THE MONARCH BUTTERFLY IN THE GALÁPAGOS ISLANDS: IS IT A NATIVE OR AN INTRODUCED SPECIES?

By: Lázaro Roque

> When I returned to the water party I saw two monarch butterflies flying slowly about, and we stopped work for a moment, but lacking a net, found it impossible to capture them. There was not the remotest chance of being mistaken in the species, and therefore *Danais* (sic) *plexippus* (or *Danais archippus* as I knew it when a boy) is definitely added to the fauna of the Galápagos Archipelago. On several islands I had seen a milkweed in blossom, so this wide-ranging butterfly should have no difficulty in establishing itself.
>
> William Beebe, 1924, *Galapagos: World's End*

One of the favorite topics in the study of insular biology is the analysis or speculation about the arrival and establishment of a species on oceanic islands. The Galápagos Islands, located 1000 km off the coast of Ecuador, are a singular place for such biogeographic and evolutionary studies. Determining if species of insects were introduced by humans or if they have naturally colonized the islands is not always an easy matter. For the monarch butterfly (*Danaus plexippus*), the answer to that question remains uncertain.

Hickin (1979) mentioned that it may have been introduced to San Cristóbal Island as a result of the frequent visits of commercial ships to the island. However, Peck (1991) wrote that the only mechanism for butterflies to arrive at the Galápagos Islands was by air, flying actively or passively. The only report of this species prior to this publication was that of Beebe (1923).

Zimmerman (1948) recognized four mechanisms by which insects could arrive at an oceanic island:

a) transported by other animals,
b) on natural rafts,
c) transported intentionally or accidentally by human beings, and

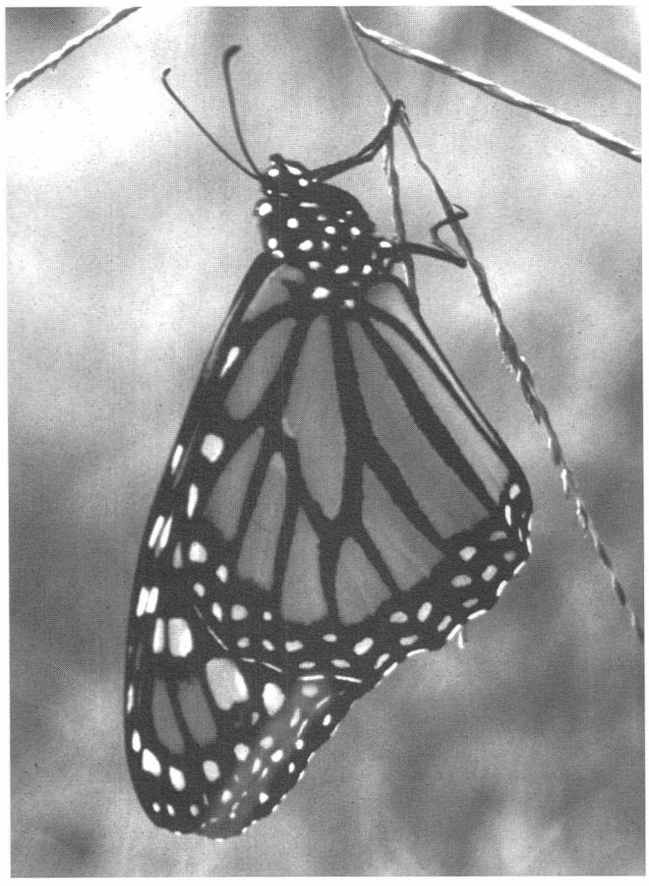

Figure 1. Adult *D. plexippus* at rest, Floreana, April 1996 (photo by Lázaro Roque).

