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The food and foraging of *Collocalia* and *Aerodramus* swiftlets: a review

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Abstract: Swiftlets (*Collocalia, Aerodramus*) make up a guild of birds which prey on a wide range of aerial insects and spiders. The studies reviewed here show their prey to include 19 orders and 55 families of insects plus spiders. Most swiftlets seem to take whatever is available at the time and place, with site to site and year to year differences noted. One species (black-nest swiftlet) appears to be a swarm-feeding specialist. Prey size ranged from <1 to 13 mm in body length and is related to swiftlet body size. Habitat and elevational differences may represent resource partitioning in foraging strategies.

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INTRODUCTION

Birds and insects have "intricate and fundamental ecological interrelationships" (Morse 1971). This is particularly true in cases where flying insects are exploited by guilds of avian predators. Guilds, as formulated by Root (1967), are made up of groups of birds which utilize similar environmental resources in a similar way regardless of their taxonomic relatedness. One particularly recognizable guild would consist of aerial insectivores, all of which capture their arthropod food on the wing. In Malaysia and other parts of south-eastern Asia this guild could consist of as many as 15 species of swallows, swifts, swiftlets, and treeswifts. However, not all of these may be resident species or ones that occur sympatrically. A more focused subset might be a guild made up of only swiftlets in the genera *Collocalia* and *Aerodramus*. This is a group of small to medium sized Apodiform birds which occur widely from the Seychelles in the western Indian Ocean eastward to India, Malaysia, north-eastern Australia, and islands of the Pacific Ocean as far east as Tahiti, and the Marquesas Islands (Holyoak

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& Thaibault 1978; Lim & Cranbrook 2002). Swiftlets are also noted for their utilization of caves as nesting and roosting sites. Individual caves can house up to 3–4 million swiftlets (Medway 1962a; Francis 1987; Lim & Cranbrook 2002). Swiftlets in the genus *Aerodramus* are known for their ability to utilize echolocation to navigate within nesting and roosting caves (Medway & Pye 1977; Collins & Murphy 1994; Price *et al*. 2004).

Aspects of the breeding biology have been documented in earlier studies of several swiftlet species (Medway 1962b; Harrisson 1974; Langham 1980; Hails & Amirrudin 1981; Waugh & Hails 1983; Tarburton 1986, 1993; Lourie & Tompkins 2000; Tarburton 2017). In addition to documenting the great diversity of prey items taken by some swiftlets, these studies have also directed attention to possible differences in foraging areas utilized by particular species (Medway 1962a; Diamond 1972; Harrisson 1974; Waugh & Hails 1983; Lourie & Tompkins 2000; Collins 2000a). Elsewhere, studies including a variety of other larger species of swifts have shown their diets to include a wide diversity of both taxa and sizes of prey, with substantial variation from place to place (Lack & Owen 1955; Gory 2008), season to season (Harrisson 1974; Cucco *et al*. 1993) as well as year to year at the same site (Tarburton 1993; Collins 2010). Local weather conditions may also influence short-term prey type availability and consumption (Lack & Owen 1955). In this review we summarize previous studies, and personal observations, of swiftlets from various regions of their extensive range. We give particular attention to their food and their foraging behaviour.

METHODS

In this review, we have summarized data presented in 20 earlier studies of 11 species of *Collocalia* and *Aerodramus* swiftlets and our personal observations. We also present new data on the diets of three swiftlets from Malaysia (Appendix 1). Body weight data were mostly derived from swiftlets which were weighed in the field at the point of capture. Some additional data were obtained from museum specimens. Data on prey type and size are largely from boluses of food, mostly insects, carried in the mouth by adults feeding nestlings. Boluses were usually ejected when the adults were captured in nets or if their mouth was gently opened. Adults were then released unharmed at the site of capture. To prevent possible detrimental effects on nestling growth, boluses in our studies were not collected on consecutive days from the same colony. The body size of prey items was measured from the tip of the head to the tip of the abdomen, excluding antennae or caudal appendages (Tarburton 1986, 1993, 2017).

As noted previously (Collins *et al*. 2009; Collins 2010, 2015) such food boluses are only available during the chick-rearing portion of the annual cycle. However, such samples may be more informative than the examination of stomach contents and faeces obtained at other times of the year which could underestimate smaller soft-bodied prey items which are subject to rapid fragmentation and digestion (Hartley 1948; Kopij 2000).

