The Seasonal Occurrence of the Grape Root Borer, (Lepidoptera: Sesiidae) in the Eastern United States[1,2]

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ABSTRACT The Grape Root Borer, *Vitacea polistiformis* (Harris), (Lepidoptera: Sesiidae) was trapped during 1985, 1986, and 1987 in seven, nine, and 13 eastern states, respectively, with pure (E,Z)-2,13 octadecadienyl acetate or a 99:1 blend of (E,Z)-2,13 octadecadienyl acetate and (Z,Z)-3,13 Octadecadienyl acetate. The length of adult activity periods ranged from six months in Florida to two or three months in Pennsylvania, Maryland, New Jersey, and Ohio. Bimodal peaks of activity occurred most commonly in the South, and single peaks were most common in the North. Activity usually began in all states (except Central Florida) in June or early July, with principal activity occurring in August in the extreme South, in late July in the central states, and about the first of July in the northern states. In Central Florida, flight began in late July with principal activity in September. Twelve other species of sesiid moths were also collected with the sex attractant, including large numbers of *Melittia cucurbitae* (Harris), *Paranthrene simulans* (Grote), and *Paranthrene asilipennis* (Boisduval).

KEY WORDS Grape root borer, seasonal occurrence, pheromone, trapping Sesiidae, *Vitacea polistiformis.*

The grape root borer, *Vitacea polistiformis* (Harris) (GRB) (Lepidoptera: Sesiidae), has been known as a pest of grapes of many years (Engelhardt, 1946). Since it does not occur in California, the principal grape producing state, a great deal of attention has not been given to the pest in the past. However, in recent years with the increase in production of muscadine, table, and wine grapes in the East, many problems with the pest have been encountered by growers. At first, muscadines were thought to be resistant to attack (Brooks, 1907), but this has proved incorrect (Wylie, 1972).

The species has a two-year life cycle, and each female lays up to 400 eggs on weeds or grass near the bases of grape vines. The eggs hatch in ca. 2 wk, and the

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young larvae bore into the roots of the vines where they construct tunnels and feed in the cambium. Most of the larvae occur in or near the crown of the root system, but many may also be found in the lateral roots (Engelhardt, 1946). They have been reported as deep as 80 cm below the soil surface (All and Dutcher, 1977). Pupation begins in the late spring or early summer, and after 2 - 3 wk, adults emerge and mate, and the cycle is repeated.

Infestations are determined by surveying the areas around the bases of grape vines for exuviae or larval workings, or by extracting a part of the root system for detection of larvae or damage (All and Dutcher, 1977). The latter procedure is difficult, time consuming, and harmful to the vines. Currently, the best control is obtained with insecticides. The discovery by Schwarz et al. (1983) of the GRB pheromone as (E,Z)-2,13 octadecadienyl acetate (EZA) and its later improvement by the addition of 1% (Z,Z)-3, 13 octadecadienyl acetate (ZZA) (Snow et al. 1987) provided researchers with a new tool for monitoring populations of the insect. Because of the lack of information on seasonality and the increased importance of the species, a survey was begun in several eastern states in 1985 which eventually grew into cooperative research that involved 13 states and 19 researchers and extended from 1985-1987. Most of these researchers are not listed as authors but their names are available under the individual state sections as well as the acknowledgements. These data are the subject of this paper.

