Another Seychelles endemic close to extinction: the emballonurid bat *Coleura seychellensis*

Laura Bambini, Andrew Blyth, Tim Bradford, Rachel Bristol, Sarah Burthe, Louise Craig, Nick Downs, Sinclair Laing, Lorraine Marshall-Ball, Denise McGowan, Terence Vel and Paul Racey

Abstract The only microchiropteran endemic to the granitic Seychelles, the sheath-tailed bat *Coleura seychellensis*, is categorized as Critically Endangered on the IUCN Red List. Using bat detectors, the islands of Mahé, Praslin and La Digue were surveyed to establish the current distribution of this species. Although two new roosts were discovered on Mahé, no bats were observed on Praslin and La Digue, and the range of *C. seychellensis* appears to have further contracted in the last 2 decades. A total of 19 *C. seychellensis* were counted emerging from or entering three roosts in boulder caves on Mahé during 18 evenings of observations. The bats foraged in open coastal habitat, some of it anthropogenic, and their echolocation calls were also characteristic of bats feeding in open habitat. This study provides no evidence that *C. seychellensis* is dependent on forest or wetland for foraging. Dietary analysis indicated that *C. seychellensis* feeds on Coleoptera, Lepidoptera and Diptera. A public education programme to highlight the conservation status of the bat and the consequences of roost disturbance is recommended, together with the urgent need for legal protection of the bats and their roosts.

Keywords *Coleura seychellensis*, dietary analysis, distribution, echolocation, roosts, Seychelles.

Introduction

The endemic sheath-tailed bat *Coleura seychellensis* is the only microchiropteran found in the granitic Seychelles. Historically recorded as abundant (Wright, 1868), the current population has been estimated at 50–100 individuals (Gerlach, 1997; Rocamora, 1997). The species is categorized as Critically Endangered on the IUCN Red List (IUCN, 2006) based on criteria C2a(i, ii), which indicates that the small population size and rate of decline are of great concern and likely to result in extinction unless action is taken. Apart from studies on a colony of *C. seychellensis* on Silhouette, there is little information on the species' distribution, roosting and foraging habitats or other aspects of its ecology (Gerlach, 1997, 2004; Hutson *et al.*, 2001). It is sexually dimorphic, with females (10–12 g) larger than males (*c.* 10 g), and is a long-winged fast-flying species with high aspect ratio and wing loading (Nicoll & Suttie, 1982).

Surveys in 1972, 1974 and 1976 found bats in low numbers in a boulder cave in Jardin Blanc, La Digue (Racey & Nicoll, 1984), and a maximum of 12 bats was counted in a cave on Praslin in June 1980 (Nicoll & Suttie, 1982). Bats were sighted on Mahé in 1993 and 1994 (Matyot, 1995) and a Glasgow University Expedition found bats on the west coast of the island in 1996, together with a single individual on Praslin but none on La Digue (Mellanby *et al.*, 1996). Joubert (2004) reported sightings of foraging bats on Mahé and an occupied roost on Silhouette. The Silhouette population is reported to have increased since 2001, and currently numbers 32 (Gerlach, 2004). The older residents of Mahé recall seeing the bats in greater numbers, and in areas now abandoned by bats, until the 1960s (pers. comms), and residents from Silhouette have reported that bats were abundant until the late 1970s (Joubert, 2004).

In accordance with the specific research needs identified for *C. seychellensis* in the Microchiropteran Action Plan (Hutson *et al.*, 2001), the aim of the present study was to survey the granitic islands of Mahé, Praslin and La Digue for *C. seychellensis* in an attempt to locate roosts, to establish the bats' foraging habitat and diet, and to assess its conservation status.

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Materials and Methods

Field work was carried out during the dry season (June–September) of 2004, when members of the Bats on the Brink 2004 Expedition were resident on Mahé; 6 days were spent on Praslin and 4 days on La Digue. Internal restrictions meant that it was not possible to visit Silhouette.

