

Observations on the behavioural ecology of the Atiu Swiftlet *Aerodramus sawtelli*

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Summary

The Atiu Swiftlet *Aerodramus sawtelli* is endemic to the Cook Island of Atiu and has an estimated total population of less than 400, rendering it one of the world's most globally endangered bird species. Over a series of five visits to Atiu, we collected data on the distribution of foraging swiftlets on the island, and their foraging and echolocation behaviour. The bird favours forests, agriculturally developed areas such as croplands, and populated sections of the island (e.g. gardens) but avoids the dry, upraised coral ring (*makatea*) of Atiu. It appears able to readily exploit new insects after they have immigrated to Atiu and may act as a natural control agent on pest species (e.g. *Xyleborus perforans* and *Atrichopogon jacobsoni*). We reanalysed the swiftlets' echolocation calls within one of their roost caves in conjunction with new recordings. The calls do not contain ultrasonic components and are uniquely single clicks compared to the echolocation vocalisations of other swiftlet species. The minimal impact of human disturbance on the remote nesting caves of this bird suggests that its numbers, although small, represent a stable population.

Introduction

The swiftlets (Apodidae: Collocaliini) are a group of Old World birds that are distinguished by their cavernicolous (cave-dwelling) habits and, especially within the genus *Aerodramus*, the ability to echolocate (Lee *et al.* 1996, Thomassen *et al.* 2003, Price *et al.* 2004). *Aerodramus* swiftlets are distributed from the Seychelles to the Marquesas Islands of French Polynesia and have received much interest at ecological, behavioural and phylogenetic levels owing to their morphological similarities (Lee *et al.* 1996). The Atiu Swiftlet *Aerodramus sawtelli* is an endemic species that inhabits the 2,693 ha upraised coral atoll of Atiu in the Cook Islands (Holyoak 1974, Tarburton 1990). Despite its status as the sole extant collocaline on this island chain (Steadman 2002) and its threatened status (Collar *et al.* 1994, McCormack 2005, IUCN 2009), little is known of the natural behaviour of this bird, known to the Atiuans as *kopeka*. Only three field studies have been conducted on it, beginning with a descriptive account of its breeding (Holyoak 1980). Its nesting population was estimated by Tarburton (1990) who reported 380 adults restricted to two roosting caves on Atiu. Fullard *et al.* (1993) analysed its echolocation calls, noting characters that distinguished it from the usual calls of other swiftlets (Medway and Pye 1977). Phylogenetic studies (Lee *et al.* 1996, Price *et al.* 2004, 2005) have surprisingly placed this bird as a sister species of *A. bartschi* from the Mariana Islands over 7,000 km away. The swiftlet contributes to a growing ecotourism industry on Atiu and its continued survival can benefit from a greater knowledge of its ecology and behaviour. With this in mind,

We dedicate this paper to the memory of our friend and colleague, Don Thomas (1953–2009).

we present data from five field studies of the habitat associations of this bird on Atiu and a preliminary examination of its insect prey.

Methods

The observations reported in this paper were made over the course of five visits to Atiu: 28 June–7 July 1989, 19–21 May 1992, 4–20 February 1999, 24–31 December 2001, and 9–18 February 2009. To obtain information about the bird's diurnal activity pattern and to estimate its population we counted birds as they exited and entered in the morning and evening at one of their two roost caves (Anatakitaki) on 10 February 1999. No birds were captured or disturbed during these observations and birds were not visited during their nesting periods. To determine the bird's foraging areas used by this species, we conducted four surveys (two in 1989 and two in 1999) between the hours of 09h00 and 16h00 by travelling most of the island's roads, stopping every 1–3 km and watching for birds for five minute periods. There are no other birds on Atiu with the swallow-like flight patterns of *A. sawtelli*, thereby allowing its identification without the need for binoculars. In choosing the survey sites, we chose to maximise the number of vegetation zones sampled but we did not systematically randomise those choices. Atiu is extensively criss-crossed by roads rendering all of the island's vegetation zones accessible to our surveys. To determine if *A. sawtelli* feeds on the island pinhole boring beetle *Xyleborus perforans* Wollaston (Coleoptera: Scolytidae), an insect ranked amongst the five most important agricultural pests of the southern and western Pacific (Waterhouse 1997), fresh faecal pellets were collected from beneath three nests at Anatakitaki in 1989 (total number of pellets = 15), two nests in 1992 (total number of pellets = 10) and six nests in 2001 (total number of pellets = 10), macerated in 100% ethanol and mounted under Permount[®] in depression slides. The slides were examined for recognisable beetle fragments (tibia and elytra) with each pellet being assigned the presence or absence of beetles. The slides from pellets collected during the 1989 and 2001 trips were compared to beetles that were captured in the late afternoon at the same time and place as birds that were actively foraging. Beetle specimens from these samples have been deposited with the Bishop Museum, Honolulu.

