INFANTICIDE OF WEDGE-TAILED SHEARWATER *PUFFINUS PACIFICUS* CHICK AT MARINE CORPS BASE HAWAII

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Colonial seabirds are highly susceptible to the effects of conspecific aggression. Their close proximity during the nesting period may result in an increased frequency of aggressive encounters and facilitate their detection (Mock 1984, Clode 1993, Parkes 2005). In seabirds, conspecific aggression can occur between adults, between adults and chicks or between chicks, and is thought to increase when environmental conditions are poor (Ashbrook *et al*. 2008). In years of low food availability in Common Guillemots (*Uria aalge*), adults leave chicks unattended for longer periods, resulting in increased attacks from neighboring adults (Ashbrook *et al*. 2008). Similarly, Fetterolf (1983) found that low food availability not only increased attacks on Ring-billed Gull *Larus delawarensis* chicks from neighboring adults, but also increased the frequency of chicks leaving the nest to beg for food from neighboring nests. This behavior can result in either voluntary feeding or aggression, depending on the reaction of the neighboring adult (Ramos 2003). There is an evolutionary "arms race" between poorly fed chicks attempting to survive and parents attempting to increase their own fitness without wasting efforts on non-filial chicks (Pierotti 1991, Brown 2000). Inherent in this scenario is the competitive struggle between nonsibling chicks when an intruder attempts kleptoparasitism.

While siblicide is commonly reported in some species of seabirds (Mock 1984), reports of fatal attacks by a nonsibling conspecific seabird chick are rare in the literature. In his studies of chick adoption, Brown (2000) found no evidence of aggression by resident Ring-billed Gull *Larus delawarensis* chicks toward wandering chicks under natural conditions. However, Young (1963) reported an incidence of a South Polar Skua *Catharacta maccormicki* chick invading a nest and killing the two smaller occupants.

Wedge-tailed Shearwaters *Puffinus pacificus* nest throughout the Hawaiian Islands and lay a single egg. Adult–adult aggression, particularly pertaining to burrow disputes, has been well documented (Gross *et al*. 1963, Shallenberger 1973, Nelson 1979), but conspecific aggression between chicks has not been documented previously in this species. Here we report an observation of a Wedge-tailed Shearwater chick killing at least one conspecific chick after several chick mortalities were detected in neighboring burrows.

Marine Corps Base Hawaii is located on the windward side of Oahu, where nearby offshore islets provide nesting habitat for many seabird species. Because of the presence of humans and introduced species, shearwater colonies are rare on Oahu itself (Smith et. al. 2002). The Wedge-tailed Shearwater colony at Marine Corps Base Hawaii was first documented in 1994 (Tanino & Rauzon 1994) and has grown to approximately 1.25 ha. Events recorded in this paper occurred within a 500 m^2 area.

A series of chick mortalities occurred before and after the observed infanticide. On 31 August 2009, we found five dead chicks outside burrows, two of which were recent enough to be collected for necropsy. On 2 September 2009, two additional dead chicks were collected. Initial field examination revealed a lack of plumage around the eyes and beak and no obvious signs of predation (blood and/or dismemberment). Samples were delivered to the USGS National Wildlife Health Center, Honolulu Field Station, in Honolulu for necropsy.

Four chicks were examined for cause of death. Significant necropsy findings included birds in good body condition with stomach full of fish, fractured skull with associated hemorrhage and ruptured liver with associated hemorrhage. It was determined that the most likely cause of death was trauma due to predation.

The colony was monitored regularly to detect the source of predation. On 8 September 2009 two additional chick mortalities were noted. While inspecting these mortalities, we heard chick calls from a nearby burrow. Inside the burrow, one chick was attacking another. The calls were made by the victim attempting to fight off the jabbing beak of the other chick, mainly directed at the victim's eyes. After we returned with a digital camera and flashlight minutes later, the victim had stopped calling but continued breathing. Approximately three minutes of video were recorded (see Appendix online), during which the attacking chick continued to jab at the victim's neck and body. Gradually the victim became less and less responsive to the attacks. A few minutes after filming, the victim stopped breathing.

Nest monitoring was initiated at the site of the infanticide and at 19 additional nest burrows in the immediate area. Burrows surrounding the documented infanticide were searched for chicks. Chicks were weighed using Avinet spring scales to ±5 g and wing chord was measured to ±1 mm; appearance was also documented. Using mass as a proxy for age (Pettit *et al.* 1984), average age of sampled chicks at the time of the documented infanticide was approximately 8–15 days. The aggressor chick had the second longest wing chord and was the third heaviest of chicks in the sample. Thus, it was likely to be older and larger than its victim. Including the aggressor chick, 17 of 20 chicks (85%) fledged. These data do not reflect the rate of infanticide, however, because nest monitoring did not begin until after the majority of mortalities were discovered.

Were other detected mortalities the result of conspecific chick aggression? It is possible that the recorded incidence was the result of a supernormal clutch, where two eggs were laid in the same nest, and that other mortalities were unrelated. However, we hypothesize that all 10 chicks died from the aggression of either a single chick,

or a high incidence of localized chick–chick aggression, based on (1) the rarity of supernormal clutches in Procellariiformes (Brooke 2004), (2) the localization of mortalities—nine other chick mortalities were found within 20 m of the recorded incidence, and the two mortalities detected just before the recorded infanticide occurred within 3 m, and (3) the necropsy finding that chicks died from trauma without visible evidence of blood or dismemberment.

A possible explanation for conspecific chick aggression at this site was the occurrence of El Niño in 2009 and the warmest summer global sea-surface temperatures during the chick rearing period of their Wedge-tailed Shearwaters (http://www.noaanews.noaa.gov/stories2009/20090916_globalstats.html). The reproductive success of Wedge-tailed Shearwaters nesting on Oahu correlates strongly with wind and oceanographic conditions, which drive prey availability (Hebshi 2008), and 2009 was a poor reproductive year island-wide with delayed development of many chicks and poor fledging rates observed in other Wedge-tailed Shearwater colonies (L. Young, pers. comm.). It is possible that low food availability increased the incidence of chicks wandering outside their nests looking for food, which led to more aggressive encounters between chicks. The necropsy finding of chick mortalities in good body condition, with stomachs full of fish, suggests that wandering chicks may have killed well-fed chicks in an attempt to gain resources.

This paper provides an example of infanticide caused by a conspecific Wedge-tailed Shearwater chick. Because this species typically lays a single egg, it is assumed this was not an incidence of siblicide. While siblicide is well-studied and occurs frequently in some seabird species (Mock 1984), documentation of fatal conspecific aggression from a nonsibling seabird chick is rare. Hence, aggression from conspecific chicks should be considered when examining nesting mortality in Wedge-tailed Shearwaters. Further studies are needed to determine how commonly conspecific aggression occurs in this species and its association with environmental stressors.

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