PERIODIC ABUNDANCE OF PINE CONE-INFESTING LEPIDOPTERA IN BLACK LIGHT TRAPS AND SLEEVE CAGES IN NORTH FLORIDA

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ABSTRACT

The seasonal flight activity of 5 species of Lepidoptera destructive to pine cones and seeds was determined from 3 years of records of black light trapping in northeast Florida. The seasonal emergence pattern of *Dioryctria amatella* (Hulst) from galls of southern fusiform rust, *Cronartium fusiforme* Hedgc. and Hunt ex Cumm., on stems of slash pine, *Pinus elliottii* Engelm. var. *elliottii*, was also evaluated by means of sleeve cages.

The larvae of three pyralid moths, *Dioryctria abietella* (D. & S.), *Dioryctria amatella* (Hulst), and *Dioryctria clarioralis* (Walker), and two species of olethreutid moths, *Laspeyresia anaranjada* Miller and *Laspeyresia ingens* Heinrich, destroy the cones and seeds of slash pine, *Pinus elliottii* Engelm. var. *elliottii*, and longleaf pine, *Pinus palustris* Mill., in north Florida. The *Dioryctria* spp. are multivoltine, whereas the *Laspeyresia* spp. are univoltine; *L. anaranjada* requires 1 year and *L. ingens* generally requires 1 year to complete life cycles.

In addition to the cone-feeding habit of the 3 *Dioryctria* spp., larvae of *D. amatella* commonly feed in galls caused by southern fusiform rust, *Cronartium fusiforme* Hedgc. and Hunt ex Cumm., that occur on stems and branches of southern pines susceptible to the disease, notably slash pine and loblolly pine, *Pinus taeda* L.

Seasonal emergence patterns of *D. amatella* moths from rust galls on slash pine were investigated from 1964 to 1966 with sleeve cages. The periodicity of seasonal flight activity of the 5 species was studied in natural slash and longleaf pine stands and plantations from 1966 to 1968 with light traps. All studies were conducted in Baker and Columbia Counties in northeast Florida.

METHODS

Sleeve Cages.—One hundred sleeve cages, hereafter referred to as cages, constructed from wire screen and cotton cloth, were placed around rust galls on 10-yr-old slash pines which showed evidence of attack by *D. amatella*. Characteristics listed by Fatzinger and DeBarr (1969) were used to select galls containing active larvae. These cages were observed at weekly intervals for emergence of moths from the galls. After moths emerged, the cages were moved to other infested galls.

Light Traps.—Black light-blue fluorescent lamps were used in all light traps, hereafter referred to as traps. Two omnidirectional (OD) traps, similar to those described by Frost (1962), contained a 15-w lamp; 3 unidirectional (UD) traps, which projected light upwards, contained a 6-w lamp (Fig. 1). Unidirectional traps, equipped with a 4-w lamp (Barnes et al. 1965), were used at one location in 1968. The UD traps were particularly useful for catching arboreal insects.

Each trap was fitted with a jar containing 80% isopropanol for killing and preserving moths. Moths were removed from the solution by filtration