Materials and Methods

Pheromone trapping of the grape root borer was conducted in seven states (Florida, Georgia, South Carolina, North Carolina, Arkansas, Virginia, and Pennsylvania) during all 3 yr, in two states (Mississippi and Ohio) in 1986 and 1987, and in four states (Missouri, New Jersey, Maryland and Michigan) in 1987 only. In 1985, the pure isomer of EZA was used; in 1986 and 1987 a 99:1 blend of EZA and ZZA was used. Both isomers were purchased commercially and prior to use were analyzed on glass capillary gas chromatographic columns coated with SP2340. Before mixing, the EZA isomer was found to be 99.5 pure, and the ZZA isomer was 98.6% pure. The attractants were prepared by blending these isomers with appropriate quantities of hexane and the total dosage/lure was 1 mg. Lures were prepared by pipetting the blended pheromone onto rubber septa (no. 1780J12, Thomas Scientific, Swedesboro, NJ) with microliter syringes. Each septum was attached to the top of the trap with a paper clip which was suspended from a wire that was threaded through the top of the trap. Fresh lures were placed in the traps at 8 wk intervals (Jun. 1, Aug. 1, Oct. 1), and monitoring was always continued until two consecutive weeks of zero captures were recorded. Captures were low in 1985 when the pure EZA was used, but the addition of 1% ZZA improved capture by 6-25 times in 1986 and 1987 (Snow et al. 1987). A general protocol was developed prior to the 1985 season that called for trapping of two vineyard locations/researcher with three traps/vineyard. Pherocon 1C wing style sticky traps (Albany International, Swainsboro, GA) or the equivalent were used by all researchers except in Mississippi, where *Heliothis* wire cone traps were utilized. Traps were suspended from trelises at a height of ca. 1 m from ground level and were checked at least once a week at which time data were recorded and fresh trap liners were installed as needed. Researchers in Central Florida, Virginia, and North Carolina

changed trap liners more than once a week during high population periods because saturation levels were reached in the traps which meant that no more moths could be trapped. When necessary, the various researchers sent specimens to Byron for positive identification; these insects were usually sent while still in the trap liner, but some were sent after the stickum had been removed with hexane or a similar solvent. These were then sent to Tom Eichlin for positive identification. This was necessary because up to 12 other species of sesiid moths were attracted to and collected in the pheromone traps.

Trapping began on Apr. 1 in each of the 3 yr except in the most extreme southern states (Georgia and Florida) where it began on Mar. 1 in 1986 and 1987. Trapping was conducted throughout the winter of 1986 in Florida because of the possibility of an extended period of moth activity in the warmer climate. Variations from the protocol occurred, and these instances along with the information on the trapping sites are listed below under the separate state headings. Trapping locations are listed as counties in all cases except northern Florida where nearby cities are used, because both trapping locations were in the same county.

Florida - Warren C. Adlerz surveyed two locations in Central Florida during 1985 - 1986. The southernmost location was a 2-ha planting of muscadine and bunch grapes in Polk Co. (Fig. 1, no. 1); the other vineyard was 9-ha of mostly bunch grapes in Lake Co. Fig. 1, no. 2). Russell F. Mizzell trapped during all 3 yr in Jefferson Co. in northern Florida at a 4-ha., 5 yr old vineyard of muscadine grapes near Windy Hills (Fig. 1, no. 3) and 3.5-ha., 15 yr old vineyard of muscadine grapes near Lafayette (Fig. 1, no. 4).

Georgia - In the southern part of the state, J. Wendell Snow trapped a 10-ha muscadine vineyard in Colquitt Co. (Fig. 1, no. 5) in 1985. During 1986 and 1987, J. D. Dutcher trapped two non-vineyard sites in Tift Co. (Fig. 1, no. 6); these data were combined into a single average because of the closeness of the sites and similarity of the data. In Central Georgia, the senior author trapped a 10-ha, abandoned vineyard of bunch grapes in Peach Co. (Fig. 1, no. 7) in 1985; in 1986 and 1987, three small vineyards within a 1-mi radius of each other were trapped near Byron (Fig. 1, no. 8) in northern Peach Co. Data from the three small vineyards were combined into a single average. In North Georgia, an 8-ha vineyard of Concord and Niagara grapes in Jefferson Co. (Fig. 1, no. 9) was trapped in all 3 yrs by John N. All.

Mississippi - James Jarratt surveyed a 4-ha vineyard of muscadine and labrusca grapes in Oktibbeha Co. (Fig. 1, no. 10) in 1986 and 1987. In 1987, he also surveyed a 1-ha vineyard in Perry Co. (Fig. 1, no. 11) in southern Mississippi.