The waterfall swift (*Hydrochous gigas*), formerly known as the giant swiftlet, has been excluded from this analysis. It is much larger (37.8 g; Becking 2006b), does not use echolocation (Medway & Wells 1969; Medway & Pye 1977), and its behind-waterfall nest sites (Becking 2006a), nestling development (Becking 2006b) as well as its flight behaviour (King 1987) contribute to a rather problematic relationship to the more typical *Collocalia* and *Aerodramus* swiftlets (Collins 2000b). However, recent DNA analyses have again supported a relationship with *Aerodramus* (Price *et al*. 2005; Thomassen *et al*. 2005). No information is currently available on its diet or foraging behaviour.

The discussion of species limits among the swiftlets has a long history. As stated in a recent review (Cranbrook *et al*. 2013) this has "proved challenging because of their limited variation in size and plumage colouration". Even today, there is a lack of universal agreement on the taxonomy of all swiftlets in the genera *Collocalia* and *Aerodramus*. For the purposes of this review we have adopted the species limits and common names presented in the IOC World Bird List which covers the full geographic range of this group. Similarly, we follow CSIRO (1970) for the ordinal and family classification of insect prey items of swiftlets.

RESULTS AND DISCUSSION

Foraging behaviour

As noted in several studies, swiftlets arise at or before first light of dawn and pour out of their nesting and roosting caves "by the thousands per minute" (Lim & Cranbrook 2002) to spend twelve hours or more aloft in search of aerial arthropod prey, before returning in the "gathering dusk" (Medway 1962a; Ali & Ripley 1970; Harrisson 1974; Lim & Cranbrook 2002). Return entry flights may take several hours at some of the largest colonies and be extended on moonlit nights (Mane & Manchi 2017). Australian swiftlets (*A. terraereginae*) usually depart an hour later and return an hour earlier than the similar white-rumped swiftlet (*A. spodiopygius*) in Fiji which has been noted returning to their caves as late as 2230 h (Tarburton 1988). Three-toed swiftlets (*A. papuensis*) have also been observed leaving their cave before first light and returning as late as 0300h (Tarburton 2018). The Indian swiftlet (*A. unicolor*) in Sri Lanka and the Australian swiftlet in

Queensland have been observed opportunistically hawking insects in areas illuminated by floodlights hours after normal roosting times (Ali & Ripley 1970; Tarburton 1987). Similar behaviour has been observed in chimney swifts (*Chaetura pelagica*) in North America (Cottam 1932).

The foraging range of swiftlets was shown to extend for up to at least 24 km, (15 miles) from the nesting cave at Niah in Borneo, (Malaysia) (Medway 1962a) and possibly as far as 81–113 km (50–70 miles) (Harrisson 1974). In Vietnam, Germain's swiftlets (*A. germani*) make daily flights to mainland foraging areas up to 250–300 km from their island nesting caves (Nguyen Quang *et al.* 2002). Such distant and dispersed foraging ranges may be a necessity for individuals from very large colonies to find sufficient prey (Harrisson 1974).

In Malaysia, the majority of the swiftlets appear to forage between 9 and 266 m (20–800 feet) above ground level with only about 2% seen at 333 m (1,000 feet) or more above the forest canopy (Harrisson 1974). In Malaysia, a group of three species of swiftlets foraged at heights of 50–60 m (164–197 feet) above ground level which was lower than the foraging height of 114–184 m (374–604 feet) recorded for two larger swifts (Waugh & Hails 1983). Notable exceptions were the glossy swiftlet (*C. esculenta*) and black-nest swiftlet (*A. maximus*). In Malaysia, the black-nest swiftlet was stated by Medway (1962: 243) to forage higher than the sympatric mossy-nest swiftlet (*A. salangana*); this trend was not confirmed by later observations (Harrisson 1974: 380). However, black-nest swiftlets did tend to go farther from the nesting cave and stay out longer and possibly take advantage of patchily distributed swarming insects especially at dusk.

