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SIRICID WOODWASPS AND THEIR ASSOCIATED PARASITOIDS IN THE SOUTHEASTERN UNITED STATES (HYMENOPTERA: SIRICIDAE)

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ABSTRACT

A survey of the Southeastern United States was made to find parasitoid species of *Sirex* species. Three siricid species, *S. abbotii* Kirby, *S. nigricornis* F., and *S. cyaneus* F., were collected and sent to Australia for nematode studies together with five parasitoid species for evaluation and eventual release in *Sirex noctilio* F. infested stands of Monterey pine *Pinus radiata* D. Don. Parasites included the ichneumonid *Rhyssa lineolata* (Kirby), the ichneumonids, *Rhyssa lineolata* (Kirby), *R. persusoria* (L.), and *R. howdenorum* Townes, and the kleptoparasite *Pseudorhyssa maculicornis* (Kreigh). The distribution and some comments on the ecology of these insects are discussed.

Key Words: Biological control, *Sirex noctilio*, ichneumonids, ibaliids, *S.E. United States*.

Since 1962, the Commonwealth Scientific and Industrial Research Organization, Division of Entomology (Australia) has been involved in the biological control of the woodwasp *Sirex noctilio* F. which was accidentally introduced into southeastern Australia in about 1947. This insect has caused great damage to the exotic Monterey pine, *Pinus radiata* D. Don in both New Zealand and Australia, and was a potential threat to extensive plantations which have been established in Australia. Insect parasitoids and nematode parasites of siricids from the Northern Hemisphere have been introduced into siricid infested areas of Australia.

Seven siricid species and six parasitoids of siricids are known to occur in the five Southeastern States of Alabama, Florida, Georgia, North Carolina, and South Carolina (Cameron 1965). One of these, *Rhyssa howdenorum* Townes, was the only known parasitoid of siricids not previously received in Australia.

In 1972, collections of siricid infested plant material were made in this area to find *R. howdenorum* and any other new parasites and nematodes for introduction into Australia.

METHODS

Dead or dying coniferous trees (logs, branches, and stumps) were examined for signs of siricid larvae or galleries. Figure 1 shows the sample collection points in the Southeastern United States where infested material was collected. The name and elevation in meters of the closest town to these collection points, as well as the name of the forested area, are listed in Table 1. Infested material was cut into 1-meter lengths and stored in numbered cages inside an unheated insectary at Athens, Georgia. Emerging adult siricids and parasitoids were collected from the cages once a day.

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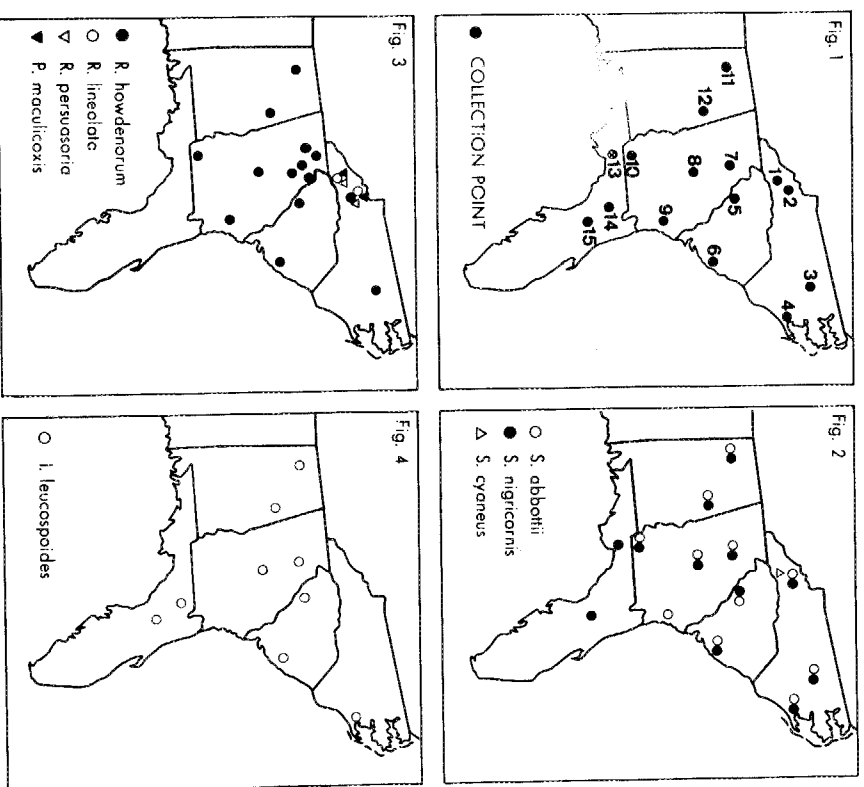