South Carolina - Clyde S. Gorsuch trapped a 3-ha vineyard of suscadine grapes in Lexington Co. (Fig. 1, no. 12) during all 3 yr, and a 0.9-ha muscadine vineyard located in Anderson Co. (Fig. 1, no. 13) in 1987. The Anderson Co. data is not plotted because of its close similarity to Lexington Co.

North Carolina - John R. Meyer trapped a 0.25-ha planting of experimental hybrids during all 3 yr in Wake Co. (Fig. 1, no. 14) and this vineyard yielded the highest capture of moths during the entire study. A 25-ha commercial muscadine vineyard in Sampson Co. (Fig. 1, no. 15) was also trapped during all 3 yr.

Arkansas - Donn T. Johnson trapped three locations in 1985 but caught moths only in a multiple cultivar research vineyard in Johnson Co. (Fig. 1, no. 17). In 1986, data were obtained from a 3.5-ha commercial 'Concord' vineyard in Benton

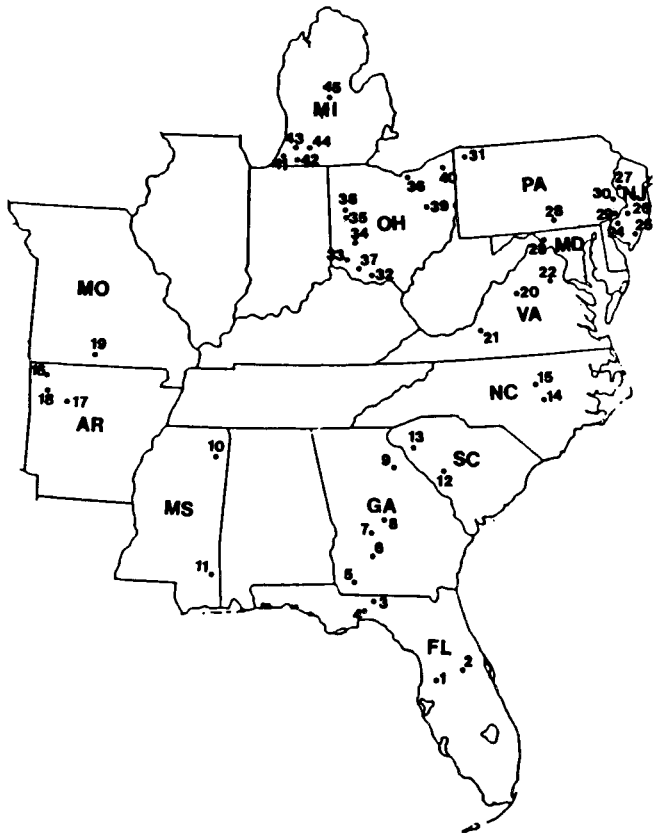

Fig. 1. Sites within each state that were trapped for grape root borer during 1985 - 1987.

Co. (Fig. 1, no. 16). In 1987, data were obtained from the same vineyard in Benton Co. and a 2.8-ha multiple cultivar research vineyard in Washington Co. (Fig. 1, no. 18).

Missouri - Howard G. Townsend trapped two vineyards in Wright Co. (Fig. 1, no. 19). Both vineyards were planted to the Catawba variety and were less than 1.5-ha in size. Data from these vineyards (which were less than 6 km apart) have been combined into a single average.

Virginia - Douglas G. Pfeiffer trapped two locations in 1985. One location in Rockbridge Co. (Fig. 1, no. 20) and in the central part of the state contained ca. 1.6-ha of French-American hybrids and vinifera-type cultivars. This site was sampled in 1985 only, and data from that site are not plotted because only three moths were captured all season. The other site, in Botetourt Co. Fig. 1, no. 21), contained 1.6-ha of American Hybrids (Concord, Delaware, and Niagara) and this site was sampled in all 3 yr. by Joella C. Killian, working in the northern part of the state, trapped a 1.5-ha vineyard of vinifera-type cultivars in Stafford Co. (Fig. 1, no. 22) duirng 1986 and 1987.