Since echolocation in the Swifts (Apodidae) continues to be of interest for understanding the phylogeny of the family (Thomassen *et al.* 2003), we re-examined the vocalisations of *A. sawtelli*. Audio recordings were made of birds near the entrance of Anatakitaki with a Sony cassette recorder (Professional Walkman WM-D3; for technical details refer to Fullard *et al.* 1993). Recordings were analysed by converting them into wave files sampled at 500 kHz (National Instruments DAQCard 6062E) and analysing them using BatSound Pro (Petterssen Elektronik AB). During the 2009 visit, bird clicks were recorded with a digital acquisition system (Avisoft condenser microphone type CM16; Avisoft UltrasoundGate 416, Avisoft Bioacoustics, Berlin, Germany; sampling rate, 16 bit, 500 kHz) to check for high frequency components that would not have been recorded using the technology of the previous study (Fullard *et al.* 1993).

Results

Cave surveys

The exit and entrance patterns of *A. sawtelli* from the Anatakitaki cave are illustrated in Figure 1. We began watching for birds at 05h00 and the first bird exited at 05h35, approximately 50 minutes before sunrise when light was barely present. We are confident that no birds exited the cave before this time without our knowledge as they would have been heard echolocating even if we were unable to see them. From this point the number of exiting birds rapidly increased until 06h00 whereupon birds began to return to the cave. The main exodus of birds ended at approximately 06h15 and was then replaced by a growing number of birds re-entering the cave, reaching a maximum at 06h45. At this time there were a small number of birds re-exiting but

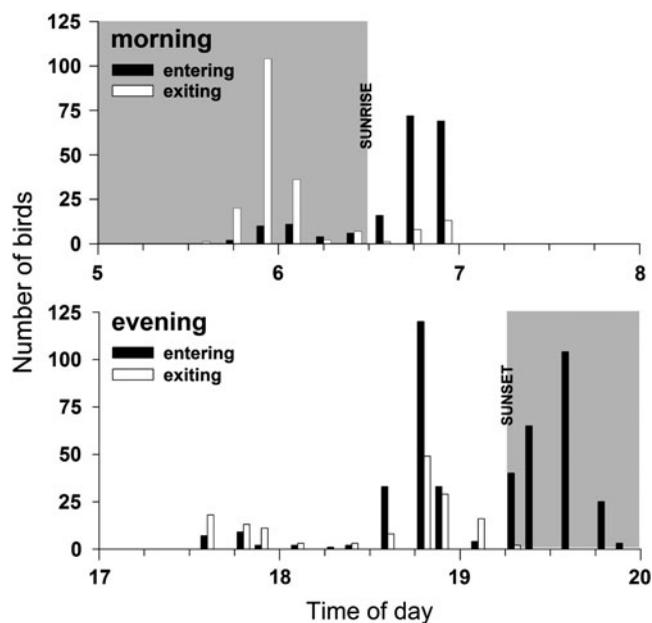


Figure 1. Numbers of swiftlets entering and exiting from the Anatakitaki cave on 10 February 1999. Grey areas indicate pre-sunrise/post-sunset times for morning and evening counts, respectively.

the impression was of a general exodus followed by a return entry. Although we did not perform counts between 08h00 and 17h00, return visits to the cave indicated that birds continued to enter and exit throughout the day. This sporadic activity was replaced by a general entry beginning at 18h30, with two activity peaks, one at 18h45 and another at 19h35 and ending with the last bird entering at 19h55. We counted a total of 163 birds that left in the morning and 241 that returned in the evening, implying a number of re-entries and re-exits. During the evening return we noticed numerous vocalisations being regularly emitted by birds outside the cave that resembled what we have previously termed a landing call (Fullard *et al.* 1993). Analyses of recordings made of the echolocation clicks using the high frequency microphone inside the cave resembled those reported in Fullard *et al.* (1993) and revealed no frequencies above 10 kHz greater than -20 dB of spectral peak.

