Acta Científica 2 (1): 40-44, 1988

TROPICAL CYCLONES EFFECTS ON INSECT COLONIZATION AND ABUNDANCE IN PUERTO RICO

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INTRODUCTION

The knowledge of the ways in which insects disperse is important in decisions concerning their control. The dispersal of insects aided by the wind cannot be regarded as accidental and occasional but as an adaptive feature of the phylum (Johnson and Bowden 1973). Due to its location, Puerto Rico is exposed to cyclone winds that can affect the colonization and abundance of insects.

In this work I present an overview of tropical cyclones on insect dispersal, the recorded arrival of insects during cyclone events, and the effects of tropical cyclones on insect abundance in Puerto Rico.

TROPICAL CYCLONES AND INSECT DISPERSION

A map showing the paths of tropical cyclones in the Caribbean will consist of a series of lines covering most of the Caribbean basin precluding the observation of any land mass. On average 10 cyclones (six hurricanes and four storms) occur per year in the Caribbean basin (National Weather Service 1988). Fassig (1929) estimated that about 50 cyclones have passed directly over Puerto Rico in 450 years (on the average 1 cyclone hits Puerto Rico every 9 years).

One of the reasons proposed to explain the low number of insect species in Puerto Rico compared with other Greater Antilles islands is the location of Puerto Rico to the east of the Greater Antilles and that prevailing trade winds blow in a northeast direction and the path of Caribbean tropical cyclones follows and east-west direction (Osborn 1932, 1935). Part of this explanation is the fact that the American continents are closer to Puerto Rico than Africa and there are almost no land masses between Puerto Rico and Africa.

Nonetheless, this explanation does not take into account that tropical cyclones also originate in the Gulf of México (Fig. 1) and many times follow a west to east direction (Fig. 2). Also, some cyclones take erratic paths and make odd turns that catch weather forecasters by surprise (Ahrens 1982). In addition, the patterns of wind circulation in a tropical cyclone are very complex and can send migrants in a westerly direction even if the cyclone is moving in an east to west direction (Darlington 1938, Ahrens 1982). The different directions taken by the winds can be seen in the study by Wadsworth and Englerth (1959) dealing with the damage to Puerto Rican forests by the tropical storm Santa Clara. Damage to forests north of Santa Clara path was due mostly to easterly winds. At El Yunque defoliation was mainly in east-facing slopes and west-facing slopes were entirely unaffected. At Guajataca (south of the path) northwest winds damaged the north and west facing slopes, leaving those facing south intact.

The distance between the land masses in the Caribbean are many times smaller than the diameter of tropical cyclones that can reach as much as 805 km (Griffiths and Driscoll 1982). In large hurricanes strong winds may occur as far as 402 km from the center, blowing across a gap of 161 km or more with little curvature in less than two hours (Darlington 1938). Under these circumstances small organisms, like insects with a great surface to volume ratio, can easily be transported among the Caribbean land masses.

CYCLONES AND INSECT ARRIVALS

The first record of insect arrival corresponds to the wasp, *Polistes major,* in Puerto Rico and Mona after the passage of the San Felipe hurricane in 1928 (Martorell 1945, Wolcott 1948). The wasps presumably came from one of the islands to the east of Puerto Rico where they were reported (Martorell 1945). Wolcott (1948) reported the wasp ocurring in all parts of Puerto Rico. Today *Polistes major* is rare in Puerto Rico. The cause of its decline is unknown. Similarly, Ballou (1943) reported the local disappearance of some *Polistes* in the Lesser Antilles.

Wolcott (1955) suggested that the arrival of the aphid *Aphis spiraecola* to Puerto Rico was related to the passage of tropical storms near Puerto Rico. This aphid was collected on October 23, 1926, on grapefruits at Mayagüez. Previous to 1924 it was reported only from the United States of America. In 1924 the aphid was found attacking citrus in Cuba and by 1928 it was found in Honduras and Costa Rica. J.R. Watson, Entomologist of the Florida Agricultural Experiment Station, (quoted by Wolcott 1955) stated that in Florida this aphid is spread by flight, not by autos or nursery stocks. Wolcott (1952) also suggested the possibility that the aphid *Myzus persicae* arrived by migration from United States, Cuba, or Hispañiola. The aphid was found attacking tobacco plants in Puerto Rico by 1950. However, in this case winds from the nortwest possibly originating in the tobacco-

