THE BIOLOGY OF *PERIPLOCA* SP. (LEPIDOPTERA: COSMOPTERIGIDAE): A GALL MAKER ON *ARDISIA ESCALLONIOIDES* (MYRSINACEAE)

JOHN B. PASCARELLA
Department of Biology, University of Miami, Coral Gables, Florida 33124-0421

With 180 species from 26 genera described for North America, the cosmopterigid moths are a taxon of small moths which are primarily leaf miners in the larval stage (Hodges 1978, Borror et al. 1989). Other species are stem and root gall makers, seed and flower predators, and plant material scavengers (Hodges 1978). In this study, I describe the life-cycle of an undescribed species of *Periploca* which creates fruit galls in the tropical shrub *Ardisia escallonioides* (Myrsinaceae). Information is presented on the geographic distribution and the life-cycle of the moth, including data on oviposition, larval development, pupation, adult lifespan, and parasitoids.

The host plant, *Ardisia escallonioides* Schlechtendahl & Chamisso (Myrsinaceae) is common to dominant understory shrub in the subtropical hammocks (=forests) of south Florida (Alexander 1958, 1967, Olmsted et al. 1983, Molnar 1990). It also occurs in the Bahamas, Cuba, Hispaniola, Eastern Mexico, Belize, Guatemala, and northern Honduras, primarily in moist coastal forests on limestone (Lundell 1966). The principal habitat of *A. escallonioides* in Florida is subtropical hardwood forest on the Miami rock ridge and the Florida Keys, although small populations are found northward along the coast and in central Florida (Little 1978, Tomlinson 1980, Snyder et al. 1990).

The biology of *A. escallonioides* and *Periploca* sp. was studied in two subtropical forest sites: Deering Estate and Matheson Hammock, Dade Co., FL. Additional observations were made at Castellow Hammock and Everglades National Park (Dade Co., FL) and Ding Darling National Wildlife Preserve, Sanibel Island (Lee Co., FL). Additional data on moth distribution was based on examination of herbarium sheets of *A. escallonioides* for the distinctive fruit galls. Laboratory data on pupation, adult be-

havior and lifespan, and parasitoids was based on fruit galls collected from Deering Estate (Miami, FL) in spring of 1992. Individual larvae were reared from fruit galls in glass vials. Data on oviposition was collected in July 1992 at Deering Estate. Various stages of flower development (young buds, older buds, open flowers, 23 flowers of each type) were examined using a 10-40× microscope to determine timing of oviposition and number of eggs laid per flower. Data on gall overwintering survival was recorded from ten marked plants (8 inflorescences on each) in 1991-1992 at Deering Estate. Data on larval emergence from fruit galls was taken during surveys at Deering Estate in 1991-1992 and Matheson Hammock in 1993.

Fruit galls were noted in all field sites and have been recorded from herbarium sheets from an additional 10 counties where the host plant occurs in Florida, from four islands in the Bahamas, and from one collection from Mexico (Table 1). Most collections with fruit galls occurred in March although collections in April were also common.

TABLE 1. REPRESENTATIVE LIST OF *ARDISIA ESCALLONIOIDES* SPECIMENS WITH FRUIT GALLS PRODUCED BY *PERIPLOCA* SP. HERBARIUM ABBREVIATIONS ARE THE FOLLOWING: FTG (FAIRCHILD TROPICAL GARDEN), GA (UNIVERSITY OF GEORGIA), AND MO (MISSOURI BOTANICAL GARDEN).

Country, State	County & Location	Collector & No., Herbarium	Month Collected
USA, Florida	St. Johns-St. Augustine	Demaree 10167, MO	Jan.
USA, Florida	Volusia	Duncan 30317, GA	Oct.
USA, Florida	Brevard-Lori Wilson Park, Cocoa Beach	Poponoe 1660, FTG	Apr.
USA, Florida	Indian River-Sneeds Rd.	Tracy 6844, MO	Apr.
USA, Florida	St. Lucie-Coastal Hammock A1A	Hansen et al. 7159, FTG	May
USA, Florida	Manatee-Palmetto	Nash 2458, MO	Aug.
USA, Florida	Highlands	Wilburt & Webster 2607, GA	Aug.
USA, Florida	Palm Beach-Delray Beach	McDaniel 9175, GA	Jun.
USA, Florida	Broward	Carter et al. S.n., GA	Mar.
USA, Florida	Dade-Old Cutler Hammock	Correll et al. 47076, FTG	Apr.
USA, Florida	Monroe-Upper Key Largo	Stern 3005, FTG	Apr.
Bahamas	Grand Bahama, Freeport	Austin and Curray 4584, FTG	Mar.
Bahamas	Andros	Correll & Godfrey 41322, FTG	Jan.
Bahamas	New Providence	Correll & Correll 48277, FTG	Mar.
Bahamas	Great Abaco	Correll & Meyer 44517, FTG	Mar.
Mexico	Tamaulipas-Mun. Aldama	MO	Dec.