Glossy swiftlets were found to be the lowest elevation feeders among several swifts and swallows in Malaysia and closely associated with the forest canopy (Waugh & Hails 1983). They were similarly recorded foraging low over open landscapes in both rural and urban areas (Rabor 1954; Francis 1987; Lourie & Tompkins 2000). Also, in 2013, glossy swiftlets were observed foraging on *Schedorhinotermes* and *Odontotermes* sp. alates below three metres in Andaman Islands during a monsoon, when termite swarms leave the nest to seek out mates in order to form new colonies (A.M. Mane *unpubl. data*). They were observed foraging less than 3 m above the ground level and below the canopy level when sympatric with the similar sized pygmy swiftlet (*C. troglodytes*) on Palawan (Collins 2000a) and the uniform swiftlet (*A. vanikorensis*) on Vanuatu (Kratter *et al.* 2006). Glossy swiftlets were similarly observed foraging, "below the canopy level flying between trees" while the sympatric Halmahera swiftlet (*A. infuscatus*) was only observed foraging above the canopy (Riley 1997). On Karkar, Solomon Islands, two species of swiftlets had segregated foraging zones with the mountain swiftlet (*A. hirundinacea*) foraging in the open, high above the treetops while glossy swiftlets "flew over rivers, in clearings and even within the forest itself" (Diamond & LeCroy 1979). Similarly, in New Guinea, glossy swiftlets generally foraged below the level of the treetops, occasionally inside the forest in more open areas where they circled and skimmed close to the foliage, at times "even hovering at foliage like a hover-gleaning flycatcher" (Diamond 1972; Diamond & LeCroy 1979; Coates 1985). In New Guinea, there is also elevational segregation with glossy swiftlets and uniform swiftlets occurring in the lowlands and hills while the mountain swiftlet is widely distributed in mountainous areas up to 4,000 m elevation (Coates 1985).

Recently, detailed analyses have been made of the foraging behaviour of glossy swiftlets and white-nest swiftlets (*A. fuciphagus*) in the Andaman Islands, India, (Manchi & Sankaran 2010) and Germain's swiftlet in Thailand (Petkliang *et al.* 2017). These studies indicated that swiftlet foraging habits changed in response to changes in the food supply in different habitat types as well as the time of day and season.

The white-rumped swiftlet in Fiji typically foraged above the canopy in rainforest areas but also down to 0.5 m in well vegetated residential and agricultural areas (Tarburton 1986). In Queensland, Australia the similar Australian swiftlet largely inhabits drier savannah areas, and rarely foraged below 8 m (Tarburton 1993). Individual Palau swiftlets (*A. pelewensis*) and glossy swiftlets have been observed coursing back and forth in open areas <3 m high under the canopy of isolated trees (Hails & Amirrudin 1981; CTC *pers. obs.*). Such foraging bouts may allow them to forage on such unique prey as Lepidoptera larvae lowering themselves on silk threads to pupate in the ground litter (Appendix 1 & 2).

Diet

Swiftlets, like other Apodidae, gather all their arthropod prey on the wing. Individual boluses were found to contain 49–1,104 prey items and over 50 morphotypes (Lourie & Tompkins 2000). Included in their prey are representatives from 19 orders and over 55 families of insects and spiders (Appendix 2). Insects in the orders Hymenoptera, Diptera, Coleoptera, and Homoptera were the most abundant items in food boluses usually making up 82–99% of all individuals identified. Other orders such as Strepsiptera (Nguyen Quang *et al.* 2002), Neuroptera (Tarburton 1986), and Dermaptera (Appendix 1), were only represented in one

Table 1. The identity and occurrence (%) of invertebrate prey of eleven swiftlet species. Location: Mal = Malaysia, Phil = Philippines, At = Atiu Island, Sey = Seychelles Islands, Aust = Australia, Viet = Vietnam, Mar = Mariana Islands. ? = number of specimens not published.