Maryland - Gerald L. Jubb trapped two locations in 1987, one in 8 Keedysville (1.2-ha) and one in Downsville (2.4-ha) (Fig. 1, no. 23). Both of these vineyards are in Washington Co. and are ca. 4.5 km apart. Two traps were operated at the Keedysville vineyard and one at the Downsville vineyard, both of which were planted in mixed French-American hybrid varieties. Data from the two locations have been combined. In this case, traps were not deployed until Jun. 26, but they were checked two days later (Jun. 28) and no males were captured.

New Jersey - Stuart R. Race trapped five locations in three southern counties and location in the northern county of Warren during 1987. Only data from Gloucester Co. (Fig. 1, no. 24) are plotted because the data obtained from the two other southern locations in Atlantic Co. (Fig. 1, no. 25) and Burlington Co. (Fig. 1, no. 26) and the single site in Warren Co. (Fig. 1, no. 27) were similar to Gloucester Co.

Pennsylvania - Michael C. Saunders trapped two vineyards in the southeastern county of Adams (Fig. 1, no. 28) and one location each in Bucks (Fig. 1, no. 29) and Delaware (Fig. 1, no. 30) cos. during all 3 yr. The two Adams Co. locations were combined into a single average. Significant numbers of GRB were collected in Bucks and Delaware cos. but these data are not plotted because of their similiarity to Adams Co. Another vineyard in the northwestern county of Erie (Fig. 1, no. 31) was also trapped in all 3 yr but no GRB were collected there. All vineyards were planted in wine grapes.

Ohio - Roger N. Williams and Steven R. Alm surveyed nine commercial vineyards during 1986 and 1987. In 1986, traps were operated in Adams (Fig. 1, no. 32), Clermont (Fig. 1, no. 33), Warren (Fig. 1, no. 34), and Miami (Fig. 1, no. 35) cos. in southwestern Ohio, and also in Lorain Co. (Fig. 1, no. 36) in northeastern Ohio. In 1987, trapping was continued in Warren Co. only, and additional sites in Brown (Fig. 1, no. 37), Shelby (Fig. 1, no. 38), Wayne (Fig. 1, no. 39), Ashtabula (Fig. 1, no. 40) cos. were added. Only data from Warren Co. will be presented because that location was trapped both years and is typical of the seasonality in the other counties of the state were GRBs were collected. No GRBs were recorded in the northeastern counties of Wayne, Lorain, and Ashtabula.

Michigan - William Taft and Dave Smitley trapped five non-vineyard locations in MI in 1987. One location each in Berrien, Case, Van Buren, and Kalamazoo cos. (Fig. 1, nos. 41-44, respectively) in the southwestern corner of the state and one location in Isabella County (Fig. 1, no. 45) in Central Michigan were trapped. Only data from Kalamazoo Co. (Fig. 1, no. 42) is plotted. The trapping scheme in this state differed from the one used in the other states in that only three locations were stationary throughout the season and no vineyards were sampled at any time. These data are included in the paper because of their value in showing the northern distribution of the species. However, all captures of GRB occurred in agricultural or lake shore areas that were situated near wild grape stands.

