Notes on the pollination of *Syzygium dealatum* (Burkill) A.C. Smith (Myrtaceae) in American Samoa

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Syzygium Gaertner (Myrtaceae) is a large paleotropical genus, containing about 500 species (Mabberly 1987), 20 of which are found in the Samoan archipelago (16 species are native to Samoa; Whistler 1988). *Syzygium* trees are common in lowland to montane rainforests of Samoa (Whistler 1980), and are considered to be important components of insular ecology. There have been few studies on the ecology of *Syzygium* species, nevertheless it is clear that the fruits of some species are components of vertebrate diets (Cox et al. 1992, Trail 1994, Banack 1996). Pteropodid bats are known dispersers of *Syzygium inophylloides* (A.C. Gray) C. Muell. seeds (Cox et al. 1992), although it is not known which species is the primary disperser in Samoa (both *Pteropus samoensis* and *P. tonganus* have been observed feeding on the fruits; Banack 1996). No empirical studies have been done on the pollination of *Syzygium* in Samoa, but observers have suggested that bats are important for *Syzygium* pollination (Cox 1983, Cox et al. 1992, Wiles and Fujita 1992, Trail 1994, Banack 1996). Nothing is known about the array of invertebrate flower visitors to Samoan *Syzygium* species, or their roles as potential pollinators. We initiated a study to determine the array and efficiency of invertebrate pollinators of *Syzygium dealatum* (Burkill) A.C. Smith on the island of Tutuila, American Samoa.

Tutuila is a tropical high (volcanic) island located 14° S, and 107° W, in the South Pacific Ocean. Annual rainfall on Tutuila ranges from 150-400 mm per month, with a dry season extending from May-September; it is classified as Tropical Rain Forest (U.S. Fish and Wildlife Service 1982).

The study was conducted on a flowering individual of *S. dealatum* at Cape Matatula, an exposed rocky point at the extreme northeast end of Tutuila. Trees of *S.dealatum* can reach 8 m in height (Whistler 1988), but the tree used for this study was only 3-4 m tall because it had been damaged during hurricanes that hit Tutuila between 1988 and 1992 (Pierson et al. 1992). Dead snags above the live branches indicated that the tree was at least 5-6 m tall prior to hurricane damage; it contained copious inflorescences.

To determine the potential invertebrate pollinator array to *S. dealatum*, we produced a visitor list by observing flowers during daylight hours over three days. Total observation time was only five hours; nevertheless, informal observations of the local volent invertebrate species revealed that most conspicuous species had been recorded visiting the flowers at least once. Because of the high winds frequently occurring at Cape Matatula, insect activity usually ceased by midmorning when winds picked up.

We defined a visit as any time a potential pollinator landed on an inflorescence and actively searched for nectar and/or pollen. Movement within the same inflorescence was considered part of the same visit. A visitor that flew off an inflorescence but then landed on that same inflorescence, however, was considered to have made two visits. Our observations were limited to inflorescences for which we could clearly distinguish all invertebrate flower visitors. Although this study did not investigate vertebrate pollinators, during the times we were observing the inflorescences we noted all nectarivorous bird species seen or heard in the vicinity.

To determine the importance of invertebrate visitors to *S. dealatum* fertilization, we caged seven inflorescences on three branches with chicken wire (N = 227 flowers). We also followed the fate of 148 flowers from seven inflorescences on two control (open) branches. To determine if *S. dealatum* is autogamous, we placed small cotton bags over 11 unopened flowers not on experimental branches. We recensused the tree after all buds had either begun swelling (a sign of fertilization), or had abscised (which occurred if the flower was not pollinated).

A total of 116 visits were recorded over the five hours; ten invertebrate and one small vertebrate species were recorded (Figure 1). The most common visitor was the bee *Homalictus* sp. (Halictidae), which accounted for >50% of the observed flower visits. Observations of *Homalictus* visits revealed that it was attracted to both pollen (which it collected) and nectar. A click beetle (*Brophlis euaensis*, Coleoptera: Elyteridae), when present, remained on the flower for the longest periods of time, commonly >10 minutes per flower. The introduced honeybee (*Apis mellifera*) also visited the flowers, and contacted numerous anthers and the stamen while probing for nectar; it was a probable pollinator of *S. dealatum*.

We also observed repeated flower visits by the Azure-tailed skink *Emoia cyanura*. This is the first recorded visit by a skink to *Syzygium* flowers, and the behavior of the animal indicated that it might be a successful pollinator. The skink was seen systematically exploring flowers for nectar on a number of branches on four different days. This indicates that it was a faithful visitor to the tree. When the animal inserted its head into the flower, it came into contact with numerous anthers and the stigma; it was seen licking nectar from its face after most visits. Because of these characteristics of skink behavior, we include it as a possible pollinator of *Syzygium dealatum*. The restricted territorial range of the skink suggests that it will likely serve only as a geitonogamous pollinator.