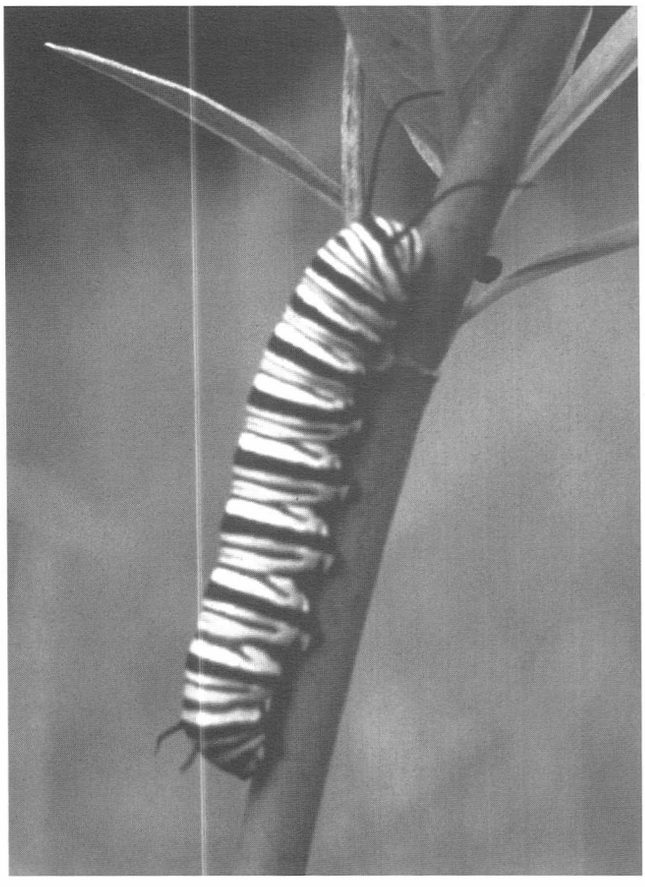

Figure 2. Caterpillar 5th instar in *A. curassavica*, Floreana, April 1996 (photo by Lázaro Roque).

d) through the air, flying actively or passively.

Only the last three modes of transport are likely to apply to diurnal butterflies.

1. Rafts: The transport of insects on natural rafts has been documented (Palmer 1944, Heatwole and Levins 1972, Peck 1994). This mechanism is less probable for adult butterflies. Nevertheless, it is possible that rafts, driven by either the Humboldt Current (during the dry season) or the Panama Flow (during the rainy season, especially during a strong El Niño year) could arrive with eggs, larvae, or pupae. It should be emphasized that the probability of successful establishment of the immature stages transported on rafts is low due to the fact that at least one male and one female must survive and find a milkweed to ensure the establishment of the species. Peck and Kukalová-Peck (1990) pointed out that another factor affecting the establishment of native insects after raft transport is the predation pressure of native lizards and birds. The intense activity of these insectivorous predators has been observed along many coasts of the islands.

2. Human Beings: There are no data on the intentional introduction of lepidopterans to the Archipelago, although the importation of plants could play a significant role in the indirect introduction of insects (Miller 1994). Human settlements in Galápagos are relatively recent. The first inhabitants settled on Floreana and San Cristóbal during the last century, bringing many plants, mainly fruits and vegetables, but also ornamental plants (Mauchamp 1997).

Asclepias curassavica L., the main milkweed host plant of *D. plexippus* in Galápagos, is an introduced plant and grows mainly in the agricultural zones of Floreana, Santa Cruz, and San Cristóbal (Lawesson *et al.* 1987). It was collected for the first time by the year-long expedition of the California Academy of Sciences in 1905-06 (Stewart 1911). However, the entomologist of that expedition, F. X. Williams, a very capable lepidopterist, neither collected nor observed the butterfly (Williams 1911). Based on this, it is possible to suggest that the species was not introduced before this date.

3. Flying: The long-distance dispersal abilities of many lepidopterans are well known (Guppy 1925, Beebe 1949, Ferguson *et al.* 1991, Smith 1992). *D. plexippus* is famous as a long-distance migrant, because it performs spectacular annual migrations in North and Central America and on occasions over the Pacific (Carlquist 1981). Zwaluwenberg (1942) verified repetitive colonization by the species on remote Canton Island, in the central Pacific, and at the same time detected the simultaneous establishment of the host plants. It is probable that Galápagos has had many such arrivals and failed attempts to colonize where there are no *A. curassavica* plants. Peck (1994) demonstrated that the winds in a strong El Niño year probably create favorable circumstances for the transport of insects between islands and from tropical America to Galápagos.