Results

Data for the 3 yr of trapping are shown by years in Figs. 2-4. The numbers of traps used at each site along with the total numbers of GRB moths collected are also included in these figures. In the cases where six or nine traps are indicated, data have been combined for two or three vineyards, respectively. The numbers of males captured is the only way the reader can make comparisons of the relative numbers of moths collected from each location. The highest numbers of GRB were

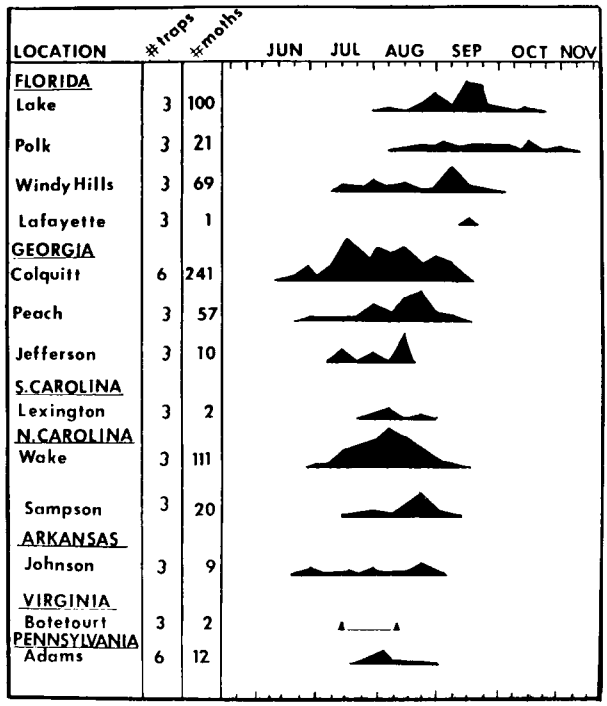

Fig. 2. Seasonal activity of grape root borer adults in the various states in 1985.

recorded in North Carolina while the lowest numbers were from Maryland. However, care must be taken in trying to assign values to these numbers because of variations in the infestation levels, grape varieties, size and age of vineyards, etc. Activity in Central and northern Florida was detected later in 1985 than it was in the other states (Fig. 2). In all cases except Windy Hills (early July), activity was detected after Aug. 1, and at Lafayette, only one moth was collected (mid-September) during the entire season. In several other states including South and Central Georgia, North Carolina, and Arkansas, activity was detected as early as mid-late June. The highest captures of moths for the entire year came from sites in Florida, Georgia, and North Carolina. Based on data shown in this figure, a tendency existed for a shortening of the adult male activity period from ca. 3 mo in the southern states to around 4-6 wk in the Virginia-Pennsylvania area. The total numbers of GRB captured also are much lower in the North (Fig. 2). A tendency for a single or bimodal curve is present in these data. However, the attractant used in 1985 was 6-25 times less attractive than that used in 1986 and 1987, thus the activity periods and height of the peaks were affected by the less attractive pheromone.

In 1986, Mississippi and Ohio were added to the survey. The improved attractiveness of the 99:1 pheromone blend was readily apparent both in length of seasonal activity and total numbers of males trapped. With the new attractant,