Distribution

Bat detector surveys were carried out on foot during June and July. On Mahé 26 2-km transects were surveyed so that all types of habitat (coastal, low altitude forest and upland forest) were included (Fig. 1). Transect h in Port Launay (Fig. 1) included a 200 m stretch along the edge of a small mangrove swamp, and an upland marsh in the Morne Seychellois National Park was surveyed on one occasion. In particular, areas where sheath-tailed bats were previously reported by Mellanby *et al*. (1996) were surveyed. Because of the extent of human development on the islands, and because much of the terrain was difficult, transects were restricted to roads and footpaths. Each transect was walked twice, on different nights, between 18.30 (dusk) and 19.30. Additionally, car surveys were carried out twice, driving around the coastal road at slow speed and holding a bat detector out of the windows on each side. Batbox III detectors (Batbox Ltd, West Sussex, UK) were used for all surveys, set to a frequency of 40 kHz (Nicoll & Suttie, 1982).

Roost searches

Because roosts had previously been reported in boulder caves (Nicoll & Suttie, 1982), roost searches were carried out in boulder fields near the areas where bats were frequently heard on bat detectors. The team was informed of the location of one roost, in Anse Major. Searches for additional roosts were conducted at dusk and dawn, during a 2-day period in Port Launay and a 6-day period in Baie Lazare on Mahé. During these searches observers with bat detectors were positioned 50–100 m apart around an area with a suspected roost. Times of bat passes were recorded, and by comparing the times when different observers encountered the bats the suspected roost location was reassessed and the observers moved closer to the putative roost location for the next search.

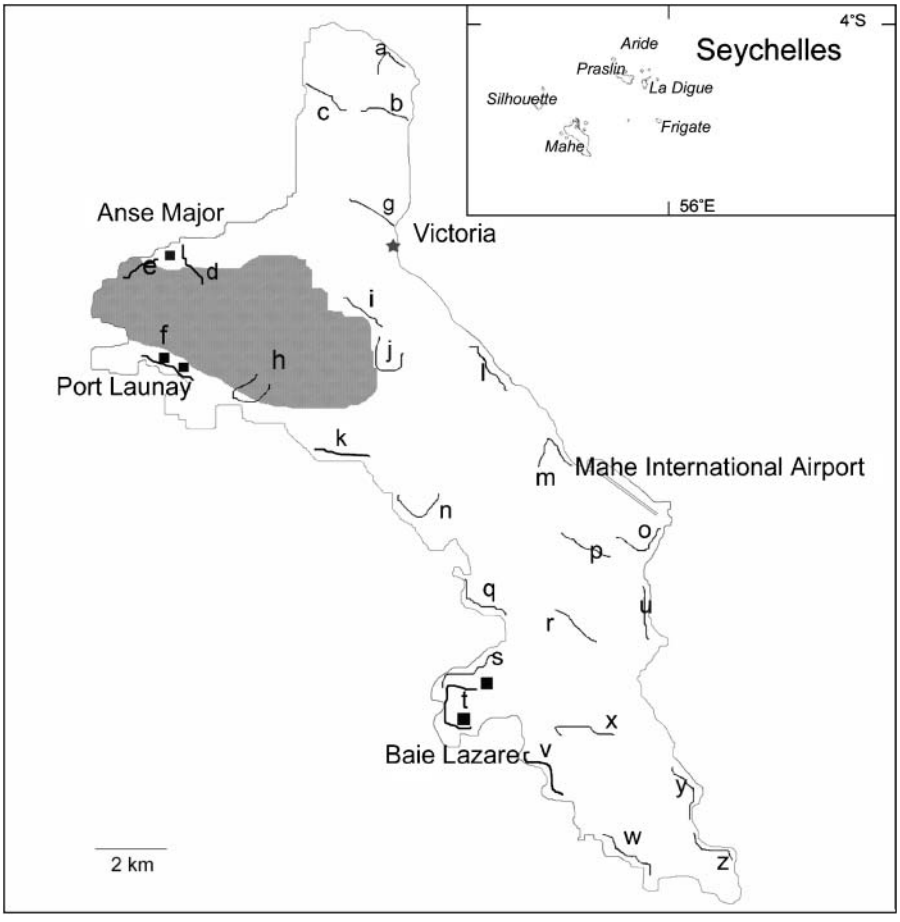

Fig. 1 The 26 transects on Mahé (a–z), surveyed on foot with bat detectors between June and September 2004. *C. seychellensis* was found on six transects (d, e, f, k, t & v). Three roosts are known, from the Anse Major, Baie Lazare and Port Launay districts. The filled boxes mark the five known bat feeding sites. The shaded area refers to the approximate extent of Morne Seychellois National Park.

