Cicada Populations on Palms in Tropical Rain Forest

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The purpose of this note is to call attention to some apparent interactions between several species of cicadas (Homoptera: Cicadidae) and palms (Palmae) in Costa Rican lowland tropical rain forest. Despite the fact that palms collectively comprise a major component of the understory of primary growth tropical wet forests (Standley, 1937; Allen, 1956; Holdridge *et al.*, 1971), little has been done regarding their ecological interactions with insects, with the notable exceptions of pollination systems (e.g., Corner, 1966; Essig, 1971; Schmid, 1970), and seed predation (Janzen, 1971).

Since very little is known about the biology of neotropical cicadas and since ecological studies of these insects have only begun (Young, 1972), this paper concerns primarily the use of various palm species as emergence sites for several cicada species inhabiting the same forest. As more information is gathered on the biology of these insects in the tropics, attention may turn to more detailed study of plant-cicada relationships, particularly with respect to the host plant specificity of the subterraneous nymphs in selected species.

Cicadas are hemimetabolic insects, possessing a nymphal period (of several instars) that is subterraneous, and which is terminated by the mature nymph digging its way out of the soil for eclosion of the winged adult. The nymphs, while subterraneous, feed on plant juices through roots and rhizoids. This paper emphasizes the importance of palm species as sites for the final molt of adult cicadas in the understory of tropical wet forests, and related ecdysis aspects of cicada natural history as influenced by palms.

Habitat and Procedures

The observations discussed in this paper were made during a sampling study of the temporal and spatial emergence patterns in several sympatric species of cicadas in plots of lowland tropical wet forest at a single locality in northeastern Costa Rica (Young, 1972). This locality is Finca la Selva ("La Selva"), a research field station of the Organization for Tropical Studies, Inc., and situated near the confluence of the Río Sarapiquí and the Río Puerto Viejo, near Puerto Viejo (Herédia Province) in the Caribbean lowlands (90–100 m. elev.) of Costa Rica. A full account of the ecological properties of the cicada populations studied is summarized elsewhere (Young, 1972), in addition to sampling techniques, location of study plots, etc. It suffices to say here that one major study plot was located in primary-growth forest understory. Nymphal skins of any cicada species were then collected from all understory plants within the plots, with records kept for each species of dicot and monocot from which skins were taken. The sampling period extended over a two-year period (1968–1970) with samples made several times (days) each month. Notes were made on the


METRIC
A
B
C

2. (A) *Asterogyne martiana* (foreground) and *Geonoma* sp. (background) in the La Selva understory. (B) several nymphal skins of *F. sericans* on the undersides of *Asterogyne martiana* leaves.

density and distribution of nymphal skins on each individual understory plant.

Results of Survey

This study revealed that four species of cicadas were regularly found on various species of palms: *Fidicina mannifera, F. sericans, Zammara smaragdula,* and *Proarna sallei* (Fig. 1-A). Nymphal skins of these species were found on palms and various dicots in the lower understory (Fig. 1-B) of the forest, and in most instances, individual nymphs were seen clinging to the ventral surfaces of leaves (Fig. 1-C).

By far the most abundant species of cicada emerging in the understory was *F. sericans,* and local populations of this cicada were most evident on the palms

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1. (A) four species of cicadas which undergo adult eclosion on palms in the La Selva forest, from left to right: *Fidicina mannifera, F. sericans, Zammara smaragdula,* and *Proarna sallei.* (B) the understory structure of the La Selva forest, illustrating the abundance of palms (*Asterogyne martiana*—foreground; *Bactris* sp.—upper right background). (C) living nymph of *F. sericans* climbing along the underside of a leaf of *Asterogyne martiana.*

3. Palms in the understory of the La Selva forest. (A) *Geonoma* sp. and *Asterogyne martiana* growing side by side (B) *Geonoma* sp., *Socratea durissima*, and *Asterogyne martiana* in the understory.

Table 1. Relative numerical abundance of cicada species eclosing on various palms in the forest understory at Finca la Selva in Costa Rica.

Palm	Number of cicada nymphal skins				
	Fidicina mannifera	*Fidicina sericans*	*Zammara smaragdula*	*Proarna sallei*	Total
Geonoma spp.	642	1,252	218	57	2,169
Asterogyne martiana	315	842	105	32	1,294
Bactris sp.	261	103	16	52	432
Iriartea gigantea	47	83	34	10	174
Socratea durissima	163	100	12	0	275

Geonoma spp. and *Asterogyne martiana* (Fig. 2-A). It was not uncommon to find several nymphal skins on each leaf of these palms (Fig. 2-B) suggesting high local population density of the cicada associated with the palms. Other species of palms bearing nymphal skins of cicadas were predominantly *Geonoma* spp., *Iriartea gigantea*, and *Socratea durissima* (Fig. 3).

Table 1 gives the relative abundance of cicada species on the palms. The most striking result of this survey is that all cicadas appear to be associated with all the palms, but that *F. sericans* shows the greatest numbers on palms. For the entire sample of nymphal skins of this cicada, more than 70% of the skins were found on palms, with about 25% on dicots and 5% on the ground. In the same habitat, the majority (55–95%) of nymphal skins in the other species were found on dicots. And with the exception of *Geonoma* sp. which is cespitose, dicots were well interspersed with the palm species in the understory; however, all palm species made up about 64% of all understory plants less than 4 meters tall in the plot of understory sampled.

