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WAVED ALBATROSS EGG NEGLECT AND ASSOCIATED MOSQUITO ECTOPARASITISM[1]

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Seabirds that nest on small, remote oceanic islands escape reproductive losses to predators that affect the breeding of continental birds (Lack 1954, Ricklefs 1969), and food availability is generally thought to limit reproductive success (Ashmole 1971, Harris 1977, Nelson 1977). In several cases, however, ectoparasites have played a significant role in determining reproductive success of oceanic seabirds (Duffy 1983 and references therein). Ectoparasites, or the diseases that they may transmit (e.g., van Riper et al. 1986), can cause nestling mortality directly during attacks (Fitch et al. 1946, Curry and Anderson 1987, McKilligan 1987), or indirectly by driving parents from colonies, sometimes en masse (Duffy 1983). We add to this small but growing list of ectoparasite-mediated seabird reproductive failures by reporting group desertion of eggs by Waved Albatrosses (*Diomedea irrorata*), apparently in response to the bites of swarms of mosquitoes.

Waved Albatrosses nest at only two sites, both in the eastern equatorial Pacific; most breed on the southern coast and inland high points of Isla Española (Hood Island) (0°N 90°W) in the Galápagos Islands, and an additional small colony has existed on Isla La Plata (1°S 81°W) (Owre 1976), just west of the South American mainland. We studied the main Española population in April and May 1986 in conjunction with long-term studies of booby breeding ecology. The island, nesting habitat, and albatross breeding biology are described by Harris (1973). Laying of the one-egg clutch typically extends from mid-April until early June and most fledglings have left the colony by the end of the following December. Adults spend the nonbreeding season away from the breeding colony and, indeed, vacate the entire archipelago (Harris 1973). In 1986 albatrosses were first seen at sea near Española on 8 March and on the island on 17 March, and the first egg was noted on 15 April. Laying proceeded rapidly for the rest of the month, and by the end of April at least 200 eggs had been laid within 3 km of our camp at the eastern end of the island. Eggs hatch 60 days after laying (Harris 1973), so the first hatching was expected in mid-June.

April was a month of heavy rain on Española (142 mm), as was the previous February (73 mm). During these periods draining precipitation flooded the large basin in the island's interior, and smaller pools formed in some parts of our coastal study area. These bodies of water provided abundant breeding sites for the mosquito *Aedes taeniorhynchus.* This species feeds on both birds and mammals (Edman 1971), and we noted adults of this species avidly pursuing blood meals from avian and human hosts from the end of February until we left the island on 7 May. A marked increase in the size of a population that was already unusually large was noted approximately 7 days after a large pulse of rainfall (131 mm) fell between 14 and 22 April. Biting activity prior to this time occurred primarily around dusk (17:00 to 20:30), but in late April and early May mosquitos took blood meals at all times of day. The only areas of the island consistently free from mosquitos were strips of coastline facing the prevailing southwesterly winds.

On 29 April we first noted unattended Waved Albatross eggs. These eggs were outside our booby study area (see Anderson and Ricklefs 1987). Eggs within our booby study area were all attended at that time, indicating that the abandonment was not due to human disturbance. Over the next 4 days increasing numbers of eggs were abandoned throughout the eastern region of the island until approximately half of all eggs were unattended in some places by 2 May. We never saw adults return to an egg once it was neglected, and neglected eggs soon became partially covered by the muddy substrate, and many were predated by Galápagos Mockingbird (*Nesomimus macdonaldi*). The poor condition of the unpredated eggs and the inability of adults to recognize their own egg when it was unattended by their mate (Harris 1973) indicated that these embryos died also, even if parents did attempt to return to their egg after we left the island.

Egg neglect appeared to be associated with geographical variation in mosquito density that we perceived as we travelled about the island. We suspected that desertion was a response to mosquito bites when we saw swarms of mosquitos taking blood meals from the facial skin of incubating adults in some areas. We tested this hypothesis by sampling mosquito population density in four subcolonies that differed dramatically in numbers of neglected eggs (Table 1). Feeding mosquitos were sampled at each site by both authors running to the approximate center of a subcolony from outside the subcolony and immediately exposing one arm from the elbow down. The number of mosquitos alighting on each arm in the subsequent minute was counted. All four subcolonies were sampled in this manner on 4 May between 17:49 and 18:36. Care was taken to

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TABLE 1. Results of sampling neglected Waved Albatross eggs and mosquito abundance in four subcolonies on 4 May 1986 between 17:49 and 18:36. Abundance of feeding mosquitoes was sampled by counting the number of mosquitoes alighting on one exposed arm of each of the two authors in a 1-min period.

Subcolony	Total eggs	% eggs neglected	No. mosquitoes
1	55	47.3	68
2	28	25.0	13
3	50	6.0	2
4	104	5.8	1

avoid disturbing incubating adult albatrosses. We also measured local windspeed at 1.5 m height with a handheld anemometer for 1 min. Windspeeds above 8 kph were measured to the nearest 1.6 kph; windspeeds below 8 kph were categorized as 0 kph or between 0 and 8 kph.