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Boulder fields were also searched during daylight for potential bat roosts. Because of the species' threatened status, roosting bats were not disturbed.

Bat activity

A total of 7 all-night observations were made at the three known roosts on Mahé to determine times of activity and feeding rates and to assess the importance of roost surroundings as foraging habitat. Foraging data were collected using Batbox III bat detectors and stopwatches. The duration of the bat passes (from when a bat orientation call was first heard to when it was last heard) was noted, and the numbers of feeding buzzes (a series of rapidly repeated calls emitted in a sequence with decreasing pulse intervals, preceding prey capture) were counted.

Three nights were spent at both the Anse Major and Port Launay roosts, and 1 night at the Baie Lazare roost. Observations were made on behaviour and the direction of flight of individuals away from the roost. We attempted to establish the numbers of bats occupying each of the known roosts by counting bats emerging from and returning to the roost. Emergence counts were carried out at dusk on six evenings at the Port Launay roost, five evenings at the Anse Major roost, and once at the Baie Lazare roost. For both the emergence counts and the all-night observations, observers were placed at a vantage point with a clear view of the roost exit.

Faecal pellets were collected from the floor of the cave roosts on Mahé and stored in 70% ethanol. Insect remains were teased apart, examined under a x40 microscope, identified to order using Shiel *et al*. (1997) and Whitaker (1988), counted, and percentage prey of each order was estimated.

Recordings of the echolocation calls of *C. seychellensis* were made using a Pettersson D240-x heterodyne and time expansion bat detector (Pettersson Elektronik Ab, Sweden) and a minidisk recorder. Recordings were made inside the roost caves, and outside in forest edge habitat, where bats were flying at a height of 3–8 m above the ground. The call structures were analysed using *BatSound Pro* software (v. 3.10 1996–2000, Pettersson Elektronik Ab, Sweden). Call parameters (duration of calls and length of the pulse interval, minimum and maximum frequencies, frequency of greatest amplitude) were measured from three sequences of commuting calls, and from one call sequence preceding prey capture.

Results

Distribution

On Mahé bats were only encountered on six of the 26 transects (Fig. 1), all on the less developed west coast, from the north to the south of the island. Three of these transects were coastal and at low altitude, following roads or trails. One transect, in the south of the island, was on a hill at 150–250 m altitude. No bats were encountered on the more developed east coast. Three of the transects on which bats were found (d, e, f; Fig. 1) were at the edges of the Morne Seychellois National Park, but the other areas where bats were found are susceptible to further human development. Individual bats were occasionally encountered inside the National Park, on the footpath to Anse Major (transect e).

Bats were mostly seen flying over roads, either commuting or foraging, at a height of 2–10 m. Foraging bats were encountered in five localities (Fig. 1), most frequently at Port Launay. Usually only one bat was seen at a time, although in Port Launay and Anse Major bats were occasionally seen in pairs. Bats were also observed flying up to the canopy and flying along the coast at the water's edge. Bats were present in developed areas near houses, sometimes foraging around street lights, and in some areas local residents reported regularly seeing individual bats flying around gardens.

No bats were encountered on Praslin or on La Digue, and an attempt to locate the previously occupied roost at Jardin Blanc, Grand Anse, in the south-east of La Digue was unsuccessful.

Roosts

We discovered two previously unknown roosts on Mahé, in Port Launay and Baie Lazare. A third roost on Mahé, in Anse Major, was previously known but had not been described. The roost in Port Launay, discovered in July 2004, is situated at the foot of the Mare aux Cochon hill within 100 m of the coast, where boulders of various sizes form a complex system of chambers and passages at different levels. Bats were seen flying into darker compartments of the cave, and no social calls were heard from within, suggesting the cave extends deeply. Four exits were found, two of which, one facing south and the other south-east, were used regularly. The exits are partly obstructed by native and non-native vegetation including *Dracaena reflexa*, *Altocarpus altilis*, *Lantannyen milpat* and *Musa* spp. This roost is situated at the periphery of the Morne Seychellois National Park, but outside the Park boundaries. A pylon line has been cut through the vegetation near the south exit, and dead wood was abundant. Plastic litter and empty bottles outside the roost suggest periodical human disturbance.