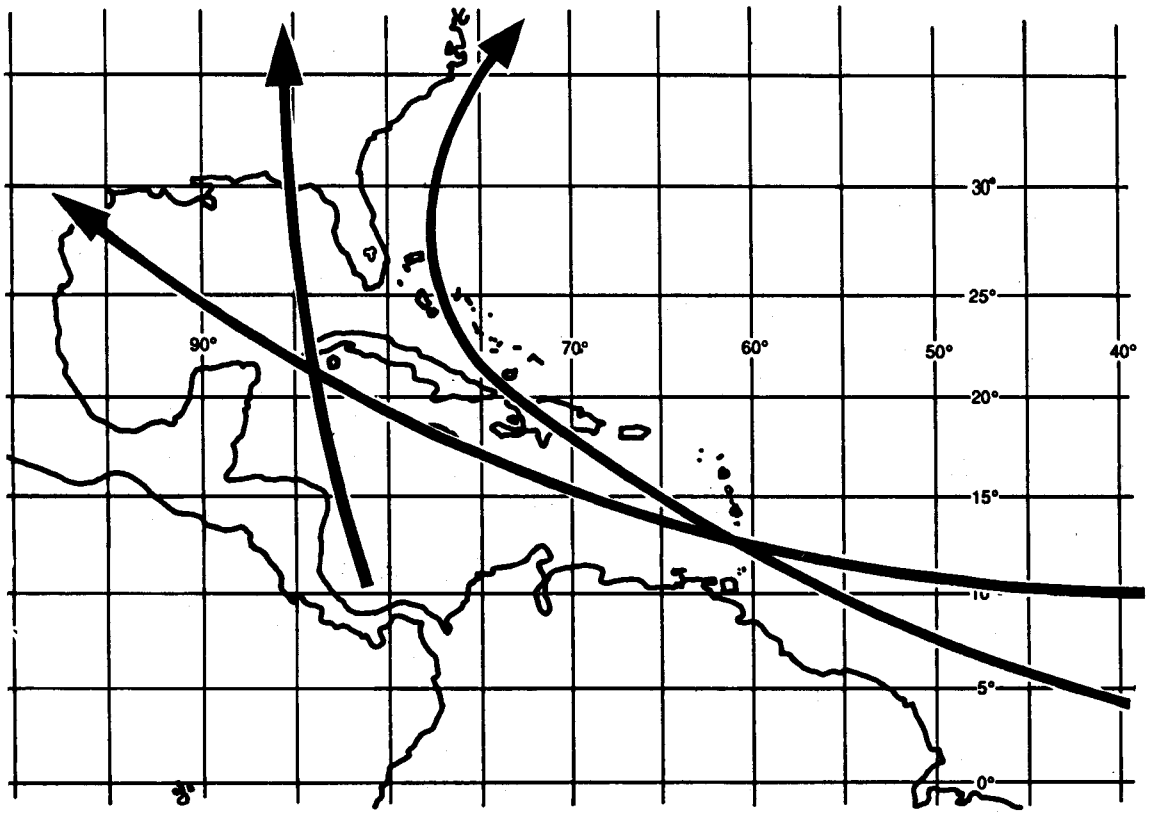

Fig 1. Typical paths of tropical cyclones in the Caribbean basin.