Island surveys

To date, a systematic description of the vegetative regions of the upland area of Atiu does not exist (but see Franklin and Merlin 1992 for the *makatea* region) and we thus categorised the island into subjective vegetation types (Table 1). The average counts of birds observed over four surveys in 1989 flying around Atiu are illustrated in Figure 2 and suggest a preference for the freshwater lake and taro swamp regions of the island, as well as the large agricultural fields in the lowland areas and the domestic cultivated gardens in the towns (Table 1). Over all the visits to Atiu, we never saw birds along the ring road that circles the *makatea* (uplifted coral) zone, the coastline, wharf or the airport. Birds were most often seen foraging 3–5 m above the ground although occasionally they descended for brief forays along the edges of trees or bushes. During these times, birds were often heard emitting faint echolocation clicks. On one occasion (2009) JF observed 10–15 birds feeding on swarms of the ceratopogonid biting midge *Atrichopogon*

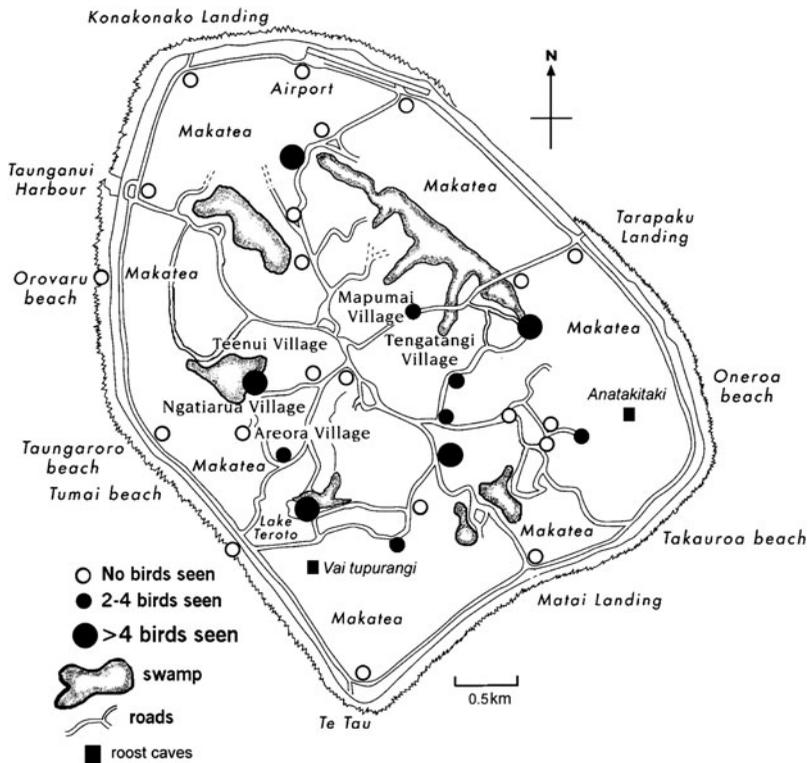


Figure 2. Results of four bird censuses done between 09h00 and 16h00. Numbers of birds represent averages of the five minute sampling periods per site.

jacobsoni every day for 10 days. The flies were clustered around inflorescences of the Wattle Tree *Acacia mangium*, an invasive species recently introduced to Atiu (Space and Flynn 2002).

Faecal analyses

All of the identifiable fragments in the faeces collected from below the nests of the birds were the remains of insects except for occasional feather fragments. In the pellets examined, only two

Table 1. General characteristics of the habitats of the island of Atiu and the prevalence of *A. sawtelli*.

Habitat type	Main vegetative constituents	<i>A. sawtelli</i>
Coastal – makatea (upraised coral) ¹	Native species (e.g., <i>Pandanus</i> , <i>Elaeocarpus</i>)	Never observed ²
Swamp, lakeshore	Native, lush species (e.g., sedges, ferns)	Common
Domestic (e.g., small cultivated gardens)	Introduced ornamentals (e.g., <i>Ficus</i> , <i>Hibiscus</i> , <i>Lantana</i>)	Common
Agricultural (large fields)	Introduced crops (e.g., taro, coconut, coffee)	Occasional

¹Includes the native forest types as described by Franklin and Merlin (1992).

²Except for the activity around the roost cave.

insect orders were identified: beetles (Coleoptera) and flies (Diptera). Fragments of the island pinhole borer beetle *Xyleborus perforans* were present in 87% of the 1989 samples, 60% of the 1992 samples and 80% of the 2001 samples for a total of 75.7% (± 4.7 SE) of all pellets analysed. Quantitative analyses of which insects were eaten and in what numbers are not possible without a comprehensive survey of the species available to the bird, but our results suggest that *X. perforans* is commonly fed upon by the swiftlets.