Swiftlet species and location	***Collocalia esculenta***			***Aerodramus fuciphagus***						***A. sawtelli***	***A. elaphrus***	***A. spodiopygius***	***A. terrareginiae***	***A. salanganus***	***A. maximus***				***A. bartschi***	***A. vanikorensis***	***A. germani***
Prey Species	Mal	Mal	Mal	Mal	Phil	Mal	Mal	Mal	Phil	At	Sey	Fiji	Aust	Mal	Mal	Mal	Viet	Mar	Phil	Viet
Hymenoptera	41.8	43.8	48.3	55.2	37.7	38.6	42.5	40.8	22	62	6.4	22	18	46	88.5	97.9	83	88	29.6	13.0
Diptera	18.9	31.3	25.8	2.1	1.2	39.2	15.3	7.7	26.2	12	53.5	43	24	25.8	4.1	0.5	0	<1	3.3	18.4
Coleoptera	20.8	9.34	9.5	34.0	57.8	4.7	34.4	3.1	8.3	3	14.0	7	2	5.9	1.5	0.7	4	2	64	1.3
Homoptera	10.2	1.9	12.4	0	0	6.4	3.5	15.4	7.7	5	16.7	24	47	8.8	3.2	0.5	0	0	0	54.1
Hemiptera	0.4	0.1	0	0	0	0.9	0.2	1.1	5.4	0	1.8	0.1	3	0.6	0.2	0.1	9	6	0	1.0
Lepidoptera	0.4	12.4	0	0	0	0	0	0	15.5	7	0	0.1	<1	0.1	0.0	0	4	0	0	0.1
Psocoptera	2.7	0	1.6	0	0	1.3	1.1	3.3	0	0	7.9	0.1	0	0.8	0.3	0	0	1	0	0
Isoptera	0	0	0	1.8	0	2.1	0	0.1	1.8	6	0	2	2	0.1	0	0	0	1	0	0
Odonata	0	0	0	0	2.3	0	0	0	0.6	0	0	0	0	0	0	0	0	0	0.3	0.1
Orthoptera	0	0	0	0	0	0.5	0	0	7.7	0	0	0	<1	0.2	0	0	0	0	0	0
Blattodea	0	0	0	0	0	2	0	0	3.6	2	0	0	0	0	0	0	0	0	0	0
Ephemeroptera	1.1	0	0	0	0	0	0	26.4	0	0	0	0.0	0	0	0	0	0	0	0	0
Trichoptera	0.3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Thysanoptera	1	0	0.7	0	0	1.4	3.3	0.5	0	2	0	0.3	<1	2.8	0.5	0	0	0	0	0.1
Other / Unidentified	0	0	0	6.9	0	0	0	0	1.2	0	0	0.2	<1	0	0	0	0	0	0	10.6
Araneae	2.4	1.2	1.8	0	0	4.5	0.7	1.5	0	1	0	0.7	4	7.6	1.6	0.1	0	0	0	1.5
n	2,135	1,475	57	1,593	?	5,114	1,794	6,924	168	1,893	114	7,433	6,583	4,643	1,989	760	750	?	?	21,696
Source	1	2	3	4	5	1	2	10	13	6	7	8	9	1	1	2	12	11	5	12

Sources: 1 - Lourie & Tompkins (2000); 2 - Collins & Francis *unpubl. data*; 3 - Hails & Amirrudin (1981); 4 - Waugh & Hails (1983); 5 - Nituda & Nuneza (2016); 6 - Tarburton (2017); 7 – Collins & Cheke *unpubl. data*; 8 - Tarburton (1986); 9 - Tarburton (1993); 10 - Langham (1980); 11 - Valdez *et al.* (2011); 12 – Nguyen Quang *et al.* (2002); 13 - Rahman *et al.* (2016).

previous study. Spiders were present in 12 of the studies summarized here (Table 1) and averaged 3.7% (0–12%) of all identified prey items.

The great diversity of prey taxa taken by swiftlets reinforces the view that they are opportunistic foragers taking whatever suitable sized prey (see below) is available at any given time and place. They are quick to exploit localized, and sometimes ephemeral, abundances of suitable prey. Mayflies (Ephemeroptera) were only present in the food boluses of three swiftlets (Table 1) but made up 26.4% of 6,924 prey items taken by white-nest swiftlets in Malaya (Langham 1980). Mayflies accounted for <1.5% of the prey taken by glossy swiftlets and white-rumped swiftlets (Table 1). Beetles (Coleoptera) were present in the boluses of all of the swiftlets in this study. They were particularly numerous (57.8–64.0%) in the prey taken by glossy swiftlets and uniform swiftlets in the Philippines (Table 1). Termites (Isoptera, Macrotermitinae), some up to 13 mm long, were prominent in the stomach contents of swiftlets collected at the Niah Great Cave in Malaysia (Harrisson 1974). However, they only occurred in nine of the 20 samples examined in this study and never made up more than 6% of the prey in any one sample (Table 1). Like mayflies, termite abundance varies seasonally and thus may be an irregularly available prey type for swiftlets. Lepidoptera larvae were an unusual prey type taken by glossy swiftlets (Hails & Amirrudin 1981: Appendix 1 & 2) presumably while coursing below a tree canopy, as noted earlier.

