophilus*, and the lesser grain borer, *Rhyzopertha dominica* (F.). However, when exports are low, large stocks of grain stored under improper conditions are vulnerable to infestation by the rusty grain beetle, *Cryptolestes ferrugineus* (Stephens), and the red flour beetle, *Tribolium castaneum* (Herbst). Grain losses occur through heating and insect damage (Sinha 1961, Sinha and Wallace 1966). Hence, cereal varieties commonly grown on the Canadian Prairies are at some time exposed to stored-grain insect pests.

In 1965 a study was began to determine what effect, if any, species and variety of cereal had on reproduction of stored-product insects. The results obtained when 5 of the major species of stored-product insects were cultured on different varieties, either whole or ground, of common (*Triticum aestivum* L.), durum (*T. durum* Desf.), and emmer (*T. dicoccum* Shrank) wheat, oats (*Avena sativa* L.), and barley (*Hordeum vulgare* L.) are reported here.

Two separate aspects of the response of stored-grain insects to different varieties of wheat, barley, and oats were studied: the mechanical barrier provided by the hull and the pericarp of the seed to invasion by the whole-grain feeders, *R. dominica* and the granary weevil, *S. granarius* (L.); and the nutritional quality of the crushed-cereal varieties resulting from biochemical factors as in the case of the crushed-grain feeders, *C. ferrugineus*, *T. castaneum*, and the confused flour beetle, *T. confusum* Jacquelin duVal.

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