During the past two years (1995-96), I have collected *D. plexippus* on San Cristóbal, Santa Cruz, and Floreana. I have found eggs and early instar larvae on the plants *Asclepias curassavica* L. and *Sarcostemma angustissima* R. W. Holm (Asclepiadaceae). The latter species is widespread throughout Galápagos. I have the impression that on islands where both milkweed plants occur, when the abundance of *A. curassavica* decreases as a result of herbivore pressure, the frequency of ovapositions on *S. angustissima* increases. Larval development, however, appears to be incomplete on this second milkweed species and may be why the monarch butterfly is only found on the islands where *A. curassavica* grows.

Based on the current distribution and well-established dispersal potential of this species, together with dates of discovery of butterflies and their host plant, it seems most reasonable to assume that *D. plexippus* arrived in the Archipelago between 1906 and 1923 through natural dispersal mechanisms, after humans had introduced the milkweed host plant.

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ANTS (HYMENOPTERA, FORMICIDAE) OF FLOREANA: LOST PARADISE?

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INTRODUCTION

Ecological impacts of introduced mammals and plants on the endemic fauna and flora of Galápagos is an important problem that has been relatively well documented (e.g., Hoeck 1984, Hamann 1991, 1994). However, little is known about the impact of introduced arthropods (Baert 1994, Meier 1994). Especially among ants, so-called "tramp" species have been readily transported by humans. Due to their biological characteristics, these "tramp" species become rapidly established and can spread out easily. Although small in size, ants are among the most widespread and destructive invading species. Introduced into a new area, they become real pests and can either displace or eliminate native ant species or other arthropods, like the imported fire ants *Solenopsis invicta* Buren in the United States (see, e.g., Vinson 1994). One of the most recent introductions, with far-reaching consequences for the Galápagos ecosystem, is the little red fire ant, *Wasmannia auropunctata* (Roger) (Lubin 1984).

In the late 19th and early 20th centuries, several papers on ants were published based on material collected during early expeditions to the Galápagos Islands (Smith 1877, Emery 1893, Wheeler, 1919, 1924, 1933, Stitz 1932). No further studies on ants were published until 1972, when problems caused by the introduction of *W. auropunctata* arose (Silberglied 1972). Although a number of studies have been conducted, particularly on *W. auropunctata* and its control (Clark *et al.* 1982, Lubin 1984, 1985, Meier 1994, Ulloa-Chacón and Cherix 1990, 1994), the resulting knowledge is still considered fragmentary (Brandão and Paiva 1994).

The aim of this study was to determine patterns of distribution of the ant fauna on the island of Floreana, with special attention to introduced ants. For this purpose, species richness, abundance, and frequency of the ant fauna were studied (Pezzatti, Irzan, and Cherix, in prep.). In addition, different collecting methods were compared as a first step in the development of standardized methods for further investigation of ants on the Galápagos Islands (Irzan and Pezzatti 1997).

Floreana Island was selected for this research because both old (Wheeler 1919, 1924, 1933) and more recent data (Lubin 1984) on ant fauna were available. Moreover, the history of Floreana and its present situation made it an interesting study site. The early colonization and introduction of plants and animals have had an important influence on the native fauna and flora, and we supposed that the ant fauna would have been similarly affected.

MATERIAL AND METHODS

Study Site

The vegetation zones, originally described by Wiggins and Porter (1971) are partly represented on Floreana. The littoral zone and the transition zone are very reduced on the lee side of the island, i.e., on the northern and western slope (Dr. Alan Tye [Head, Department of Plants and Invertebrates of the Charles Darwin Research Station (CDRS)], Iván Aldaz [Botanist, CDRS], pers. comm.; pers. obs.).

In the humid highlands of Floreana, two different "subzones" of the *Scalesia* zone can be distinguished: one area