Discussion

Since palms comprise a major component of the understory flora at La Selva (Fig. 1–3), and since several species of cicadas (Fig. 1) undergo ecdysis on them (Table 1), it is interesting to discuss these observations in terms of how palms may function in the biology of cicadas.

There are four major ways in which palms may affect the biology of neotropical cicadas: (1) provision of suitable oviposition sites, (2) provision of suitable sites for ecdysis, away from the ground and litter, (3) provision of host plants for nymphs, and (4) perhaps providing sites of concentration of resting spores of various fungi pathogenic to cicada nymphs and adults.

Young (1972) found that female *F. sericans* lays eggs in the stems of dead palm leaves (mostly *Geonoma* sp.) still attached to the plants. No other egg-laying sites for this cicada have been found in the understory at La Selva. It is not determined if other cicadas lay eggs in palms.

In northern forests, cicadas commonly undergo the final molt on the ground and on the trunks of very large (canopy-size) trees (Marlatt, 1907; Lloyd and Dybas, 1966). At La Selva and other localities in Costa Rica, nymphal skins are seldom found on the ground or on tree trunks. Predation rates on nymphs after leaving their subterraneous burrows might be high on the ground and tree trunks in tropical forests. The litter of tropical forests can support a high diversity of amphibians and reptiles (Lloyd, Inger, and King, 1968), many of which may be predators on insects such as cicadas. Under such conditions, palms and other understory plants might provide sites for the final molt in which the likelihood for predatory attack is diminished. By undergoing ecdysis on palms and other understory plants, cicadas may "escape" from predation on the ground and on large tree trunks in tropical forests. Thus the forest understory as a whole provides a micro-environment where cicada nymphs face less chance of being found and eaten. Depending on the forest in question, palms might provide the largest portion of this micro-environment (such as at La Selva, Table 1).

By far the most interesting question resulting from these observations concerns the possibility that the root or rhizome systems of palms provide suitable feeding sites for nymphs before their final molt. While no data are available yet on this question, the observed abundance of nymphal skins of *F. sericans* on *Geonoma* sp. is suggestive of such a feeding relationship. Until digging studies are conducted and directed towards this question, nothing conclusive can be stated, especially since many canopy-size tropical tree species have extensive horizontal root systems. But the possibility of such an interaction between cicadas and palms is an intriguing one, and studies are now being planned to examine host plant specificity in situ for selected cicada species in various regions of Costa Rica.

Young, Tyrrell, and MacLeod (1972) have noted high incidence of pathogenic attack on the cicada *Procollinia biolleyi* by the fungus *Entomophthora echinospora* in a montane tropical forest locality in which palms are very abundant. It is known that various fungal species of *Massospora* (which also attacks cicadas) and *Entomophthora* have resting spores which lay on plant surfaces (D. M. MacLeod, pers. comm.). The possibility that palms provide a site for the transmission of pathogenic attack, either in the soil via the roots to nymphs or on aerial portions for contact with nymphs undergoing ecdysis, also merits investigation.

Summary

Several sympatric species of neotropical cicadas undergo the final molt on various palm species in the understory of lowland tropical wet forest in northeastern Costa Rica. Of the various cicadas observed, *Fidicina sericans* is the most common cicada on the most abundant palm, *Geonoma* sp. This cicada also lays its eggs in the dead leaves of *Geonoma* sp. The possible interactions between cicadas and palms in tropical forests are best seen by considering palms as a micro-environment for cicadas, providing these insects with (1) oviposition sites, (2) predator-free sites for the final molt, (3) possible host plants for feeding nymphs, and (4) possible sites for the mobilization of resting spores of fungi pathogenic to cicadas. The extent of species-specificity in such interactions is undetermined.

Acknowledgements

This is a contribution from N.S.F. Grant GB-7805, Dr. Daniel H. Janzen, principal investigator, and the Organization for Tropical Studies, Inc., in Costa

Rica. Dr. L. R. Holdridge (Tropical Science Center—San Jose, Costa Rica) acquainted the author with La Selva palms during a course, "Tropical Dendrology," in October 1968. Dr. Thomas E. Moore (University of Michigan) identified the cicadas.

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How many people have been clobbered by falling coconuts? Is it rare, or do people get bopped on the noggin by nuts all the time?—C. M.

It's so rare it's almost unrecorded. Dick Reeves of the Miami Beach Parks Department says the last case he recalls happened in 1968 when a local citizen got clonked by a privately owned tree. City of Miami officials told us they couldn't remember anyone complaining of direct hits recently and Art Peavy, Jr. of the Dade County Parks Department told us trees in heavy use areas are kept well trimmed to avoid unpleasant incidents. Local legend says coconuts fall only on tourists, but that's not completely true. We discovered a total of four Dade Countians throughout the years who'd been underneath a coconut when the nut decided to drop. One sported a beautiful shiner for days.

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Over 1,200 South Florida coconut palms have died since the lethal yellow blight made its first appearance in Miami in October. This same disease destroyed over 15,000 coconut palms in Key West and turned many lush Jamaican coconut plantations into graveyards. The disease has been around for 50 years and still baffles plant scientists. Picture Miami or Key Biscayne with nothing but hundreds of thousands of dead trees. The cure for lethal yellow blight can't be too elusive. All we need is the money for immediate research and action.—PAUL A. DRUMMOND, The Palm Society.

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