The proportion of albatross eggs neglected in a subcolony was positively associated with number of mosquitos that landed on human arms (Table 1; Spearman's rho = 1.00, $P = 0.05$, $n = 4$). In addition, up to 15 mosquitos per bird perched simultaneously on exposed facial skin of incubating adults in subcolonies 1 and 2 while we sampled; few or no mosquitos were noted on or near adults in subcolonies 3 and 4. Parasitized albatrosses exhibited signs of distress (frequent preening and shifting position) not seen in unparasitized adults. Contrary to our expectation, variation in the local windspeed did not account well for variation in alighting mosquitos during our sampling period. Maximum windspeeds were between 0 and 8 kph in subcolonies 1 and 2, 0 kph in subcolony 3, and 11.2 kph in subcolony 4.

Harris (1973) reported only 4.7% of eggs deserted in 1970 and 1971, years during which mosquito populations are not known to have been unusually large. However, widespread desertion of eggs by waved Albatrosses in association with high mosquito density was reported in 1965 (Peterson 1967). As in 1986, heavy rain fell at the Charles Darwin Station on Isla Santa Cruz in the first half of 1965 (Anderson, unpubl.), and probably also on Española; total monthly rainfall on Española during the first 4 months of the year is strongly correlated with monthly rainfall on Santa Cruz (Spearman's rho = 0.950, $n = 9$, $P < 0.01$).

Data from other years show that such desertion is not the norm when El Niño-Southern Oscillation (ENSO) events are not occurring (Harris 1969, 1973; Rechten 1986); during our study ENSO conditions did not prevail (Anderson, unpubl.) and other pelagic seabirds were breeding successfully in subcolonies 2 and 4 (Anderson and Ricklefs, unpubl.). In fact, the timing of the Waved Albatross nesting season allows breeders to minimize their presence on the island during the annual "warm" season, with its occasional heavy precipitation (Harris 1982; Anderson, unpubl.) and associated feeding mosquitos. Instead, breeding occurs during the "cool" season, when the lower air temperature is more similar to that experienced by other albatross species nesting at higher latitudes and precipitation is misty and does not accumulate as standing water, and when feeding mosquitos are typically absent or at undetectably low densities (Anderson, pers. observ.). Our observations in 1986 indicate that reproductive losses due to mosquito blood-feeding cannot always be avoided by this breeding regime, and that seasonal abundance of this ectoparasite may act as a powerful constraint on the timing of breeding of Waved Albatrosses. An evaluation of the relative importance of this factor in determining the nesting season must await future studies of other proximate seasonal influences on reproductive success, such as food abundance and nest microclimate.

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ACCESS TO WINTER FOOD RESOURCES BY BRIGHT- VERSUS DULL-COLORED HOUSE FINCHES[1]

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Key words: Carpodacus mexicanus; *dominance; foraging; House Finch; plumage maturation; social behavior.*

The adaptive significance of delayed plumage maturation in passerines is not yet understood, despite much discussion and speculation (Selander 1965; Rohwer 1975, 1978; Rohwer and Niles 1979; Rohwer et al. 1980; Flood 1984; Studd and Robertson 1985; Lyon and Montgomerie 1986). Rohwer (1986) recently suggested that female-like subadult plumages may confer competitive advantages to yearlings during the winter, when individuals compete for access to critical food resources. Virtually all empirical study of delayed plumage maturation in birds to date has been done during the breeding season, and there is little evidence to evaluate Rohwer's hypothesis that female-like plumages benefit individuals during the nonbreeding season. In this paper we report that female-like plumage in House Finches (*Carpodacus mexicanus*) is potentially advantageous during the winter, when males yield access to critical food resources in favor of females.

METHODS

Our observations were conducted at a feeder located in our backyard in Guilford, New Haven County, Connecticut, from 8 November 1987 through 8 January 1988. A cylindrical feeder containing four portholes through which sunflower seeds were dispensed was placed about 2 m from a window through which our observations were made. The four perches were located on the same horizontal level, 90° apart. A total of 64 hr was spent observing the feeder, mostly from 08:00 to 12:00, EST, in all weather conditions. As a measure of access to food, we recorded which individuals actively supplanted others and which individuals deferred to others. A supplant was recorded whenever one bird approached a bird sitting on one of the perches, usually from the back, and displaced it. If the perched bird repelled the intruder, no supplant was recorded. We could not quantitatively record attempted displacements that were repelled, however, because many birds simply flew to the feeder and hovered near it. These individuals did not directly approach a specific incumbent but nevertheless were clearly prevented from feeding by birds already there, thus making criteria for assigning attempted (but unsuccessful) displacements overly subjective. If a displacement occurred, the incumbent usually left the perch without a fight upon the approach of the other bird. House Finches were scored as either "gray," meaning no red was visible in the plumage, or "red," those containing variable amounts of red plumage. For interactions between red individuals, we scored the birds in that given interaction as either roughly equivalent in amount of red plumage present, or differing in the amount of red. We did not establish categories of redness. About 50 House Finches of both red and gray plumages (in approximately equal frequency) used the feeder during the time of observations. All interactions were considered statistically independent. Although no birds were color-marked (some were recognizable by plumage differences), there appeared to be frequent turnover among

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