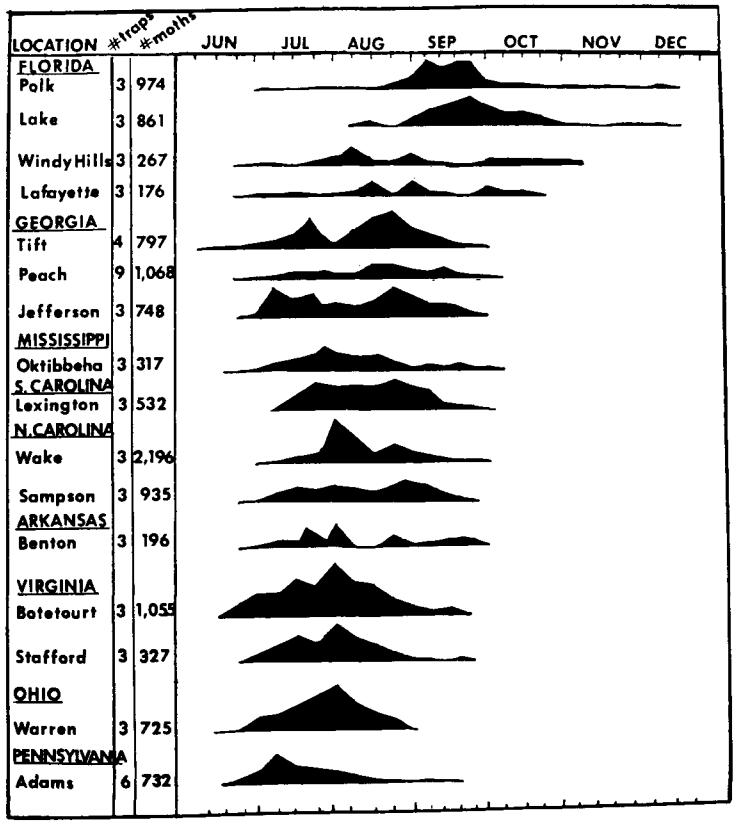

Fig. 3. Seasonal activity of grape root borer adults in the various states in 1986.

activity in Florida was detected for 4 mo at Lafayette in northern Florida and for almost 6 mo in Polk Co. in the central part of the state. With the improved attractant, moths were also collected much earlier in the season. It has been speculated that GRB adults may be active year-round in Florida, but our negative results from year-round trapping in 1986 prove that continuous activity does not occur in northern or Central Florida. However, Sharpe and Eichlin (1979) reported one specimen from Broward Co. in southern Florida (ca. 250 miles south of Polk Co.) so this study does not exclude the possibility that continuous generations occur further south. With the exception of Central Florida, activity at all locations in the nine states began ca. the same time. This is unlike 1985, when we speculated that activity might begin earlier in the North because of the shorter growing season. In the central and northern states, activity lasted ca. 2-3 mo. In all states, cessation of activity was related to the onset of cooler temperatures. When both single and double peaks of activity occurred, the tendency was for bimodal peaks of activity in the South and single peaks of activity in the North.

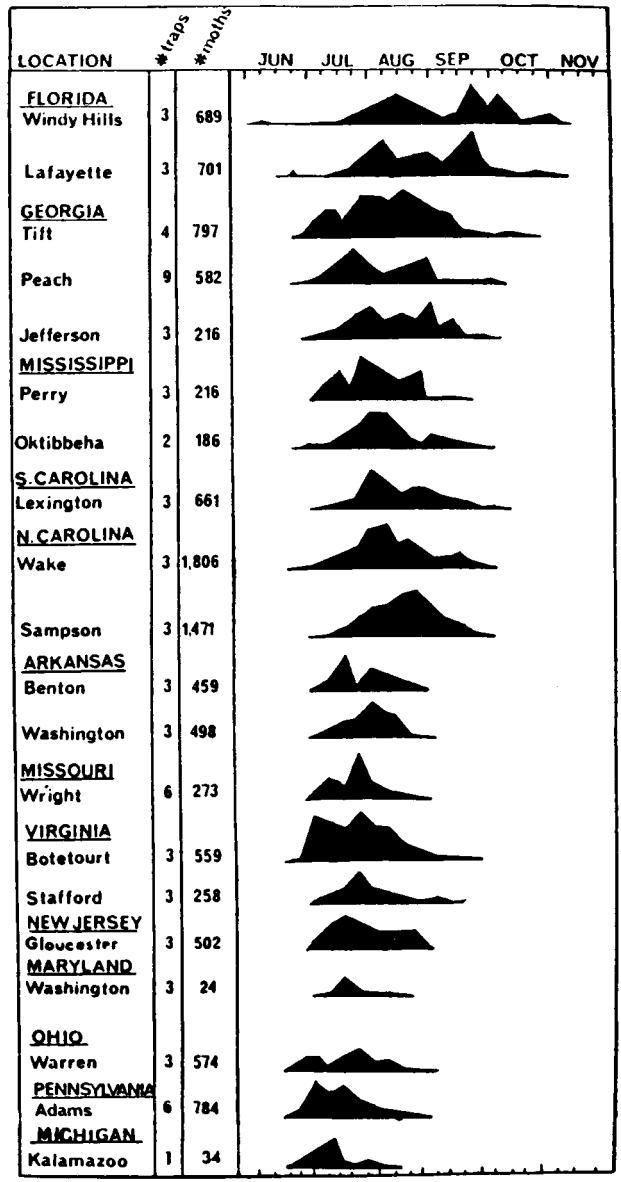

Fig. 4. Seasonal activity of grape root borer adults in the various states in 1987.