All stages of flower development were associated with at least a single larvae. More larvae were found in older stage flowers [young buds=30% attacked (7/23), older buds=39% attacked (9/23), open flowers=65% attacked (15/23)]. Attacked flowers were distinguishable by a brown oviposition scar on the outside of the ovary. The larvae were consistently found at the base of the central placenta where it was attached to the peduncle. The larvae first ate the ovules inside the ovary. This was followed by the development of a nutritive layer of gall tissue. Fruit galls did not contain seeds. Gall formation was independent of pollination. Both hand-pollinated and emasculated, bagged flowers produced fruit galls in a separate plant breeding system experiment (unpublished data).

Galled fruits were distinguishable from unattacked fruits by their darker green color and swollen, misshapen appearance. Fruit galls were found from 1-9 m in height on the host plant. In flowers that were attacked in July and August in all years, larvae left the fruit galls in approximately four-five wks after hatching. In all flowers that were attacked later than August (September-December), larvae overwintered inside the fruit galls until the following summer. Although unattacked fruits ripened in the spring months (February and March) and were dispersed by frugivorous birds in March and April, galled fruits remained green and did not ripen until the following summer. At Deering Estate, 3% of the overwintering fruit galls were lost from November 1991 to May 1992. At Deering Estate in 1992, 2298 moths out of 2679 (86%) left their fruit galls between June 15th and August 15th. At Matheson Hammock in 1993, a detailed census of 120 fruit galls from May to October found that relatively few moths left during May, June, and July (29% total), most left during August (62%), and the remainder left in September (9%) (Fig. 1). Larvae left the fruit galls by boring a small tunnel. Larvae likely pupate in the leaf litter and soil.

In the laboratory, moth larvae emerged from the fruit galls within 4-20 d after the removal of the galls from the plant. They consumed the entire contents of the fruit galls before leaving. The larvae are approximately 6 mm long by 1.1 mm wide. Larvae were active for 3-10 d before beginning pupation. Mean larval weight ± 1 SE was 4.2±0.03 mg (range 2.0-6.9 mg, n=21), while mean gall weight ± 1 SE was 169.0±24.0 mg (range 33.0-357.7 mg, n=21). Larval weight was not significantly correlated with fruit gall weight (r=0.07, P=0.75, n=21). Larvae pupated in a whitish cocoon. Pupation lasted 28 to 37 d (mean length=32.4±3.7 d, n=85 larvae).

Adult females are slightly larger (approximately 6 mm body length), have larger labial palps, and are more brightly marked than males. Females have black and glittery gold wing markings while males have pale, translucent wings. Adult moths in the laboratory did not feed on a nectar solution nor on fresh flowers with nectar. Length of adult life was short, with mean length of survival ± 1 SE, 3.06±0.33 d (range 1-10 d, n=36).

Less than 2% of larvae that reached pupation in the laboratory were parasitized by the encyrtid wasp, *Copidosoma* sp. Wasp pupation lasted approximately 20 d. In 14 parasitized larvae, 19-33 wasps ($\bar{x}$=26.8±4.1 wasps) emerged over a 4-7 d period ($\bar{x}$=5.1±0.8 d). The mean number of wasps/larvae was positively correlated with larval length (r=0.60, P<0.05, df=12). All wasp larvae pupated successfully (100% emergence) and no parasitoids of the encyrtids were noted.

The moth life-cycle is highly synchronized with the flowering phenology of its host plant, *Ardisia escallonioides*. *A. escallonioides* begins flowering in July, peaks in September and October, and ceases flowering by December (Pascarella, 1996). The bivoltine life-cycle permits moths to locate both early and late flowering plants. Moths that attack later flowering plants undergo diapause and do not emerge until the following summer, an adaptive response given the strong seasonal flowering of the host plant.

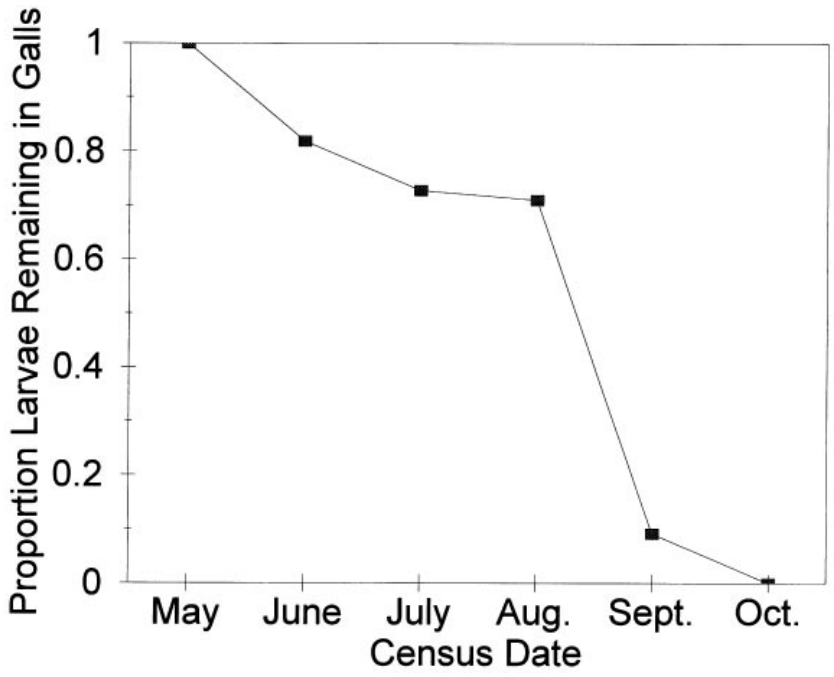

Fig. 1. Temporal pattern of larval emergence from fruit galls during summer months at Matheson Hammock, Miami, FL (1993).