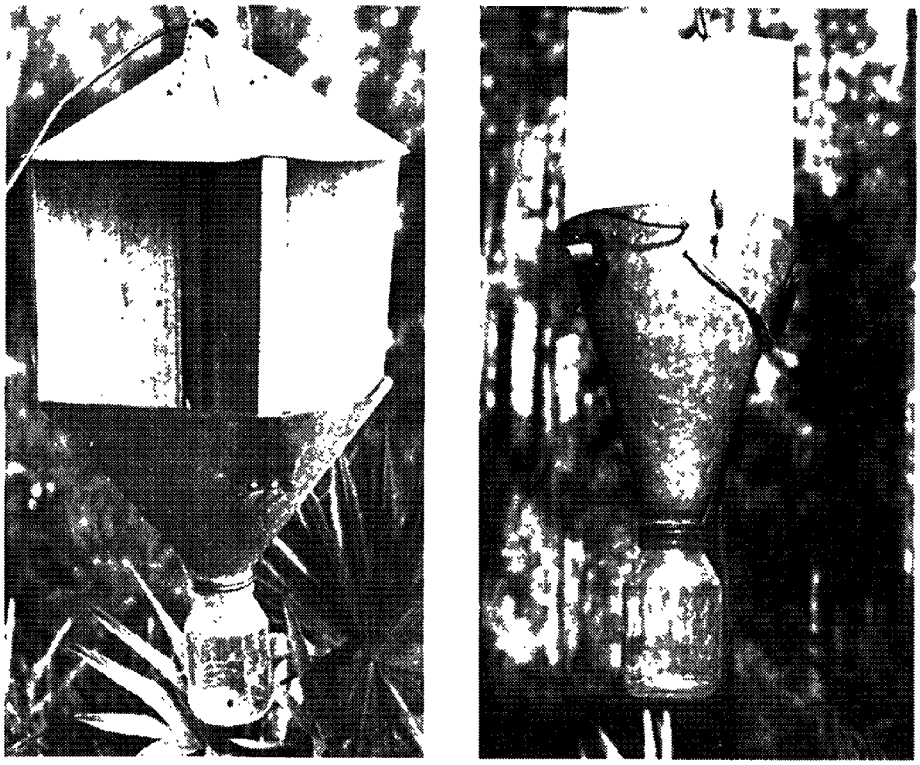

Fig. 1.—Left, omnidirectional (OD) light trap with vertically mounted, 15-w, black light-blue, fluorescent lamp; right, unidirectional (UD) light trap with horizontally mounted, 6-w lamp.

and dried at room temperature to facilitate identification of species. The traps were operated daily from 7:00 PM to 7:00 AM (E.S.T.). Collections from each trap were made daily from Monday to Thursday and catches from Friday through Sunday were combined. Because daily conditions of temperature, weather, and moonlight affect moth catches, results were summarized by weekly intervals to estimate flight activity.

During 1966 and 1967, 3 traps were operated 60 ft above ground in a 40-yr-old stand of natural longleaf pine. One UD trap (No. 3) was located at the border of this stand and a natural stand of slash pine that was 80 yrs old. A second UD trap (No. 2) was located 100 yards into the longleaf stand, and an OD trap (No. 1) was placed 200 yards into the stand. Two traps were also operated 20 ft above ground in a 9-yr-old plantation of slash pine. These traps, 1 OD (No. 4) and 1 UD (No. 5), were located 50 ft apart and about 1-1/2 miles from the traps in the longleaf pine stand. Height of traps varied between locations due to differences in tree heights.

In 1968, only 2 traps were used in the longleaf pine stand; i.e., the border UD trap (No. 3) and the OD trap (No. 1). In the slash pine plantation, four 4-w UD traps were operated 20 ft above ground in a single tree from April 24 through June 4, and only one of the 4-w traps was used at this location before and after this period.