Figure 1. Sample collection points in the Southeastern United States.

Figure 2. Collection points of the three species of woodwasp reared from infested timber.

Figure 3. Collection points of the three ichneumonid parasitoids of the genus *Rhyssa* and the kleptoparasite *Pseudorhyssa maculicoxis*.Figure 4. Collection points of the ibaliid parasitoid *Ibalia leucospoides* ensiger Norton.

Flying parasitoids attracted to siricid trees were captured with a sweep net and placed in 20 cm diameter styrofoam flower pots covered with gauze and supplied with a water and honey food supply. Adult parasitoids collected from the rearing cages were placed in similar pots. These styrofoam pots were boxed and air freighted to Australia, as described by Taylor (1967). Siricid females had their ovipositors removed and all adults were dewinged before being placed in small plastic tubes for shipment with the parasitoids to Australia. Nematodes were extracted from the siricids in Australia.

Table 1. Names and elevation of towns closest to sample collection points.

Map Location	Location	Name of Forest	Elevation In Meters
NORTH CAROLINA			
1	Mt. Mitchell	Pisgah National Forest	2,037
2	Linville	Pisgah National Forest	382
3	Research Triangle Park	—	—
4	New Bern	Croatan National Forest	152
SOUTH CAROLINA			
5	Edgefield	Sumter National Forest	116
6	Moncks Corner	Francis Marion Nat'l For.	20
GEORGIA			
7	Scul Shoals	Oconee National Forest	213
8	Macon	Hitchiti Experimental For.	108
9	Jesup	International Paper Co. land	31
10	Bainbridge	International Paper Co. land	81
ALABAMA			
11	Double Springs	W.B. Bankhead Nat'l Forest	108
12	Ebenezer	Talladega National Forest	400
FLORIDA			
13	Wilma	Apalachicola National Forest	18
14	Lake City	Osceola National Forest	59
15	Silver Springs	Ocala National Forest	27

RESULTS AND DISCUSSION

Siricids were reared from eight coniferous tree species (Table 2). These were Fraser fir, *Abies fraseri* (Pursh) Poir.; sand pine, *Pinus clausa* (Chapm.) Vasey; shortleaf pine, *P. echinata* Mill.; slash pine, *P. elliotii* (Engelm.) var. *elliotii*; longleaf pine, *P. palustris* Mill.; pitch pine, *P. rigida* Mill.; loblolly pine, *P. taeda* L.; and Virginia pine, *P. virginiana* Mill. The average diameter of the Fraser fir logs (18.0 cm) was nearly three times the 6.8 cms average diameter of pine logs.

Three siricid species, *Sirex abbotii* Kirby, *S. cyaneus* F., and *S. nigricornis* F., and five parasitoid species, the ibaliid *Ibalia leucospoides*

Table 2 — Woodwasps and parasitoid rearings from stored host tree species.