A large portion of the prey items taken by most swiftlets were Hymenoptera, particularly winged ants (Formicidae). This was particularly true for black-nest swiftlets where 83.0–97.9% of their prey in both Malaysia and Vietnam were ants (Table 1). Some Neotropical swifts (Cypseloidinae) take similarly large numbers of flying ants (Collins & Landy 1968; Marin 1999; Rudalevige *et al*. 2003; Potter *et al*. 2015). These swifts are thought to forage widely in search of swarms of this lipid-rich prey. The data presented here support the previous suggestions of Medway (1962b) and Harrisson (1974) that black-nest swiftlets utilize a similar swarm-feeding strategy otherwise unique among the swiftlets.

Prey size

The size of the prey items swiftlets take varies substantially, ranging from 0.7 mm to 13.0 mm. The mean prey size is more consistent ranging from 1.71 mm in white-nest swiftlets to 3.64 mm in Australian swiftlets (Table 2). The exceptions are two samples consisting almost entirely of large ants taken by black-nest swiftlet, which averaged 3.74 mm and 7.39 mm (Table 2); 82.7% of their prey items were larger than 6 mm. Black-nest swiftlet also had significantly fewer prey items and morphotypes per bolus than sympatric species (Lourie & Tompkins 2000), again an indication of their specialization on large-bodied swarming ants (Lim & Cranbrook 2002). The distribution of the sizes of all prey items is available for four swiftlets (Tarburton 2017; Appendix 1). In three of the four cases the prey sizes are sharply positively skewed (Table 3); there being an abundance of smaller prey items <6 mm long (Figure 1). This presumably reflects the greater abundance of smaller prey items in the air column (Glick 1939). Larger prey items, when available, may be preferred as they would have greater energy value and proportionally less indigestible exoskeleton chitin.

Table 2. Body weight (grams) and prey size (mm) of swiftlets (*Collocalia* and *Aerodramus*).

Species name	Body size (g)	SE	n	Source	Prey size (mm)	SE	n	Source
A. fuciphagus (Malaysia)	10.67	0.43	365	1	1.71	0.03	5,114	8
A. fuciphagus (Malaysia)	10.67	0.43	365	1	3.09	0.05	1,611	9
A. spodiopygius (Fiji)	8.19	0.06	102	2	2.48	0.11	7,309	2
A. elaphrus (Seychelles)	8.95	0.18	19	3	2.51	0.08	114	3
A. sawtelli (Cook Islands)	8.56	0.06	144	4	2.6	0.05	1,893	4
C. esculenta (Malaysia)	7.13	0.03	133	5	2.61	0.03	1,456	9
C. esculenta (Malaysia)	8.28	0.28	114	6	2.72	0.14	2,135	8
A. salangana (Malaysia)	12.7	1	304	1	2.73	0.06	4,643	8
A. terraereginae (Australia)	9.3	0.03	567	7	3.64	0.24	6,583	7
A. maximus (Malaysia)	17.98	0.30	40	1	3.74	0.04	1,989	8
A. maximus (Malaysia)	17.98	0.30	40	1	7.39	0.08	760	9

Sources: 1 - C. M. Francis, *unpubl. data*; 2 - Tarburton (1986); 3 - Collins & Cheke *unpubl. data*; 4 - Tarburton (2017); 5 - Francis (1987); 6 - Hails & Amirrudin (1981); 7 - Tarburton (1993); 8 - Lourie & Tompkins (2000); 9 - Appendix 1.

Table 3. Distribution of prey sizes in the diets of four swiftlet species.

Species	Mean prey size (mm)	Range	n	skewness	% prey > 6mm
Glossy swiftlet (*C. esculenta*)	2.61	0.9–8.7	1,456	1.18	<1.0
White-nest swiftlet (*Aerodramus fuciphagus*)	3.09	0.7–10.3	1,611	1.82	10.3
Atiu swiftlet (*Aerodramus sawtelli*)	2.6	1.0–13.0	1,893	1.76	10.1
Black-nest swiftlet (*A. maximus*)	7.4	0.9–11.0	760	-0.84	82.2