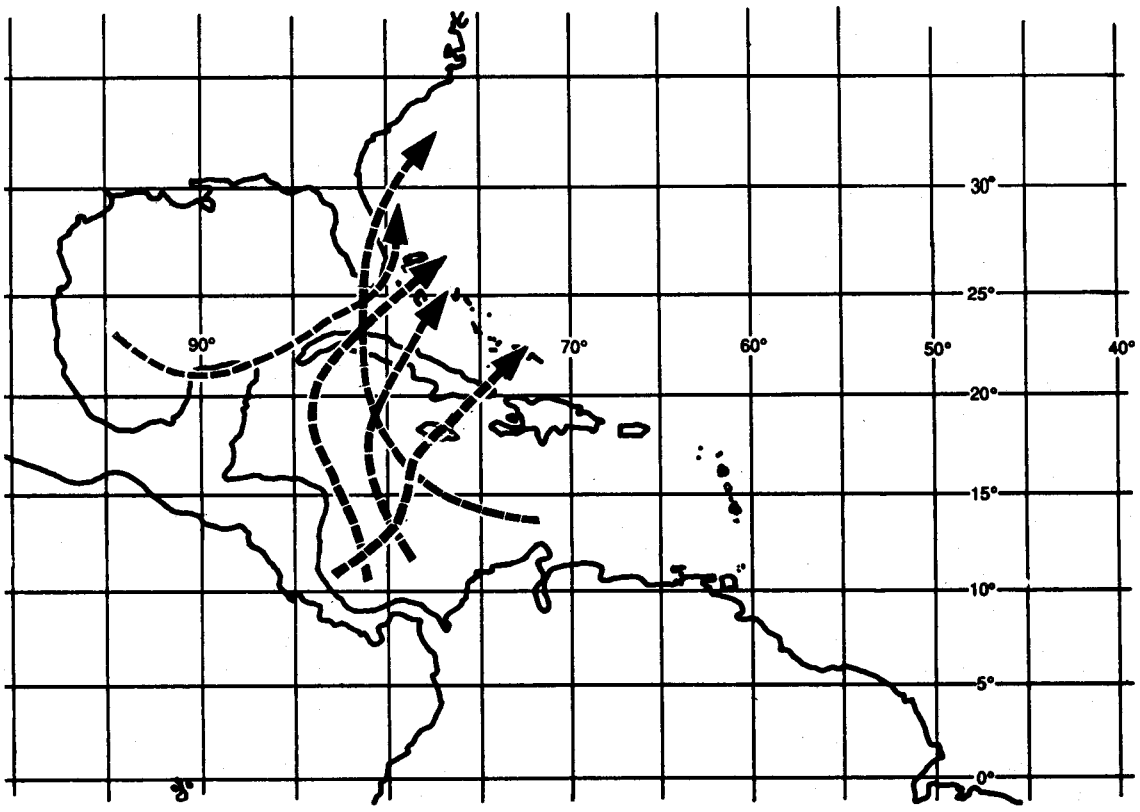

Fig. 2. Tracks of some of the cyclones that originate in the Gulf of México. Adapted from Darlington (1938).