The roost in Bel Ombre, Anse Major, is in a large tidal boulder cave beneath a coastal glacis (exposed rocky outcrop) *c*. 10 m from the sea. Light enters the main cavern through openings at the top and bottom of the glacis, and there are at least two darker and smaller

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compartments at each end of the main cavern. Bats were observed flying into these compartments, where they are presumed to roost. In the well lit part of the cave 3–5 roosting bats were observed. Two exits were found: a long and narrow opening at the top of the cave, facing south, and a larger opening at the bottom of the cave facing north (rarely used by bats), both unobstructed by vegetation. An exit was also found at the side of the cave but only one bat was observed emerging from this narrow opening, which was obstructed by native and non-native vegetation (*Canthium* spp., *Euphorbia pyrofolia*, *Chrysobalanus icaco*). Signs of human disturbance were evident, with litter and broken glass inside the main cavern and in the surrounding area.

The roost at Baie Lazare, discovered in September 2004, is in a boulder field situated at the top of a steep river valley at *c*. 100 m altitude and <800 m from the coast. The main cavern has a low (<2 m) ceiling sloping at *c*. 45°. Bats were observed flying into the dark areas at the back of the cave. Only one exit was found, facing south and opening to the main cavern, and *c*. 160 cm from the ground. Bats were seen leaving through the exit and flying through a gap between two boulders. An endemic palm (*Verschaffeltia* spp.) partly covered this route. The roost is surrounded by native and non-native vegetation, with a high incidence of endemic plant species. It is relatively undisturbed, although a local hotel owner revealed development plans for the area.

Activity

The first bat emergences from the Anse Major roost were at 18.42–18.47, generally individually, occasionally in twos, and once three were seen leaving together. After leaving, bats generally flew along the coast and occasionally down the glacis towards the sea. Following emergence, feeding attempts were observed in the vicinity of the roost. Bats were active at this roost throughout the three nights of monitoring (Fig. 2) but with a period of reduced activity around midnight. Bats emitted audible social calls within the roost, and circled in flight around the top entrance and over the glacis. Strong or gusty winds are common in this area, and bats were sometimes seen struggling against the easterly wind and being blown westwards. Bats began to return individually or in groups of 2–3 from 05.00 onwards, and a total of eight were seen entering the roost. Observers entered the large cavern of the roost on several occasions, and 4–5 bats were seen roosting in the well lit area near the top entrance, 1–2 m apart, and some initial alarm calls were emitted. Bats were observed chasing one another in flight, and when roosting sometimes flapped their wings in what appeared to be a form of display.

On the one night of monitoring of the Baie Lazare roost, bat activity started at 18.20, when social calls were heard within the roost. Bats were heard flying inside the roost, and at 18.32 one bat emerged briefly. Four bats were later observed leaving the roost together. Bats foraged in an opening in the vegetation near the roost cave, and circling flight was observed both in foraging bats and in bats leaving the roost. The bats returned to the roost at intervals, sometimes following each other. Bats flew either solitarily or in groups of 2–3. Individuals leaving the roost to forage elsewhere flew south or south–west. Bats maintained similar activity levels around the roost throughout the night except around midnight when no bats were observed leaving the roost (Fig. 2).

Emergence from the Port Launay roost was at 18.32–18.38, individually or in pairs, and occasionally in threes. A maximum of seven bats were observed emerging. High levels of activity, including foraging activity in the vicinity of the roost, were maintained throughout the night (Fig. 2) with peaks at dusk and dawn. Bats flew around the area cleared for the pylon line, at a height of 5–8 m. Individuals were seen flying east, west and north-east. Bats were observed in flight near the roost,