Sample Location	Host Tree Log	Number Diameter cm	Height m	Parasite Species				Host Tree Species	
				<i>Rhyssa</i> <i>howdenorum</i>	<i>Rhyssa</i> <i>persuasoria</i>	<i>Pimpla</i> <i>maculicornis</i>	<i>Pimpla</i> <i>maculicornis</i>	<i>Sirex</i> <i>howdenorum</i>	<i>Sirex</i> <i>nigricornis</i>
1	Fraser fir	23	15.0	-	X	X	-	X	-
2	Pitch pine	8	5.5	X	X	X	-	X	X
3	Shortleaf pine	39	7.2	X	-	-	-	X	X
4	Loblolly pine	39	8.2	-	-	-	-	-	X
5	Pine	29	7.0	X	X	X	-	X	X
6	Loblolly pine	41	6.2	X	-	-	-	-	X
7	Loblolly pine	35	8.0	X	-	-	-	X	X
8	Loblolly pine	26	7.0	X	-	-	-	X	X
9	Slack pine	20	5.7	X	-	-	-	-	X
10	Shortleaf pine	18	5.0	X	-	-	-	X	X
11	Virginia slip	43	5.7	X	-	-	-	X	X
12	Loblolly pine	42	7.5	X	-	-	-	X	X
13	Loblolly pine	5	6.0	-	-	-	-	-	X
14	Slack pine	21	8.0	-	-	-	-	-	-
15	Slack pine	14	7.5	-	-	-	X	-	-

ensiger Norton (see Kerrich, 1973), the ichneumonids *Rhyssa howdenorum* Townes, *R. lineolata* (Kirby), *R. persuasoria* (L.), and the kleptoparasite *Pseudorhyssa maculicornis* (Kreich) (Ichneumonidae) were obtained (Table 2).

WOODWASP SPECIES

Sirex cyaneus is known to be associated with *Abies* species throughout its European and Southwestern United States range (Spradbery and Kirk unpublished; Kirk unpublished). In the Southeastern United States, *S. cyaneus* was reared only from Fraser fir. Amman (1969) also recorded this species attacking Fraser fir in North Carolina.

Sirex abbotii and *S. nigricornis* were not reared from Fraser fir and have never been recorded from *Abies* in the United States. *Sirex abbotii* has been recorded from eastern larch, *Larix laricina* (Du Roi) K. Koch, in New York and *S. nigricornis* from shortleaf pine in Georgia (Muesebeck *et al.* 1951).

The distribution of the three siricid species is shown in Figure 2.

The timber infested by *S. abbotii* and *S. nigricornis* consisted of standing dead trees of small diameter which still had red needles attached. As few other wood attacking insects were reared, it seems likely that *S. abbotii* and *S. nigricornis* were attacking small live *Pinus* trees possibly weakened by overcrowding.

PARASITOID SPECIES

Rhyssa howdenorum (Townes): This parasitoid was recorded for the first time from Alabama, Georgia, and South Carolina (Fig. 3). It was also collected from islands in Lakes Hartwell and Lanier, near Cleveland, Georgia, and on the University of Georgia campus, Athens, Georgia.

These records with those from shortleaf pine in Maryland² and from Virginia pine in Virginia and North Carolina (Townes and Townes 1960) indicate the presence of *R. howdenorum* in *Pinus* forests throughout the Piedmont and Coastal Plain of the Southeastern United States excepting Florida. *Rhyssa howdenorum* was collected from trees attacked by both *S. abbotii* and *S. nigricornis*. No collections of this parasitoid were made from *Sirex* infested Fraser fir or sand pine (Fig. 3).

Rhyssa persuasoria (Linnaeus): The only record of this ichneumonid species in the area surveyed is in the mountain areas of western North Carolina and eastern Tennessee (Townes and Townes 1960). In this study, this parasitoid was reared from infested Fraser fir and pitch pine from western North Carolina (Fig. 3). It was associated with all three species of woodwasp.

Rhyssa lineolata (Kirby): Townes and Townes (1960) record this species from the mountain region of North Carolina and one Piedmont site. While *R. lineolata* was associated with all three *Sirex* species, it was only collected from Fraser fir and pitch pine at two sample sites in western North Carolina (Fig. 3).

Pseudorhyssa maculicornis (Kreich): This kleptoparasite is associated with *R. persuasoria* and *R. lineolata* on Mt. Mitchell and with all three ichneumonids at Linville, N.C. (Fig. 3).

Ibalia leucospoides ensiger (Norton): This parasitoid was found in all the states surveyed but did not occur in the material collected from Mt. Mitchell or Linville Gorge in the mountains of western North Carolina. It was, however, the only siricid parasitoid reared from infested timber collected in Florida (Fig. 4). *Ibalia leucospoides ensiger* was collected from trees infested with both *S. abbotii* and *S. nigricornis*.