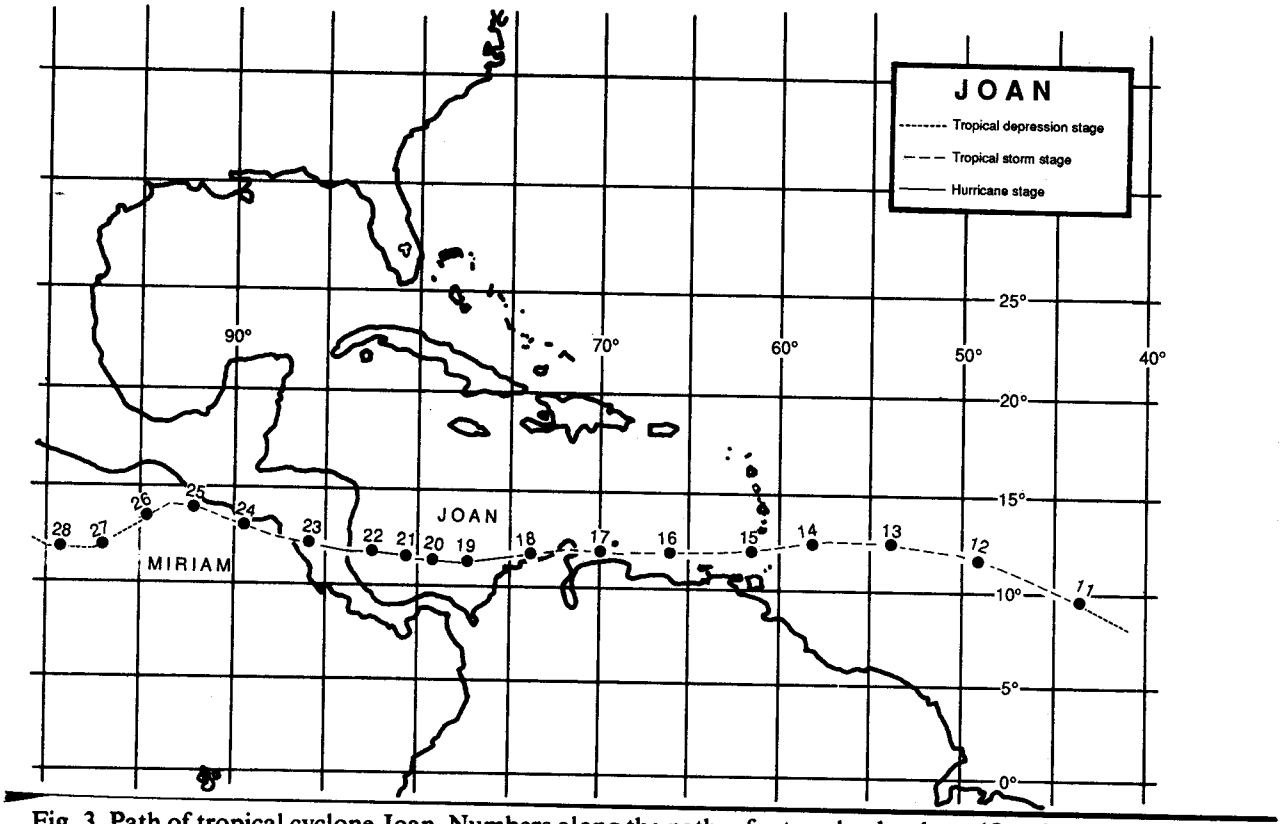

Fig. 3. Path of tropical cyclone Joan. Numbers along the path refer to calendar dates (October, 1988). Source: National Hurricane Center, U.S. Department of Commerce.

growing areas of the United States or more probably anti-trade winds of local origin may have carried the aphids to Puerto Rico.

On October of 1988 Puerto Ricans were surprised by the arrival of thousands of individuals belonging to the locust *Schistocerca gregaria* after the passage of tropical storm Joan south of Puerto Rico. Tropical storm Joan originated on October 11 and dissipated on October 22 of 1988. It passed close to Puerto Rico from October 15-17 (Fig. 3). The locusts were reported along a distance of 1,900 km from Puerto Rico to Surinam (Simpson 1988). They were reported on the islands of St. Vincent, Barbados, St. Lucia, St. Kitts, Dominica, and Martinique (Simpson 1988, De León 1988, U.S.F.S. 1988). Three important points emerge from this case:

(1) Tropical storms can be a force in the homogeneousness of insect biota. The arrival of *S. gregaria* to many Caribbean islands at the same time contradicts the position of Barbour (1916) concerning the biogeography of the West Indies: "This homogeneity of the fauna is the best possible proof that winds (tornados, hurricanes, etc.), birds, small floating drift, etc., have played no considerable part in populating the islands by carrying eggs or adult, since it is inconceivable that by these means the same improbable choice of passengers would be carried to so many islands". Homogeneity of the fauna in a given region could be explained by factors other than the existence of land bridges (Barbour 1916) as this massive arrival of locusts has indicated.

(2) If the taxonomic distinction between *Schistocerca gregaria and Shistocerca paranensis* remains valid (Johnson and Bowden 1973), then this is the first time that *S. gregaria* is reported crossing the Atlantic Ocean.

(3) It seems that *S. gregaria* did not become established in Puerto Rico. Most of the individuals died in about a week upon arrival. The majority were so exhausted that lay persons collected hundreds of them by hand. One factor that contributes against the establishmet of *S. gregaria* is that the species mates only at the end of the migration (Johnson and Bowden 1973) and the organisms were exhausted by this time.

TROPICAL CYCLONES AND INSECT ABUNDANCE

The information on the effects of tropical cyclones on insect abundance is mostly from the San Felipe hurricane of September 13, 1928. Osborn (1935) collected homopterans in 1929 finding severe reduction on their abundance. He even postulated the possible extinction of rare species by the recurrent devastating hurricanes that affect the island. The soft green scale, *Coccus viridis,* first reported in Puerto Rico in 1925 became highly destructive in the coffee areas denuded of shade by San Felipe in 1928 (Wolcott 1933, Smith 1942). The scale abundance depends on humidity; its numbers are greatly reduced by entomogenous fungi which

thrive during wet weather. The populations of the ant, *Myrmelachista ramulorum* (*la hormiguilla*), were reduced after the passage of San Felipe in coffee groves. This arboreal ant nested mostly in old guaba (*Inga vera*) and guamá (*Inga laurina*) that were brought down by the hurricane (Wolcott 1933). For a period of 29 years (1899-1928) Puerto Rico was not affected by a seriously destructive hurricane, and infested shade trees were so large that they could not be eliminated without damaging the coffee trees underneath (Wolcott 1933).

Williams et al. (1942) reported a flight of monarch butterflies in San Juan fying against the north-east trade winds about a month after San Felipe. The flight lasted for about a week. The relation between the hurricane and this flight are unknown.