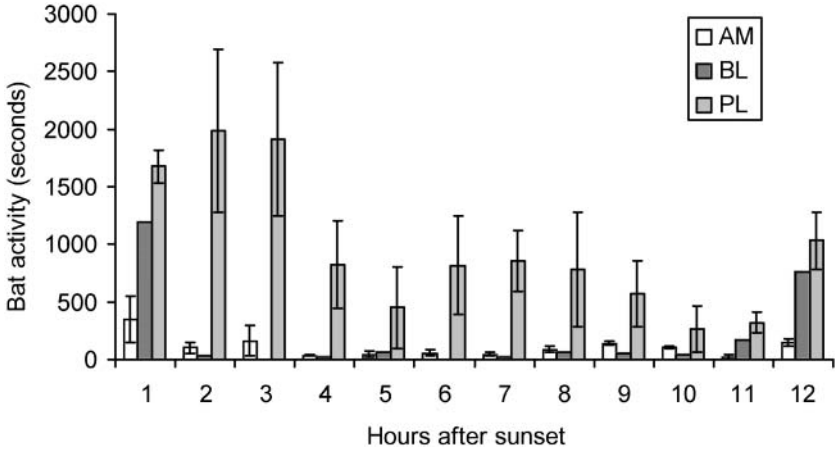

Fig. 2 Bat activity observed at the Anse Major (AM), Baie Lazare (BL) and Port Launay (PL) roosts during seven nights of monitoring, expressed as mean ± SE duration of bat activity (seconds) each hour after sunset. Observations were carried out from dusk (18.30) until dawn (06.00). Anse Major and Port Launay roosts were monitored over three nights, and the Baie Lazare roost was monitored for one night only.

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where 2–3 bats often foraged together or performed manoeuvres in the air, chasing each other and emitting audible calls. Within the large caverns of the cave complex we observed 4–5 bats flying together between compartments. Once, five bats were observed in what appeared to be aggressive interactions, chasing and flying towards each other.

Foraging was observed around the roosts at dusk (18.30–19.30) and dawn (05.30–06.00), when it was possible to confirm visually that the bats were foraging. On average 12.4% (n = 319) and 12.7% (n = 102) of the bat passes contained feeding buzzes at the Anse Major and Baie Lazare roosts, respectively, whereas at the Port Launay roost 30.8% of the bat passes (n = 1,614) contained feeding buzzes.

Diet

Faecal analysis revealed that *C. seychellensis* consumed Lepidoptera, Coleoptera and Diptera, with Coleoptera most prominent (Table 1). Lepidoptera were present in most samples, and in samples from all three roosts.

Echolocation calls

The bats emitted echolocation calls at frequencies of 12.0–46.6 kHz. The calls in the search phase and the feeding buzz were frequency modulated over a narrow bandwidth, consisting of two harmonics with a steep downward modulation (the second harmonic modulated over *c.* 3–9 kHz). In the search phase most power was in the second harmonic, whereas in the feeding buzz the first harmonic had the greatest amplitude. The second harmonics were at 27.9–46.6 kHz (Fig. 3) and the first harmonics were often in the range audible to the human ear (Table 2).

When commuting or searching for prey, bats emitted calls of two distinct types, characterized by different frequencies. These two types of calls were usually alternated in a sequence (Fig. 3). Following prey localization, the bats lowered the frequency (kHz) of the calls and increased the duty cycle (proportion of time when calls are emitted), shortening the inter-pulse interval. Occasionally, the feeding buzzes were audible to the observers as they were emitted at lower frequencies. Bats also emitted calls at lower frequencies when flying inside the roost cave (Table 2), and social calls were audible to observers outside the roost exits.

Discussion

Distribution and roosts

Our study indicates the population of *C. seychellensis* has undergone further range contractions in the past 2 decades (Nicoll & Suttie, 1982; Mellanby *et al.*, 1996; Joubert, 2004). Although the present distribution of bats on Mahé is similar to that reported a decade ago, some areas previously occupied (Joubert, 2004) now seem to have been abandoned. Bats appeared to be more abundant around the periphery of Morne Seychellois National Park, perhaps indicating more favourable conditions around the edges of the protected area. The wind patterns in the Seychelles show a marked seasonal variation, so that during the dry season (May–October), strong south-easterly winds prevail in contrast to the moderate north-westerly wind dominating the wet season (November–March). This could result in different roosts being used in different seasons but all records to date are for the dry season.