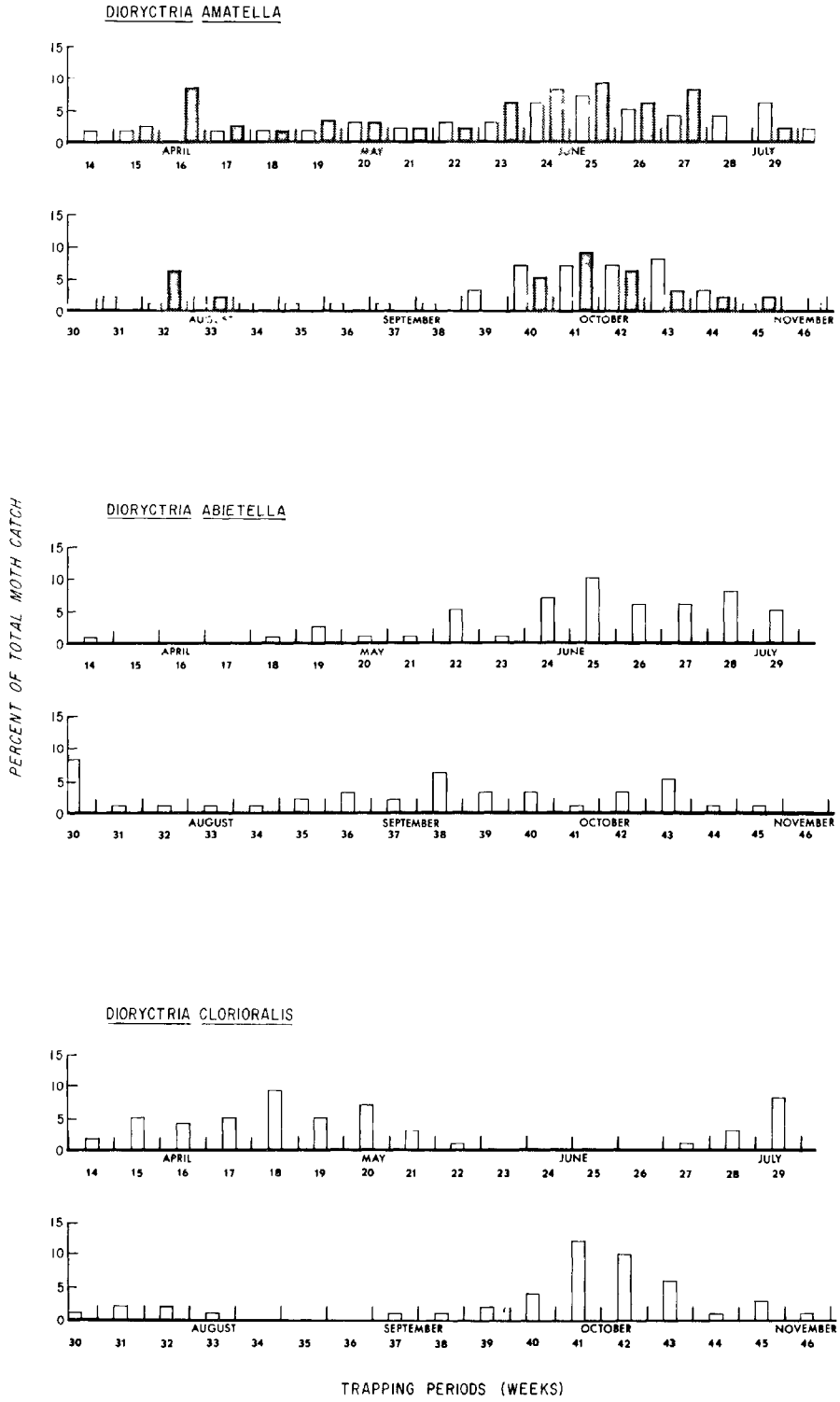

Fig. 2.—Seasonal catch of *Dioryctria* spp. moths in black light traps and emergence of *D. amatella* in sleeve cages at Olustee, Florida.