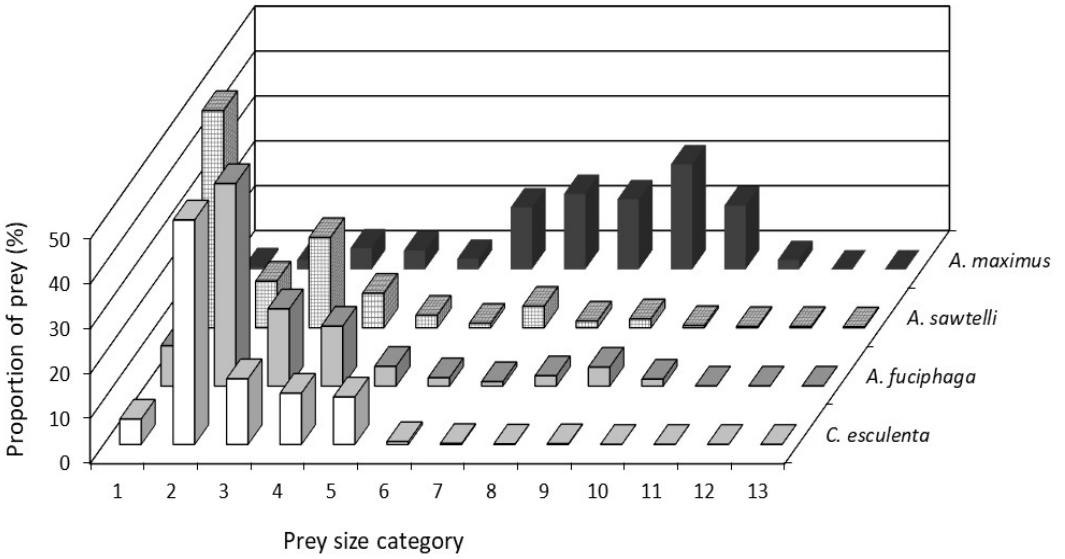

Figure 1. Proportion of prey sizes, showing abundance of smaller prey in three of the four swiftlet species (*Aerodramus*, *Collocalia*). Prey size categories indicated as follows; 1 = 0.5–1.4 mm, 2 = 1.4–2.4 mm, 3 = 2.4–3.0 mm, *etc*.

In the larger swifts in the genera *Apus* and *Tachymarptis* there is a positive relationship between prey size and predator body weight (Collins *et al*. 2009). For the swiftlets, there is a similar positive relationship (Table 2) although the body weights are more clumped ranging only from 7.1 g to 17.9 g (Table 2). A Spearman's Rank correlation of the data in Table 2 gives a probability of 90–95%, showing a loose correlation between body size and prey size.

SUMMARY

The food of both swifts and swiftlets consists entirely of aerial arthropods, mostly insects, captured on the wing. Swiftlets are often characterized as being opportunistic foragers taking whatever prey is available in the air column at a given time and place (Lack & Owen 1955). They can also be considered as generalists, as outlined by Morse (1971). However, the exact prey taken by swifts and swiftlets shows a lot of variability from place to place, season to season, and even year to year, at the same location. Prey size taken has long been assumed to be related to swift body size (Brooke 1973; Salmonson 1983) and recently documented for swifts in the genera *Apus* and *Tachymarptis* (Collins *et al*. 2009) and five Neotropical species (Collins 2015). This review of prey size in the smaller swiftlets confirms this expectation and extends it to the wide array of sizes found in both the swifts and swiftlets which make up the family Apodidae. A further finding is the swarm-feeding behaviour of the black-nest swiftlet which is convergent to the similar foraging behaviour shown by Neotropical Cypseloidine swifts. There are several examples reported here of habitat partitioning among swiftlets, presumably to avoid inter-specific competition. Such niche partitioning has been examined more closely

among a guild of Neotropical swifts (Collins 2015). The widespread distribution of the 32 currently recognized species of swiftlets includes many more examples of sympatry, and opportunities for habitat partitioning, the study of which would contribute further to our understanding of the foraging behaviour of swiftlets.

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Appendix 1. Arthropods in the diets of three swiftlets in Sabah, Malaysia: the black-nest swiftlet (*Aerodramus maximus*), the white-nest swiftlet (*Aerodramus fuciphagus*), and glossy swiftlet (*Collocalia esculenta*). Prey items were identified in food boluses obtained from black-nest and white-nest swiftlets living in the Gomantong Caves (Sabah, Malaysia) and the glossy swiftlets near Sandakan (Sabah, Malaysia). See Tarburton (2017) for details about collection and identification procedures.