Data collected for 1987 are shown in Fig. 4. In this year, Missouri, New Jersey, Maryland, and Michigan were added to the study as well as an additional site in southern Mississippi. Trapping was discontinued in Central Florida because of the death of the researcher (Warren Adlerz). During 1987, activity again appeared to begin at all sites at ca. the same time, and no trend for earlier activity in the North was detectable. However, the extended cycle (up to 5 mo) in the South and the compressed cycle (2 mo) in the North was again noted. Cessation of activity again was related to the onset of cooler temperatures. In 1987, we noted the tendency for bimodal activity in the southern states and single peaks of activity in the northern states as more pronounced but not absolute. This year did, however, show the strong tendency for the principal activity to occur later in the season as one proceeds further south.

Again, no insects were collected in Eric Co., PA, in the extreme northwestern corner of the state. The northernmost captures in Ohio occurred in Shelby Co. in the west-central region of the state. GRB moths were collected in southwestern Michigan, but none were recorded in Central Michigan, the northernmost location in the survey.

Other Insect Captures

Other sesiid species captured during this 3-yr study are shown in Table 1. Seasonal curves and trends for these species will not be given because they are beyond the scope of this paper and most are available (for GA) in earlier papers by Snow et al. (1985) and Snow et al. (1988). The squash vine borer, *Melittia cucurbitae* (Harris), was the most widely trapped, as it was collected in all states except Missouri. In total, 611 specimens were collected during the 3 yr study. This species' pheromone is known to contain EZA as the major constituent and ZZA as the minor constituent (Klun et al. 1988). *Paranthrene simulans* (Grote), a pest of oak, was collected in all states except Maryland and Michigan; however, the species is known from those states and probably was not captured because it is active very early in the spring and trapping did not begin until later in the season. It was highly attracted to the GRB pheromone as over 1400 specimens were collected during this study. *Paranthrene asilipennis* (Boisduval), the oak clearwing borer, also attacks many species of oak and was captured in varying numbers in all states except Mississippi, South Carolina, Maryland, and Ohio. It is also known from these states and probably was not captured because of the placement of traps away from its host. Both of these species have been collected in large numbers with EZA (Snow et al. 1988). *Synanthedon acerrubri* (Engelhardt), a maple borer, was captured in nine of the 13 states. The species occurs throughout the eastern United States and is attracted to EZA (Snow et al. 1985). *Synanthedon refulgens* (Hy. Edwards) had not previously been reported in pheronome traps; the species was thought to occur only in Georgia, Alabama, and North Carolina, but in this study it was collected in all states except Virginia, Maryland, New Jersey, Pennsylvania, Ohio, and Michigan, thus, its range has been greatly expanded. Three specimens of *S. rileyana* (Hy. Edwards) were captured in Georgia in 1986. This species, which attacks horsenettle, is attracted to (E,Z)-3,13 octadecadrenyl alcohol (Snow et al. 1985). *Synanthedon scitula* (Harris), the dogwood borer, was collected in small numbers in nine states but in quite large numbers in South Carolina. That species attacks a variety of hardwoods and has been reported to cause serious damage to flowering dogwoods in Tennessee (Pless and Stanley,

Table 1. Captures of other Sesiidae species in the various states during 1985 - 1987.