Delayed fruit ripening of the fruit galls results in few galls being consumed by frugivorous birds which generally avoid green fruits (Foster, 1977).

This species of *Periploca* appears to be a specialist on *Ardisia escallonioides*. While widespread on this plant in Florida, the Bahamas, and Mexico, occurrence of the moth on *A. escallonioides* populations elsewhere is unknown due to lack of examination of herbarium specimens from these areas.

Funding for this research was provided by a University of Miami Curtis Plant Sciences grant and a University of Miami Graduate Research Support award. I was supported by a National Science Foundation Predoctoral Research Fellowship and a University of Miami Maytag Fellowship, and I wish to thank Metro-Dade County Natural Areas Management for permission to work at the Dade County Parks. Special thanks to J. B. Heppner of the University of Florida Entomology and Nematology Insect Identification Laboratory for identification of the cosmopterigid moth, and M. E. Schauff, U.S.D.A., Systematic Entomology Laboratory, Agricultural Research Service for identification of the encyrtid wasp. This is contribution number 516 from the University of Miami Program in Tropical Biology, Ecology, and Evolution.

SUMMARY

An undescribed species of cosmopterigid moth, *Periploca* sp., is a specialized gall-maker on the tropical shrub, *Ardisia escallonioides* (Myrsinaceae), in Florida. Eggs are laid in flowers where a single larva induces a gall. The life-cycle is bivoltine with

a summer generation and an overwintering generation. The overwintering larvae leave the galls the following summer, primarily in August. Pupation takes 28 to 37 d. Adults live 2-5 d in the laboratory. Of larvae reared in the laboratory, 1.8% were parasitized by the encyrtid wasp, *Copidosoma* sp., which was polyembryonic with an average of 27 wasps per infested larva.

REFERENCES CITED

ALEXANDER, T. R. 1958. High hammock vegetation of the southern Florida mainland. Quarterly Journal Florida Academy of Sciences 21: 293-298.

ALEXANDER, T. R. 1967. A tropical hammock in the Miami (Florida) limestone: a twenty-five year study. Ecology 48: 863-867.

BORROR, D. J., C. A. TRIPLEHORN, AND N. F. JOHNSON. 1989. An Introduction to the Study of Insects. Saunders College Publishing, Ft. Worth, TX.

FOSTER, M. S. 1977. Ecological and nutritional effects of fruit scarcity on a tropical frugivorous bird and its fruit source. Ecology 58: 73-85.

HODGES, R. W. 1978. The Moths of America North of Mexico including Greenland. Fascicle 6.1 Gelechioidea Cosmopterigidae. E. W. Classey Limited and the Wedge Entomological Research Foundation, London, UK.

LITTLE, E. L., JR. 1978. Atlas of United States Trees. Vol. 5: Florida. U.S. Forest Service Miscellaneous Publication Number 1361. U.S. Government Printing Office, Washington, D.C.

LUNDELL, C. L. 1966. Myrsinaceae, pp. 137-199 *in* P. C. Standley and L. O. Williams, [eds]. Flora of Guatemala. Fieldiana:Botany 24: No.1 and 2. Chicago Natural History Museum, Chicago, IL.

MOLNAR, G. 1990. Successional dynamics of a tropical hardwood hammock on the Miami rockridge. M.Sc. dissertation, Florida International University, Miami, FL.

OLMSTED, I. C., W. B. ROBERTSON, JR., J. JOHNSON, AND O. L. BASS, JR. 1983. The vegetation of Long Pine Key, Everglades National Park. Everglades National Park South Florida Research Center Report Number SFRC-83/05.

PASCARELLA, J. B. 1995. The effects of Hurricane Andrew on the population dynamics and the mating system of the tropical understory shrub *Ardisia escallonioides* (Myrsinaceae). Ph.D. dissertation. University of Miami, Coral Gables, FL.

PASCARELLA, J. B. 1996. Pollination ecology of *Ardisia escallonioides* (Myrsinaceae). Castanea, in press.

SNYDER, J. R., A. HERNDON, AND W. B. ROBERTSON, JR. 1990. South Florida rockland, pp. 230-274 *in* R. L. Myers and J. J. Ewel, [eds]. Ecosystems of Florida. University of Central Florida Press, Orlando, FL.

TOMLINSON, P. B. 1980. The biology of trees native to tropical Florida. Published by the author. Petersham, MA.