All three *Rhyssa* species were reared from pitch pine above Linville, North Carolina, a transitional point between the Mountain and Piedmont regions. *R. persuasoria* and *R. lineolata* were associated with all the siricid species found and *R. howdenorum* with two species. None of the ichneumonids are therefore restricted to one species of siricid.

R. persuasoria has been shown by Spradbery (1970) to be attracted to siricid larval hosts by a fungus-produced odor emanating from siricid larval frass. He states that there is no evidence that the tree species influences the attraction of *R. persuasoria* to a host larva or that there is pre-imaginal conditioning of the parasitoid to the fungal symbiont associated with each siricid host.

This explains why *R. persuasoria* has been recorded from a very wide range of coniferous tree species and siricid hosts (Townes and Townes, 1960). The wide tree and siricid range of *R. lineolata* in North America (Townes and Townes, 1960) suggests that it behaves in a similar way.

²Personal communication C. C. Porter 1971

R. howdenorum, however, has been recorded only from *Pinus* species. The south-eastern *Pinus* species form a closely associated group, as shown by natural hybridization between many of them (Critchfield and Little 1966). Whether *R. howdenorum* actively selects the south-eastern *Pinus* species or has evolved in association with them cannot be shown without further study.

A well established siricid parasitoid complex along with the parasitic nematodes found infesting siricid adults³ probably help maintain the siricid population and consequent damage to trees at a sub-economic level requiring little or no remedial action by the forester in the United States.

ACKNOWLEDGMENTS

I wish to thank Dr. Harry O. Yates III, Project Leader, U.S.D.A., Forest Service, Forestry Sciences Laboratory, Athens, Georgia, for the use of laboratory and insectary facilities and Mr. Rex Allen, University of Georgia, for his valuable help during and after the survey. Funds for the project were provided by the National Sirex Fund, Australia.

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Personal communication. R. A. Bedding 1973

FALL ARMYWORM:¹ NOCTURNAL ACTIVITY OF ADULT MALES AS INDEXED BY ATTRACTION TO VIRGIN FEMALES

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ABSTRACT

Hourly sampling catches of male fall armyworm moths, *Spodoptera frugiperda* (J. E. Smith), made with an electrocutor grid trap baited with virgin females during late summer 1972 showed these moths to be active during all hours of the night. Two small, distinct peak periods of activity were recorded. The largest peak occurred around midnight; another occurred ca. 3 hr later.

Key Words: *Spodoptera frugiperda*, fall armyworm, moth activity

Knowledge of the nocturnal activity of an insect species is an important consideration in any release-recovery programs and in control programs that utilize synthetic baits and released insects. Reported here are data concerning nightly activity of the male fall armyworms, *Spodoptera frugiperda* (J. E. Smith), monitored with an electrocutor grid trap baited with virgin females. The study was made during late summer 1972 at Gainesville, Fla.

MATERIALS AND METHODS

A cylindrical electric grid trap equipped with an automatic sample-changing device (Mitchell *et al.* 1972) was positioned ca. 100 m from experimental plots of field corn and baited with three 2-day-old virgin female fall armyworm moths (replaced every 2nd day). The females were obtained by rearing larvae in the laboratory on artificial diet (Burton 1969). As soon as the females emerged, they were maintained in the laboratory at ca. 26 C with a light-dark rhythm closely synchronized with prevailing field conditions. These conditions during the observation period (Aug. 24 - Sept. 25) were: average time of sunset and sunrise ca. 6:37 PM and 6:14 AM (EST).

RESULTS

Male fall armyworm moths began responding to the bait virgin females shortly after sunset and remained active until ca. 1 hr before sunrise (Fig. 1), but two small, distinct peak periods of activity were recorded. The largest (15% of the total collection of 4057 ♂♂) occurred around midnight; another (10%) occurred ca. 3 hr later.

Night temperatures in the field during the test period ranged from an average of 80.5 F to an average low of 64.8 F. As Fig. 1 shows, the lowest average temperatures were therefore above any minimum threshold temperature that may be required for pheromone production by fall armyworm females and for response of males to calling females.

¹Lepidoptera: Noctuidae.

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