Discussion

In contrast to Tarburton's (1990) report that *A. sawtelli* forages all over the island except for the wharf and airstrip, we never observed the bird within the coastal *makatea* region (with the exception of its nesting cave). The preference of the bird for the inland regions surrounding the lake and agricultural swamps of Atiu as well as the cultivated gardens within the towns suggests that these habitats support the insects upon which this bird forages and the plants that are used in constructing its nests (Tarburton 1990). This indicates that *A. sawtelli* has shifted its foraging activities from the original habitats that existed when the bird first arrived to those containing the plants that have been imported by human settlers. Our preliminary analysis of the diet of *A. sawtelli* suggests that it feeds extensively on *X. perforans* and it may serve as a natural control on the populations of these insects. Our observation that the bird forages on insect swarms around a recently introduced plant, *Acacia mangium*, suggests that *A. sawtelli* is able to quickly exploit new sources of insects after they have immigrated to the island suggesting that it can adapt to new food resources as they become available.

Fullard *et al.* (1993) reported that *A. sawtelli* differs from other swiftlets in that it emits exclusively single rather than double clicks in its echolocation call. Thomassen *et al.* (2004) and Price *et al.* (2005) suggested that this was not unusual because most typically double-clicking swiftlets will also emit single clicks. In a survey of over 600 *A. sawtelli* clicks recorded from all our visits to Atiu, we have never observed a double-click call and we maintain that this character remains an important distinction from other *Aerodramus* spp. As suggested by Fullard *et al.* (1993), the as yet undescribed clicks of the Tahitian *A. leucophaeus* and Marquesan *A. ocistus* will provide valuable information regarding a possible west – east evolutionary change in swiftlet echolocation. These two species represent the easternmost points of swiftlet distribution and their inclusion in future phylogenetic studies is necessary to answer this question as well as that of the unusual placement of *A. sawtelli* as a sister species to the distant Mariana Swiftlet *A. bartschi* (Lee *et al.* 1996, Price *et al.* 2004, 2005).

As was noted for the Papuan Swiftlet *A. papuensis* (Price *et al.* 2005), we commonly heard echolocation clicks from *A. sawtelli* as they were flying in the dim light beneath bushes and in the late afternoon before they returned to their caves. We believe that these sounds are still only navigational in nature and, unlike bats, they do not use them to locate their insect prey. The vocalisations that were heard from flying birds as they prepared to enter the cave have been previously termed landing calls (Fullard *et al.* 1993), yet the birds were not near their nests when they produced these calls. Considering the crowded flight conditions around the entrance to the cave and the dropping light levels, we suggest that this call also serves as a general social signal emitted in flight to warn other birds that may approach too closely.

Regarding *A. sawtelli*'s status as a threatened species, our 1989 estimate of 163–241 birds in Anatakitaki compared with Tarburton's (1990) count of 148 adults in the same cave (based on the number of nests) suggests that at least in this cave, the population of *A. sawtelli*, although small, remains stable. As some birds re-entered and re-exited the cave, our population estimate has some uncertainty. Tarburton (1990) estimated the number of birds in the other nesting cave, Vaitupurangi, as 232 while another survey counted a total of 172 nests (82 in Anatakitaki and 90 in Vaitupurangi) in 1994 and 175 (69 and 106 respectively) in 1995 (R. Dobbs and G. McCormack unpubl. data). We caution that on-going objective estimates of the bird's population are required before the actual state of its total population can be assessed. The bird enjoys

considerable respect within the island community, is appreciated for its insect-catching lifestyle and its roosting caves appear to be free of significant predation except from that of the crabs, *Birgus latro* and *Cardiosoma longipes* (Tarburton 1990). Unlike most other Pacific Islands, Atiu remains for now free of Ship Rats *Rattus rattus*, which have impacted the population of another threatened bird, the Rarotonga Flycatcher *Pomerea dimidiata* in the Cook Islands (Robertson et al. 1994). There are guided tours of one of the caves several times a week, but these are done under strict supervision and the remoteness of the caves combined with the low level of human impact (e.g., they are not exploited for birds-nest soup as in other threatened swiftlets in other parts of the Pacific; Sankaran 2001) should provide these unique birds some degree of protection for the foreseeable future.

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