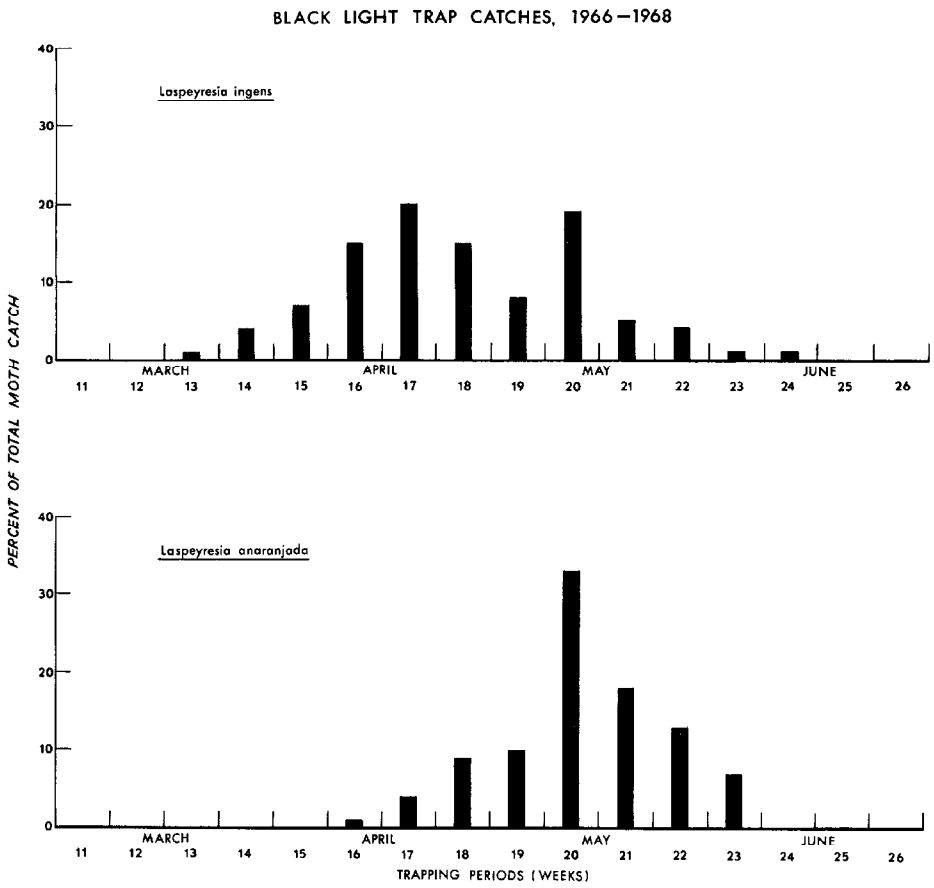

Fig. 3.—Seasonal catch of *Laspeyresia* spp. moths in black light traps at Olustee, Florida.

Results and Discussion

The numbers of *Dioryctria* spp. and *Laspeyresia* spp. caught in all traps are summarized in Table 1 and are expressed as percentages of the total 3 year catch by weekly intervals in Fig. 2 and 3. In addition, the percentage of total *D. amatella* moths emerging in cages around fusiform rust galls on slash pine are presented with the trap catches (Fig. 2).

No attempt was made to determine the number of annual generations for a given species from the trapping results. Differences in generation time of *D. abietella* were shown to result from differences in the larval diets (Fatzinger 1968), and similar nutritional differences probably occur between the various feeding niches of larvae; e.g., slash and longleaf pine cones, buds, and cankers. These differences, coupled with differences in the microenvironmental parameters within the feeding niches, undoubtedly affected the developmental rates of insects caught in the traps during this study. Thus, periodicity of adult flights for each species may have only reflected nutritionally or environmentally induced time lags in adult emergence within a given generation. However, the periodicity of moth emergence, as evidenced by the trap catches and particularly by the cage

emergence records, did support previous reports of the number of annual generations of these insects.

Dioryctria spp.—A total of 2,045 *Dioryctria* spp. moths were captured in the traps during the 3 year period. Of these, we identified 59% as *D. clarioralis* (sex ratio[1] 3.2:1), 34% as *D. amatella* (sex ratio 1.9:1), and 7% as *D. abietella* (sex ratio 1.1:1) (cf. Table 1). A preponderance of male moths in black light traps has been previously reported (Tashiro 1961).

Although *D. clarioralis* was the least abundant of the 3 species of *Dioryctria* reported to emerge from slash and longleaf pine materials collected by Ebel (1963, 1965), it was the most abundant of those caught in the traps during this study (Table 1). Three distinct moth flight periods of *D. clarioralis* occurred from April to May, July to early August, and from late September to early November (Fig. 2). Ebel (1965) reported the occurrence of *D. clarioralis* larvae on field-collected host materials from November to April, which pupated from March to April; another generation of larvae from May to June, which pupated in mid-summer; and the last generation of larvae in late summer, which pupated and emerged as adults in the fall to give rise to the larvae which overwintered. Our records of periodic abundances of *D. clarioralis* adults agree closely with Ebel's (1965) records of the occurrence of larvae and support the hypothesis of three distinct annual generations. The first-generation[2] adults emerge from July to early August, the second-generation adults emerge October to early November, and the spring-generation adults emerge from April to May.

The periodic abundance of *D. amatella* moths caught in traps and those emerging from caged fusiform rust galls corresponded closely (Fig. 2). Except for a 2-week period in August, there were few *D. amatella* moths captured in either traps or cages from late July through mid-September.