The bats showed a clear preference for coastal areas, and although individual bats were occasionally found further inland, they never occurred at high elevations. Two of the known roosts are within 100 m of the sea, and the Baie Lazare roost, furthest from the coast, is at low altitude. In view of the abundance of sizeable boulder caves on the east coast of Mahé, roost availability is, despite human development pressure, unlikely to be a limiting factor for *C. seychellensis*. Common to all roosts was the presence of a large main cavern, which the bats used when flying between more secluded roosting compartments. Historically, such caves were used by escaped prisoners and slaves, and roost disturbance appears to be ongoing, judging from the litter found in and around the caves.

Table 1 Proportion of prey items of each insect order, assessed from faecal analysis. Total identifiable fragments refers to number of prey items identified in the faeces under a binocular x40 microscope.

Origin of sample	Coleoptera (%)	Diptera (%)	Lepidoptera (%)	Others (%)	Identifiable fragments	No. of pellets
Anse Major (August 2004)*	10	70	5	5	*c.* 35	10
Anse Major (August 2004)		90	10		10	5
Baie Lazare (September 2004)	100				10	5
Port Launay (August 2004)	30	*c.* 50	20		15	5
Port Launay (September 2004)	80	20			10	5

*Sample obtained by placing a plastic sheet on the floor of the cave; collection period *c.* 5 weeks.

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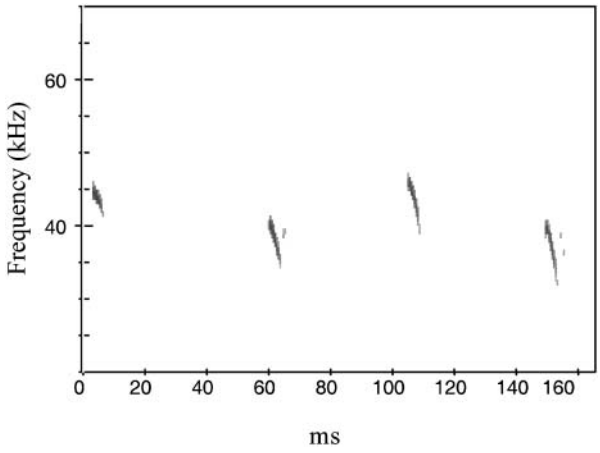

Fig. 3 An example of a search phase echolocation call sequence of *C. seychellensis*. The calls were frequency modulated, with most energy in the frequency range of 33–45 kHz. The consecutive calls shown here vary between high and low calls with different start and end frequencies.

Obstacles on the approach to a roost can affect their accessibility to bats (Fenton *et al.*, 1998) and the roost entrances always contained an area (>1 m^2) unobstructed by vegetation, although the bats were observed occasionally using partially obstructed entrances. The entrances face south, in contrast to Wright's (1868) report of roost sites with 'north-facing entrances screened by palm leaves'. It has also been reported that bats have occasionally roosted in dark corners of the ceiling of an old house on Silhouette (Matyot, 1995).

Habitat use, foraging behaviour and activity patterns

The fact that bats were found commuting and foraging over roads, around streetlights, near houses and over gardens, suggests that *C. seychellensis* is not forest dependent. Although coastal zone marshlands have previously been suggested as foraging habitat for this species (Gerlach, 2004; Joubert, 2004) we found no evidence in support of this as no bats were encountered in marshy areas. However, this finding is not conclusive, as the extent of the area surveyed limited the amount of time spent monitoring any particular area, and more studies are required to assess habitat use. Nevertheless, our results suggest that *C. seychellensis* forages in anthropogenic habitat. Bats from the Port Launay roost foraged in the vicinity of the roost, where felling of trees for the pylon line has created a clearing and potentially increased insect abundance (Russo & Jones, 2003). Faecal analysis confirmed that *C. seychellensis* has a broad diet (Joubert, 2004; Gerlach & Taylor, 2006), and the varying relative abundance of each insect order suggests the bats are not dependent on any particular prey taxon.

Number of bats remaining

The replicated counts carried out at each of the known roosts confirmed the existence of a minimum of 19 bats on Mahé. The number of bats in the Port Launay roost is likely to be higher than the seven confirmed in the emergence counts, and was estimated to be at least 12. The observed number of bat passes at the Port Launay roost during the overnight monitoring greatly exceeded that of the other roost sites, suggesting a larger colony at this roost. At the Anse Major roost a total of eight bats was counted; the simple structure of the cave, and the frequent observations of bats flying in the main cavern indicated that this was a relatively accurate estimate. The number of bats in the Baie Lazare roost is probably higher than the four reported there; limited time was

Table 2 Call parameters measured from four echolocation call sequences recorded from *C. seychellensis*. Commuting sequences contained calls of two distinct types characterized by different frequencies. These call types were alternated and their mean parameter values are presented separately (high and low calls). The interpulse interval (presented here as a mean for each sequence) was measured from the start of a call to the start of the next one in the sequence.

