Madagascar has developed a unique avifauna because of its early split from the African continent about 160 million years ago (Rabinowitz et al. 1983; Krause 2003). A total of 283 species (of which 209 breed regularly on the island) has been recorded from Madagascar, of which 109 species are endemic (Hawkins & Goodman 2003). The Ashy Cuckoo-shrike Coracina cinerea is one such endemic species, and is common throughout Madagascar (Langrand 1990). The family (Campephagidae) is represented by more than 70 species occurring throughout the Old World tropics. Only one species, the Ashy Cuckoo-shrike, nests in Madagascar (Sinclair & Langrand 2003).

The Ashy Cuckoo-shrike occurs in lowland and mid-altitude evergreen humid forest, dry forest and gallery forest (Langrand 1990). It is gregarious, sometimes found alone or in pairs but more often accompanies mixed-species flocks where it is usually to be found in the canopy (Langrand 1990; Hino 1998). Langrand (1990) described the shallow bowl-shaped nest, one clutch and the egg color (roseate-white egg spotted with red) of this species. However, the breeding system, in particular the relative contributions of the sexes and detailed observations during different phases of reproduction, have not been described. The adults of this species feed on invertebrates include Coleoptera, cicadas, mantises et al. (Langrand 1990), but no information is available on the nestling diet. The aims of this study are therefore: (1) to provide the first detailed information on the breeding ecology and nestling diet of Ashy Cuckoo-shrikes, and (2) to determine the breeding system by evaluating the parental investment of each sex throughout the reproductive cycle.

STUDY AREA AND METHODS

This study was conducted in the tropical rain forest of Ranomafana National Park, situated in southeastern Madagascar from October to December 2007. This montane tropical rainforest is composed of secondary growth (mainly consisting of the introduced Psidium cattleianum) and primary forest with a high floristic diversity. The understory is very diverse with many shrubs. We found three nests: two were in the Sahamalaotra area (21°13’S, 47°23’E; 1141 m above sea level) and one was in the Talatakely area (21°15’S, 47°25’E; 949 m above sea level) of Ranomafana National Park.

Male and female Ashy Cuckoo-shrikes are similar in size, but show slight plumage color dimorphism; males have black heads, chins, throats, and necks,
whereas females have gray heads, chins, throats, and necks (Langrand 1990), making it possible to identify the sexes in the field.

The three nests were designated as Nests A, B and C. We identified the scientific name of the nesting trees, and measured the height above ground of each nest and the diameter at breast height (DBH) of each of the nesting trees. To examine the relative contributions of the sexes to reproductive efforts, we studied the following activities: (1) time budgets of incubation (percentage of time that individuals spent incubating), (2) time budgets of brooding (percentage of time that individuals spent brooding) and (3) feeding frequency (times/h/brood). We also examined food items given to the young. An incubation session was defined as having started when a focal individual began incubating eggs and ending when that individual left the nest. Similarly, a brooding session was defined as starting when a focal individual began brooding nestlings and ending when it left the nest.

Direct observations were made using a 20× spotting scope (for a total of 65.5 h) and indirect observations were made with a SONY video Hi8 camera (CCD-TRV96; for a total of 11 h) from a vantage point that allowed a good view of the nest (20–30 m). Direct and indirect observations were usually made between 0600 and 1200, sometimes from 0700 to 1300. Nests were visited at intervals of three days to examine breeding schedules.

All statistical tests were conducted with StatView 5.0 (SAS 1998). Mean values in the text are reported with the standard error (±SE).

RESULTS

We found Nest A on 27 October, Nest B on 13 November, and Nest C on 2 December. On these dates parents had already begun delivering food to the nestlings in Nest A, and incubation had begun at Nests B and C. The characteristics of nest trees are summarized in Table 1. Nests, built high above ground (≥12.5 m) in a tree fork, were shallow bowls made up largely of mosses and lichens. Because of their heights above the ground, we were unable to determine the clutch sizes, but as Nest A contained one nestling and Nest B contained two nestlings, it is likely that the clutch size is of one or two.