The San Ciprían hurricane (September 26-27, 1932) destroyed most of the cottony cushion scale (*Icerya purchasi*) except in areas protected by high buildings (Wolcott, 1941). The scale was first reported in Puerto Rico in October 1931 and was attacking the Australian pine, *Casuarina equisetifolia.* In adition, San Ciprían eliminated the pink bollworm (a pest of cotton) from some areas in the north coast when it destroyed the fruiting portions of the maga trees. Maga was the most important alternate host of the pink bollworm in the north coast (Wolcott 1941).

DISPERSION OF SOCIAL INSECTS

The recent invasion of some ant species like the fungus grower ant, *Trachymyrmex jamaicensis* (1982, J. Torres personal observation) into Puerto Rico could be associated with weather disturbances. *Trachymyrmex jamaicensis* was reported in Mona (Ramos 1946) and Vieques (Smith 1936). Ants like termites have nuptial flights that are correlated with rainy events (Wilson 1971, Brian 1978). The fact that a mating event coincides with strong winds could facilite the establishment of an inseminated queen over long distances.

The common paper wasp, *Polistes americanus,* does not nest in the interior of the highland rain forests of Puerto Rico. Nonetheless, this wasp was observed on El Yunque rock on April 5, 1939 (Wolcott 1948), so abundant that one could not approach in safety. Wolcott (1948) suggested "that air currents had carried these wasps up the mountain against their will, and continue to keep and concentrate them there despite their efforts to fly away." This event shows the strong influence that weather events can have on insect dispersal.

CONCLUSIONS

There are very few documented examples of the arrival of insects to Puerto Rico through the action of tropical cyclones. I think that one of the reasons for this scarcety of records is the simplified paradigm of the movements of winds during a tropical cyclone. Many scientists and laypersons have the impression that cyclones in the Caribbean move only in an east to west direction and cyclone winds blow also in that direction.

It seems that there is a bias in the report of the effects of hurricanes on insect dispersal. This is due to the fact that many times scientists become aware of new insect arrivals through public enquires. The public is impressed by the presence of large insects, and stinging or biting ones, while ignoring insects that do not met these criteria.

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ERRATA

El artículo de Pedro Gelabert, Acta 1(2-3): 84-91, requiere las siguientes correcciones:

Página	Párrafo	Línea	Error	Corrección
84	3	7	mayoría	mejoría
84	4	8	(falta línea)	industrial, inició en Inglaterra
				en el Siglo XVIII con la
84	4	6	(falta "y")	carbón y del vapor
84	5	5	forma	fama
85	1	15	(Figura 1)	ver Figura 1
86	1	1	crecimiento cero	(eliminar línea)
			en el consumo global	
			de los países	
87	2	11	(falta línea)	lanza al ser humano a un alto nivel
				de vida dividiendo a los habitantes
90	2	5	pero	peso
91	1	5	(falta línea)	ricos y los pobres seguirá ampliándose.
				Actualmente, los países
91	1	6	(falta coma)	mundo, el 80%
91	2	4	falta después	importados
			de barratos	
91	8	12	combatiendo	compartiendo
90	4	4	efluente	afluente

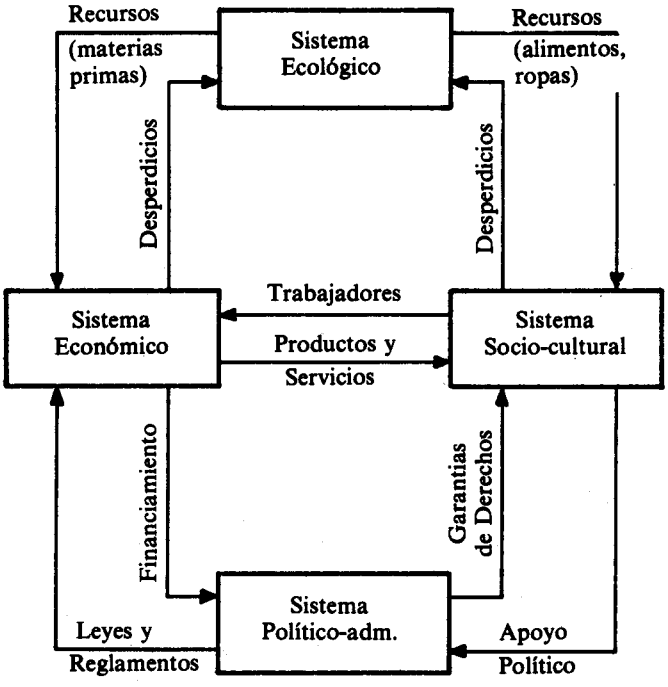

Figura 1. Modelo integral de una sociedad occidental.