Order	Family/Super family	Glossy Swiftlet	White-nest Swiftlet	Black-nest Swiftlet
Hymenoptera		639	685	744
	Formicidae	511	576	741
	Apoidea	22	1	
	Apocrita	101	108	2
	Brachonidae	-	-	1
	Colletidae	1	-	-
	Ichneumonidae	2	-	-
	Sphecidae	2	-	-
Coleoptera		136	554	5
	Bostrichidae	1	-	-
	Bruchidae	2	-	-
	Buprestidae	2	-	-
	Chrysomelidae	12	82	-
	Carabidae	-	-	1
	Curculionidae	51	6	-
	Coccinellidae	5	1	-
	Dermestidae	13	3	-
	Elateridae	4	-	-
	Histeridae	4	1	-
	Nitidulidae	2	2	-
	Ostomidae	-	7	-
	Phaloceidae	-	2	-
	Scaphididae	1	-	-
	Platypodidae	10	25	1
	Scarabeidae	-	2	-
	Scolytidae	15	303	3
	Staphylinidae	12	119	-
	Unidentified	2	1	-
Diptera		456	247	4
	Asilidae	3	-	-
	Bibionidae	2	1	-
	Chironomidae	2	-	-
	Dolichopodidae	1	-	-
	Otitidae	-	3	-
	Muscidae	-	-	1
	Mycetophilidae	7	-	-
	Nematocera	19	-	-
	Playpezidae	1	1	2
	Sepsidae	31	1	-
	Stratiomyidae	6	3	-
	Syrphidae	-	5	-

Appendix 1. *continued*

Order	Family/Super family	Glossy Swiftlet	White-nest Swiftlet	Black-nest Swiftlet
	Tachinidae	2	1	-
	Tephritidae	-	1	-
	Tipulidae	1	-	-
	Unidentified	381	231	1
Homoptera		27	54	4
	Aphididae	16	45	2
	Cicadellidae	2	2	-
	Fulgoroidea	7	5	2
	Membracidae	1	1	-
	Psyllidae	1	1	-
Hemiptera		2	4	1
	Aratidae	2	-	-
	Thomastocoridae	-	3	-
	Tingidae	-	1	-
	Unidentified	-	-	1
Lepidoptera		180		
	Gracillaridae	180	-	-
Thysanoptera			53	
	Phalothripidae	-	53	-
Isoptera				1
	Termitidae	-	-	1
Psocoptera			1	
	Unidentified	-	1	-
Dermaptera			1	
	Unidentified	-	1	
Araneae		16	12	1
	Unidentified	16	12	1
Total		1,456	1,611	760

Appendix 2. Orders and families of insects recorded as prey of one or more species of swiftlets (*Aerodramus*, *Collocalia*).

Hymenoptera: Formicidae, Apidae, Apocrita, Brachonidae, Colletidae, Ichneumonidae, Sphecidae, Pteromalidae, Torymidae.
Coleoptera: Bostrichidae, Bruchidae, Bupestidae, Chrosomelidae, Carabidae, Curculionidae, Coccinellidae, Dermestidae, Elateridae, Histeridae, Nitidulidae, Ostomidae, Phaloceidae, Scaphididae, Scolytidae, Staphylinidae, Cryptophagidae, Mordellidae.
Diptera: Asilidae, Bibionidae, Chironomidae, Dolichopodidae, Otitidae, Muscidae, Mycetophilidae, Playpezidae, Sepsidae, Stratiomyidae, Syrphidae, Tachinidae, Tephritidae, Tipulidae, Tamypedidae, Sciaridae, Chloropida.
Homoptera: Aphididae, Cicadellidae, Fulgoridae, Membracidae, Psyllidae.
Hemiptera: Aratidae, Thomastocoridae, Tingidae.
Ephemeroptera: Ephemeridae.
Blattodea: Blattidae.
Lepidoptera: Gracillaridae.
Thysanoptera: Phalothripidae.
Isoptera: Termitidae.
Psocoptera: Pseudocaecillidae.
No families were identified for prey in the following orders: Dermaptera, Neuroptera, Strepsiptera, Phasmatodea, Orthoptera, Thysanura, Odonata, Trichoptera.