			Mean call frequency (kHz) ± SE			Call timing (ms) ± SE		
Situation	Call type	No. of calls	Max	Min	Peak energy	Duration	Pulse interval	No. of intervals measured
Commuting								
Forest edge	High calls	4	43.48 ± 0.38	40.55 ± 0.27	41.83 ± 0.36	9.2 ± 0.9	82.5 ± 9.3	9
	Low calls	6	39.22 ± 0.14	33.68 ± 0.46	37.13 ± 0.18	11.6 ± 0.6		
Forest edge	High calls	3	44.27 ± 1.07	38.30 ± 0.21	41.61 ± 0.72	8.4 ± 0.2	104.4 ± 12.8	4
	Low calls	2	40.15 ± 0.15	33.90 ± 0.00	36.91 ± 0.01	9.5 ± 0.5		
Inside roost	High calls	3	37.07 ± 0.03	28.03 ± 0.35	28.50 ± 6.08	7.0 ± 2.0	103.2 ± 11.8	5
	Low calls	3	35.77 ± 0.32	28.07 ± 0.63	28.66 ± 4.23	5.7 ± 0.3		
Foraging in open space								
Over road	Feeding buzz	29	18.34 ± 0.10	12.15 ± 0.12	16.19 ± 0.18	3.5 ± 0.1	9.8 ± 1.3	28

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spent monitoring this roost after its discovery. Regular sightings of bats in two areas where no roosts are known (Fig. 1) raises the possibility that additional roosts remain to be discovered. Nevertheless, the surveys carried out in 2004 are consistent with previous estimates that the total population size of *C. seychellensis* is unlikely to exceed 100 individuals (Gerlach, 1997; Rocamora & Joubert, 2004).

Causes of population decline

The forests of the biogeographic region that includes the Seychelles are considered threatened (Olson & Dinerstein, 1998). Two centuries of human colonization have meant that logging, clearing, fire, cultivation and secondary succession have wiped out most of the original lowland and coastal forests on Mahé (Procter, 1984). The present total of 295 introduced plant species constitutes 57% of the flora (Procter, 1984) and this preponderance of non-native species has had a detrimental effect on the insect fauna of the islands (Lionnet, 1984). It is not known what has caused the decline of *C. seychellensis*, although increased human disturbance of caves, habitat degradation (Gerlach, 1997) as well as predation by barn owls *Tyto alba* have been suggested (Racey & Nicoll, 1984). Predation by domestic cats and rats cannot be discounted (Racey & Nicoll, 1984).

Pesticides have been used to a limited extent on the islands. Pyrethrum synergist and malathion were used in the 1970s to control sandflies (Laurence & Mathias, 1970). Diazinon was also used to control sandflies, and dieldrin was sprayed on the coconut plantations to control *Melitomma* spp. (Coleoptera: Scarabidae; Way, 1973). Some larger scale spraying occurred on Praslin pre-1977, when para-dichlorobenzene fumigation was carried out on coconut plantations, and other organochlorides were used to some extent (Mathias, 1971). Some of the pesticides used in the Seychelles have low mammalian toxicity (e.g. pyrethrum; Morse & McNamara, 2004), and the sprayings undertaken were probably on a small scale. However, the treatments were concentrated in the coastal zone (Laurence & Mathias, 1970) where the bats forage, and some of the substances used can potentially have an adverse effect on wildlife. Russo & Jones (2003) have demonstrated pesticide use can affect bat populations through changes in insect communities.