Ebel (1965) stated that *D. amatella* produced from 1 to 4 generations each year, depending on whether diapause occurred in late spring or summer. The emergence of moths from fusiform rust galls on slash pine during this study also indicated that at least four generations occur in this habitat, beginning mid-April, during June and early July, in mid-August, and in October and early November. Trap records showed that adults of *D. amatella* are present in varying numbers from early April to late October.

A few adults of *D. abietella* were captured earlier in the year (January and late March) than were the other species of *Dioryctria*, but, the largest catches occurred from late May to late July and from late August to late October (Fig. 2). Thus, the earliest peak emergence period of *D. abietella* occurred later than the earliest peak emergence periods of *D. clarioralis* and *D. amatella*. Ebel (1965) reported from 5 to 6 generations a year for *D. abietella*. Trap catches demonstrated that adults were present in the field from January to November. Assuming an average of 43 days per generation (Merkel and Fatzinger 1966, Fatzinger 1968), it would require

[1]Sex ratio = ♂ : ♀.

[2]Terminology for generations of multivoltine insects is that proposed by Schurr and Rings (1964).

TABLE 1.—TOTAL NUMBERS OF 5 PINE CONE-INFESTING MOTHS CAUGHT IN BLACK LIGHT TRAPS AT OLUSTEE, BAKER COUNTY, FLORIDA, 1966-1968

Year	*Dioryctria* spp.:			*Laspeyresia* spp.:	
	clarioralis	*amatella*	*abietella*	*anaranjada*	*ingens*
			Number		
1966	740	329	76	496	449
1967	364	236	60	462	228
1968	97	125	18	423	392
Total	1201	690	154	1381	1069

at least 5 or 6 generations a year to maintain the adults in the field that were captured in the traps.

No adults of either *D. amatella* or *D. clarioralis* were trapped in the Baker County, Florida study area from late November through March (Fig. 2). However, Frost (1964) caught adults of both species in black light traps during every month[3] from November through March in Highlands County, in the southern Florida peninsula, 230 miles south of our study area.

Laspeyresia spp.—A total of 2,450 *Laspeyresia* spp. moths were captured in the traps during the 3 year period (Table 1). These moths were identified as *L. anaranjada* (1,381 moths trapped, or 56%) and *L. ingens* (1,069 moths trapped, or 44%); the sex ratios were 2.4:1 and 2.3:1, respectively.

L. anaranjada was caught in traps from mid-April through early June (Fig. 3). This time span closely fits the period of moth emergence from mature slash pine cones reported by Merkel (1967) at Olustee, Florida, where it was found to complete its life cycle in 1 year.

Adults of *L. ingens* were captured in traps from late March to mid-June, with the most abundant catches from mid-April to mid-May (Fig. 3). This period corresponds well with the duration of moth emergence from mature longleaf pine cones near Gulfport, Mississippi, reported by Coyne (1968).

The number of moths caught were related to trap design, light intensity, and to the age-species composition of the forest stand in which traps were located. The comparison in moth catches between a 15-w OD trap and a 6-w UD trap, at the same locations for the 3 year study period, is shown in Table 2. The UD trap consistently caught more moths of each species than the OD trap for 3 consecutive years. The UD trap caught 2.6, 5.1, and 1.4 times more moths of all species, in 1966, 1967, and 1968, respectively, than the OD trap (Table 2).

Another comparison between a 15-w OD trap and a 6-w UD trap at a different location in 1966, and between the same OD trap and a 4-w UD trap in 1967, is presented in Table 3. In this case, both traps were placed

[3]Verified by personal communication with S. W. Frost, The Pennsylvania State University, Department of Entomology, University Park, Pa. 16802.