The tree was in the territory of a Wattled Honeyeater (*Foulehaio carunculata*), which was seen in the vicinity of the tree during every observational period. However, it was never seen visiting the flowers. The only other nectarivorous bird heard in the area was a Cardinal Honeyeater (*Myzomela cardinalis*). Both of these bird species are gregarious visitors to *S. samarangense* (Bl.) and *S. inophylloides* flowers (personal observation), so it is possible that they visit *S. dealatum* as well. No bats were seen in the vicinity of Cape Matatula, although we only spent one night at the study site. The closest known *P. tonganus* roost was 2.5 km distance; solitary *P. samoensis* were possibly closer.

Percent fertilization did not differ between caged and open inflorescences (Table 1, two sample t-test $p > .05$), and no autogamy was recorded for the bagged flowers. Mean fertilization rates of caged inflorescences (insect + skink fertilization) are lower than, but generally corresponded with, fertilization rates of caged inflorescences of *Syzygium cormiflorum* (F. Muell.) B. Hyland in north Queensland, in which about 18% insect fertilization was directly measured (Crome and Irvine 1986). Our data did not allow us to determine which of the visitors to the caged inflorescences were the most efficient pollinators. Indeed, it is possible that *Apis mellifera* was the most efficient pollinator; however, we consider the possibility of introduced insects being the sole pollinators unlikely, based on the fact that the pollination syndrome of *S. cormiflorum* includes native insects (Crome and Irvine 1986).

The low fertilization rate of open inflorescences probably reflects the fact that this tree was on an highly exposed rocky point, where visits by vertebrates and invertebrates would be deterred by high wind speeds. Indeed, even during informal observations outside the scope of this study, we never noted vertebrate visits to any *Syzygium* trees at Cape Matatula, whereas in other, more protected sites, birds are very frequent visitors. Moreover, flower visits by bats were most likely reduced or non-existent because the shrubby, wind-damaged stature of the tree did not provide high enough branches for landing or roosting. *Pteropus tonganus* has been seen visiting the flowers of *S. dealatum* (Banack 1996), but Pteropodids tend to visit large trees that overhang steep slopes (A. Brooke, personal communication). Therefore, visitation rates to this tree by birds and bats were probably severely reduced.

Despite low rates of fertilization, these results suggest that *Syzygium dealatum*, like *S. cormiflorum*, is a generalist species, capable of being fertilized by a wide array of pollinators. We expect that many or most other *Syzygium* species share this generalist pollination syndrome. The nectar-bearing hypanthium of a *S. dealatum* flower is 4-6 mm diameter (Whistler 1988), whereas in *S. cormiflorum* it is 9-16 mm (Crome and Irvine 1986). Because the generalist pollination syndrome is present in these two species, it is probably utilized by most or all of the Samoan *Syzygium* species, which exhibit a very similar flower morphology (the hypanthia generally fall within the size ranges above; Whistler 1988). Although there may be a gradient of visitor preferences corresponding with flower size, the unspecialized Myrtaceous flower is probably attractive to most nectarivorous animal species. For example, insects are probably relatively more important pollinators of *S. effusum* (A. Gray) C. Muell., which has an hypanthium of 1.5 - 2 mm diameter, whereas birds and bats could be more important to *S. neurocalyx* (A. C. Gray) Christoph., which has an hypanthium 15 - 22 mm diameter.

Our results offer no direct information on the importance of birds and bats to the pollination of insular *Syzygium* species, nor can we rule out the possibility of low levels of abiotic pollination for S. dealatum. We infer from floral morphology, observations of visitors to congeners, and results from Crome and Irvine (1986) that birds and bats are important to *Syzygium* pollination. That the fertilization rate of open flowers in this experiment was low on an highly exposed ridge with very few potential bird and bat pollinators also indicates that *Syzygium* does depend in part on those vectors for maximum fertilization. Most certainly, birds and bats will increase the outcrossing distance of *S. dealatum*. On the other hand, 12% fertilization by insects and (possibly) skinks suggests that these smaller animals play a role in the geitonogamous or short-distance xenogamous pollination of *S. dealatum*.

A generalist pollination syndrome would increase the probability of successful establishment by *Syzygium* in novel environments, including islands. The attractiveness of *Syzygium* flowers to a wide array of potential pollinators, in addition to geitonogamous fertilization seen in *S. cormiflorum* (Crome and Irvine 1986), could significantly contribute to the wide distribution of the genus across the Pacific Islands.

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Table 1. Fertilization rates for seven caged and seven open inflorescences of *Syzygium dealatum* at Cape Matatula, Tutuila, American Samoa. Mean (± 1 SD) are given in boldface. There was no significant difference in % fertilization between caged and open inflorescences (two sample t-test $p > .05$).

Treatment	# Flowers	# Fertilized	% Fertilization
Caged	34	6	17.6
	69	7	8.7
	37	5	13.5
	27	4	14.8
	30	1	3.3
	6	1	16.7
	24	2	8.3
Mean % Fertilization (Caged)			**11.9 ±5.2**
Open	47	3	6.4
	23	4	17.4
	25	2	8.0
	16	1	6.3
	12	2	16.7
	13	4	23.1
	13	4	23.1
Mean % Fertilization (Open)			**14.4 ±7.5**

Figure 1. Recorded visits to *Syzygium dealatum* at Cape Matatula, Tutuila. Numbers in parentheses represent the number of species in that pollinator group, when different from one.