The future of *Coleura seychellensis*

When the number of local populations is small, and each contains only a few individuals, the metapopulation is not likely to survive for long (Hanski *et al.*, 1996). Key threats to small populations include demographic and environmental stochasticity and loss of genetic variation (Caughley & Gunn, 1996), and it is often impossible to determine a particular size at which the population is no longer at risk from extinction (Soulé & Simberloff, 1986; Thomas, 1990; Hanski *et al.*, 1996). Most authors agree that for stable populations in stable environments, 500 individuals may be sufficient to guarantee long-term persistence of the population and an effective population size of 50 individuals may be enough to prevent serious inbreeding problems (Thomas, 1990; Gray, 1996).

Small populations should not, however, be 'abandoned as hopeless' (Thomas, 1990), as many populations have managed to recover from small numbers (Samson *et al.*, 1985; Caughley & Gunn, 1996). Although the Seychelles kestrel *Falco araea* was reduced in numbers in the 1960s and 1970s, at present a stable population of 370 pairs is reported on Mahé (BirdLife International, 2005). Similarly, the Seychelles magpie-robin *Copsychus sechellarum* declined to <20 individuals in the 1960s. A recovery programme was initiated in 1990, by 1994 the number of birds had more than doubled, and in 2004 the population size was 136 (BirdLife International, 2005). The Seychelles black paradise-flycatcher *Terpsiphone corrina* has also recovered from a low of *c*. 50 individuals in the 1980s to >200 individuals in 2001 (Currie *et al.*, 2003).

As pesticide use is identified as a potential cause of the decline of *C. seychellensis*, we recommend that control and mitigation measures are implemented to prevent unnecessary further accumulation of harmful substances in the island ecosystem. A comprehensive ecosystem impact assessment regarding chemical use in the past could benefit environmental management programmes in the Seychelles in general, as pesticide use has been linked to the decline of other Seychelles endemics (e.g. the Seychelles kestrel; BirdLife International, 2005). It remains unclear whether any such initiatives are currently in place.

Although the prevention of disturbance of bats in their roosts is a requirement for the survival of *C. seychellensis*, fencing or grilling of roosts in boulder fields would be difficult, mainly because of the open nature of the roosting caves. Although Rocamora (1997) recommended that the roost sites are given legal protection, and also that foraging areas of the bats are protected from further development, no action appears to have been taken. We additionally recommend that because of their rarity the bats are given legally protected status.

A public education programme raising awareness of the existence of, and threats to, the bats, is likely to improve the status of the Seychelles sheath-tailed bat. Education has successfully improved the conservation of endemic megachiroptera *Pteropus* spp. on other western Indian Ocean islands (Trewhella *et al.*, 2005). Public perception of the bats among the Seychellois seemed to vary from not knowing they existed, through indifference

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to genuine interest and concern for their survival. An effective public education campaign promoting community-based conservation action, and the designation of a protected area in the south of the island where no protected areas exist, may improve the chances of survival of *C. seychellensis*.

The Bats on the Brink 2004 Expedition has produced a preliminary Species Action Plan that incorporates these recommendations, and outlines an immediate course of action to prevent the extinction of this species (Bambini *et al*., 2005). This Action Plan recommends a continuous and comprehensive monitoring programme to ensure that any conservation action taken has a positive impact on the population. To date, no such programme exists despite being recommended by Rocamora (1997) and Rocamora & Joubert (2004), although the Seychellois conservation authorities have carried out some intermittent bat detector surveys. Additional bat detectors were presented to these authorities by the Bats on the Brink Expedition to encourage increased monitoring efforts. To refine the Action Plan further, research is also required to identify the specific habitat requirements of *C. seychellensis*.

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Biographical sketches

Prior to visiting the Seychelles the members of the Bats on the Brink Expedition all had previous experience of field research with bats either in the UK or elsewhere when they were associated with Paul Racey's research group in Aberdeen, UK. Laura Bambini, Andrew Blyth, Tim Bradford and Louise Craig are currently completing Master's degrees. Sarah Burthe and Lorraine Marshall-Ball have completed their PhDs and Lorraine now works for the RSPB. Nick Downs and Sarah now work with environmental consultancies, Denise McGowan is working at the Durrell Wildlife Conservation Trust, and Sinclair Laing is working in the Environmental Sustainability Section at Aberdeen City Council and about to embark on a canopy research expedition to Borneo. Terence Vel was a successful applicant for a BP Conservation Programme Follow up Award and with the support of Rachel Bristol will continue conservation efforts for *Coleura seychellensis* in the Seychelles.

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