Species	State*													
	FL	GA	MS	SC	NC	AR	MO	VA	MD	NJ	PA	OH	MI	Total
M. cucurbitae	6	49	27	165	243	32	0	7	16	15	3	46	2	611
P. simulans	11	311	33	256	325	79	76	77	0	133	0	145	0	1446
P. asilipennis	78	190	0	2	1	8	51	28	0	36	13	0	0	407
S. acerrubri	0	43	0	4	7	0	0	11	4	56	9	100	20	254
S. refulgens	13	11	0	1	4	2	3	0	0	0	0	0	0	34
S. rileyana	0	3	0	0	0	0	0	0	0	0	0	0	0	3
S. scitula	0	6	0	597	31	5	6	13	5	15	2	2	0	682
S. decipiens	0	2	0	1	0	0	2	0	0	88	0	0	0	91
S. dominicki	0	16	0	0	27	1	1	0	0	1	0	0	0	46
S. pyri	0	0	0	0	0	0	0	0	0	0	0	18	3	21
S. sigmoidea	0	0	0	0	0	0	0	0	0	0	0	0	1	1
S. tupuliformis	0	0	0	0	0	0	0	0	0	0	0	0	3	3

* Numbers of insects in all trapped areas of the state are combined.

1967). *Synanthedon decipiens* (Hy. Edwards), a species that attacks mainly oak, was collected in low numbers in three states and relatively high numbers in New Jersey. Both of these species are attracted to ZZA (Snow et. al. 1985). *Synanthedon pyri* (Harris), a bark borer in apple, was collected in Michigan and Ohio in 1987. This is the first report of the species in pheromone traps. The known occurrence range of *S. dominicki* (Duckworth and Eichlin) was expanded since the species was previously known only from South Carolina (Duckworth and Eichlin, 1973) and Florida (Brown et al. 1985), but in this study it was collected in Arkansas, Missouri, and New Jersey, in addition to the southeastern states of Georgia and North Carolina. One specimen of *S. sigmoidea* (Beutenmuller) a borer of willow, and three specimens of *S. tipuliformis* (Clerck), a borer of currant, were collected in Michigan in 1987.

Discussion

Because of the many people involved in this study and the deviations in methods and techniques, detailed and specific conclusions about the GRB are difficult to make. However, the data presented herein are very useful in showing the activity pattern of the species over the entire East Coast. These greatly increase our knowledge of the species and are an excellent starting point for further studies of the life cycle as well as for the timing of appropriate pest management strategies. Our data show a very systematic pattern of occurrence for the GRB from the South to the North. In general, activity begins ca. the same time in each state: somewhere around late June to early July. Adult activity continues throughout the season, until the onset of cold weather in the fall. The GRB is active for ca. 6 mo in the most southern areas trapped and for ca. 2-3 mo in the northern states. Activity is in the form of a single or bimodal peak with a tendency for bimodal peaks in the South and single peaks in the North. Whether this difference is caused by the longer growing season in the South or is the result of some other biological phenomena is unknown. A general tendency for peak activity of male flight to be later in the South and earlier in the North was evident. In general, peak activity occurred in August in the extreme South, in late July in the

central states, and ca. the first of July in the northern states. No GRB were collected at the Erie Co., PA location, a fact that suggests the area is beyond the northern limits of the species. Neither were captures recorded in the northeastern Ohio counties of Wayne, Lorain, or Ashtabula which suggests this area is also outside the northern limits of the species. No traps were operated in northwestern Ohio, but GRB were recorded from southwestern Michigan which is ca. 170 miles northwest of Shelby Co., OH. The captures in Michigan near Lake Michigan represent the northernmost collection of the species in this study. No moths were collected in Isabella Co. in the central part of the state. It thus appears that the species can be found at least as far north as Central Pennsylvania and Ohio, and along Lake Michigan in Michigan. More trapping in these areas is needed to clarify the exact northern limits of the species.

Twelve other species of clearwing moths were attracted to the 99:1 blend which indicates that this is an important pheromone common in many species of the family Sesiidae. It is sufficiently attractive to *M. cucurbitae, P. simulans* and *P. asilipennis* to serve as a useful monitoring tool.

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