Males and females took turns incubating, spending a total of 94.1±3.2% (N=4 days; Fig. 1) of their time. On some days (e.g. 14 November at Nest B and 8 December at Nest C), the males incubated longer than the females (Fig. 1). However, the differences in incubation session (min) between the sexes were not significant at either Nest B (male; 25.4±9.8, N=5, female; 22.8±9.4, N=4, U=9.5, P=0.90) or Nest C (male; 48.3±6.9, N=6, female; 51.8±9.2, N=5, U=11.0, P=0.47). The change of incubation task was often preceded by a series of two different calls: “kick-oo” and “koo” uttered softly by the arriving adult. The incubating adult flew away when the vocalizing bird arrived at the nest. We were unable to determine the duration of incubation because incubation had already begun when we found nests.

We observed brooding at Nest B. Nestlings at 1 day of age (on 17 December) and at 4 days of age (on

Table 1. Nest information for three nests (A, B and C) of Ashy Cuckoo-shrikes; nesting trees (scientific name), height (m above the ground) of nest, DBH (diameter at breast height) of nest tree.

<table>
<thead>
<tr>
<th>Nest</th>
<th>Area</th>
<th>Nesting tree (Family name)</th>
<th>Height (m)</th>
<th>DBH (cm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Sahamalaotra</td>
<td><em>Ocotea</em> sp. (Lauraceae)</td>
<td>12.5</td>
<td>35.0</td>
</tr>
<tr>
<td>B</td>
<td>Sahamalaotra</td>
<td><em>Policias</em> sp. (Araliaceae)</td>
<td>14.0</td>
<td>22.0</td>
</tr>
<tr>
<td>C</td>
<td>Talatakely</td>
<td><em>Eugenia</em> sp. (Myrtaceae)</td>
<td>17.0</td>
<td>31.0</td>
</tr>
</tbody>
</table>
20 December) were brooded by either sex. The time budgets of the brooding male and female, when the nestling was 1 day of age, were 22.7% and 45.8%, respectively. There was no difference in brooding session between males (10.2 ± 3.8, N = 8) and females (17.6 ± 6.1, N = 8, U = 24.0, P = 0.40). When the nestling was 4 days old, the time budgets of the brooding male and female were 23.1% and 22.8%, respectively. There was no difference in brooding session between males (13.8 ± 1.6, N = 6) and females (11.7 ± 4.8, N = 7, U = 14.0, P = 0.32). We did not observe Nest B from 5 to 13 days of age. Nestlings were brooded at 1 and 4 days of age, but not after 14 days of age.

Both sexes delivered food to the nestlings during the nestling period (Fig. 2). The feeding frequency of females was higher than that of males, regardless of the age of the nestlings, except when they were 1 and 22 days of age at Nest B (Fig. 2).

We could not determine the nestling period (i.e. the time from hatching to leaving the nest) at Nest A, because the nestlings were predated by a Henst’s Goshawk Accipiter henstii. At Nest B, the parents were seen incubating eggs on 16 November and two young left this nest on 9 December, suggesting that the nestling period was about 24 days. When the young fledged, they flew between the nesting tree and other trees nearby. After fledging, the young remained near the nest tree, and their parents continued to feed them for at least 11 days. However, we did not know the exact duration of post-fledging parental care.

Throughout 58 h of observation during the nestling period at two nests (Nests A and B), we observed 176 prey items being fed to nestlings (data pooled for the two nests). However, it was difficult to identify all food items, both because food was usually masticated by the parents before offering it to the nestlings, and because feeding was very quick. Thus, we were only able to identify 57 food items. Caterpillars (26.3%), grasshoppers (21.1%), butterflies (14.0%) and small chameleons (14.0%) accounted for most of the identified prey. Other items included walking sticks (Phasmatodea, 12.2%), spiders (5.2%), flies (1.8%), dragonflies (1.8%), shield bugs (1.8) and mayflies (1.8%).

**DISCUSSION**

Some traits that characterize monogamous breeding systems include less marked sexual dimorphism (Andersson 1994; Ligon 1999), biparental care, and similar sex roles (Clutton-Brock 1991; Davies 1991; Ligon 1999). Body color suggests that the Ashy Cuckoo-shrike lacks remarkable sexual dimorphism, and our results suggest that both male and female Ashy Cuckoo-shrikes contribute equally to overall breeding activity. Both sexes participated in incubating and brooding. During the nestling period, both sexes fed nestlings (Fig. 2). The parents were not aided by any helpers in any of these nesting activities. This description is supported by observations made by Rand (1937) and Langrand (1990), who usually found this bird alone or in pairs during the breeding season. We therefore conclude that the mating system of this species is best described as socially monogamous.

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