TABLE 2.—TOTAL MOTH CATCHES FOR BLACK LIGHT TRAPS No. 1 (15W-OD) AND No. 3 (6W-UD)* AT OLUSTEE, FLORIDA, 1966-1968

Species	Trap No. 1—15-w OD				Trap No. 3—6-w UD			
	1966	1967	1968	Total	1966	1967	1968	Total
				Number				
Dioryctria abietella	14	10	4	28	24	36	4	64
D. amatella	40	17	14	71	147	164	64	375
D. clarioralis	116	48	41	205	374	266	49	689
Laspeyresia anaranjada	16	15	17	48	200	107	85	392
L. ingens	169	48	195	412	183	125	170	478
Totals	355	138	271	764	928	698	372	1998

*Trap numbers 1 and 3 were 500 ft. apart and 60 ft. above ground. Trap no. 1 was completely surrounded by 40-yr.-old longleaf pines, whereas trap no. 3 was situated on the border between the longleaf pine stand and an 80-yr.-old slash pine stand.

TABLE 3.—TOTAL MOTH CATCHES FOR BLACK LIGHT TRAPS No. 4 (15W-OD) AND No. 5 (6W- & 4W-UD)* AT OLUSTEE, FLORIDA, 1966-1967

Species	1966		1967	
	15-W OD	6-W UD	15-W OD	4-W UD
		Number		
Dioryctria abietella	19	14	2	7
D. amatella	52	64	21	19
D. clarioralis	44	82	14	21
Laspeyresia anaranjada	62	210	101	230
L. ingens	26	14	21	14
Totals	203	384	159	291

*Trap numbers 4 and 5 were 50 ft. apart and 20 ft. above ground in a 9-yr.-old slash pine plantation; a 6-w lamp was used in trap no. 5 in 1966 and a 4-w lamp was used in the same trap in 1967.

20 ft above ground and only 50 ft apart. The 6-w UD trap caught 1.9 times as many moths of all species as the OD trap in 1966; and the 4-w UD trap caught 1.8 times as many moths as the OD trap in 1967.

The species composition of stands in which light traps were located had a pronounced effect on the catch of certain moth species, particularly *Laspeyresia* spp. *Laspeyresia anaranjada* infests slash pine almost exclusively, whereas *L. ingens* prefers longleaf pine, but it will infest slash pine if its preferred host is not available. One could almost determine whether slash pine or longleaf pine dominated a stand by simply inspecting the relative abundance of *L. anaranjada* and *L. ingens* at a given trap location. This is demonstrated by a comparison of the total catches of these species in the traps (Tables 2 and 3). For example, trap no. 1 (Table 2) was completely surrounded by a pure stand of mature longleaf pine and this trap caught 8.6 times more *L. ingens* than *L. anaranjada* over a 3 year period.

Trap no. 3 (Table 2), on the other hand, was located on the border between the mature longleaf stand and an overmature slash pine stand and consequently the total 3 year catch of *L. ingens* exceeded that of *L. anaranjada* by only 1.2:1. Another example of the apparent effect of stand composition on *Laspeyresia* catches is shown in Table 3. Traps 4 and 5 were situated in a pure slash pine plantation with only scattered individual longleaf pines occurring within a quarter-mile radius of these traps, and in this case, 8 times more *L. anaranjada* than *L. ingens* were caught in both traps over a 2 year period.

Light traps located within, or adjacent to, longleaf pine stands (traps 1 and 3 [Table 2]) caught 5 times more *D. clarioralis* in 1966 and 1967 than were caught during the same interval in traps 4 and 5 (Table 3), which were located in a slash pine plantation.

In general, the 6-w UD traps caught more moths of all species than the 15-w OD traps. Consequently, the UD trap would have the advantage of using less electrical current if traps had to be battery operated. In addition, we found that sorting cone-infesting moths in UD traps was much faster than in OD traps because of the lower volume of extraneous insects trapped.

Conclusions

Black light traps can be used to determine at a given location the presence or absence of the 5 species of *Dioryctria* and *Laspeyresia* captured in this study and to determine when adults of each species are active. Information on seasonal moth activity of each species should be particularly useful in the development of spray schedules for residual-type insecticides designed to control moths, eggs, or young larvae before they enter their host food.

The total number of moths of each species trapped varied between years. However, no conclusions can be drawn about possible causes in annual fluctuations in moth catches for any species because different quantities and designs of traps were used throughout the 3 year trapping period.

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