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First nest description, breeding behaviour and distribution of the Madagascar Serpent-Eagle *Eutriorchis astur*

RUSSELL THORSTROM[1]* & LILY-ARISON RENÉ DE ROLAND[2]
[1]*The Peregrine Fund, 566 West Flying Hawk Lane, Boise, ID 83709 USA*
[2]*The Peregrine Fund, B.P. 4113, Antananarivo (101), Madagascar*

The critically endangered, endemic Madagascar Serpent-Eagle *Eutriochis astur* was searched for and studied from 1993–98 on Masoala Peninsula, northeastern Madagascar. Fifteen individual serpent-eagles were detected at nine different localities throughout the Masoala Peninsula. The first nest of the Madagascar Serpent-Eagle was discovered on 7 November 1997. The nest was in an epiphytic fern *Asplenium nidus* supported by vines and branches, 20.1 m above the ground in a *Potameia capuroni* of 36.2 cm diameter at breast height. The epiphytic fern was lined with leaves in the centre and twigs were positioned to form a nest rim. The nest measured 76 × 57 cm and contained one white egg. The female and male incubated for 77% and 21% of 118 hours of nest observations, respectively. The egg hatched on 21 November 1997, and the young fledged 62 days later on 22 January. Chameleons *Furcifer* and *Calumma* spp., and leaf-tailed geckos *Uroplatus* sp., made up the most numerous prey types taken, representing 83% of the 133 identified prey. Currently, the Masoala Peninsula forest contains the greatest number of sightings and known density of serpent-eagles in Madagascar.

The critically endangered, monotypic Madagascar Serpent-Eagle *Eutriorchis astur* is one of the rarest birds of prey in the world (Collar *et al.* 1994, del Hoyo *et al.* 1994). Historically, serpent-eagles were believed to inhabit original humid eastern rainforests of Madagascar (Rand 1932). Until recently, the species was known from only 11 museum specimens, the last of which were collected in the 1930s (Dee 1986) and subsequently was thought to be extirpated. There have been several sightings in recent decades from Marojejy Reserve (14°21′S, 49°38′E), including a detailed account of a sighting made in 1988 by Sheldon and Duckworth (1990). Recently, its continued existence in Ambatovaky Reserve (16°51′S, 49°08′E) was confirmed from a skull and three primary feathers collected from a decomposed carcass found on 23 January 1990 (Raxworthy & Colston 1992), and with a brief observation in 1994 at the Réserve Spéciale d'Anjanaharibe-Sud (Thiollay 1998) (Fig. 1). Between 1993 and 1998, this secretive raptor has been repeatedly sighted and captured on the Masoala Peninsula, northeastern Madagascar (Thorstrom *et al.* 1995, Thorstrom & Watson 1997). A new national park was established on the Masoala Peninsula and inaugurated in October 1997 for protecting serpent-eagles and other endemic Malagasy fauna and flora, and for conserving the intact coastal lowland rainforest, which is extremely threatened in Madagascar. General natural history knowledge of Madagascar Serpent-Eagles has increased in recent years but no information exists on their breeding biology. We report here the first observed nesting and systematic study of the behaviour and ecology of this highly endangered bird of prey plus its current distribution in protected areas and forests throughout eastern Madagascar.

STUDY AREA AND METHODS

A general survey for serpent-eagles was conducted from September 1993 to February 1998 throughout Masoala Peninsula in northeast Madagascar. We also distributed tapes of the vocalization of the Madagascar Serpent-Eagle to biologists and birders in 1995 to learn the distribution of this species. From 13–21 September 1997 we also visited Zahamena Special Reserve (17°40′S, 48°50′E) in central-eastern Madagascar (Fig. 1).

The first documented nest was located on the west side of Masoala Peninsula several kilometres east of the village of Ambanizana (15°37′S, 49°58′E), and was

*Corresponding author.

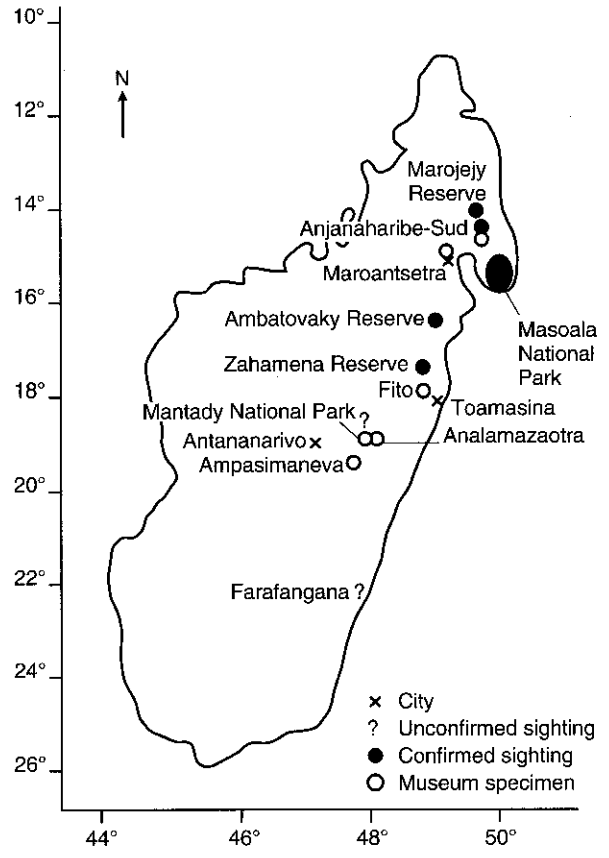

Figure 1. Locality map of Madagsacar showing sites mentioned in the text.

studied from November 1997 to Feburary 1998. The west coast of the peninsula is roadless and composed of a mosaic of slash-and-burn clearings, secondary growth, and primary forests. The mature lowland rain forest of the Masoala Peninsula has a canopy height near 30 m with emergent trees, high floristic diversity and steep mountainous topography (Guillaumet 1984). Elevations on the Masoala Peninsula range from 0–1200 m. Average annual rainfall recorded at Andranobe Field Station (AFS), 7 km south of the nest site, was 6049 mm from 1991–96 (Thorstrom *et al.* 1997). Monsoon rains and cyclones occur between December and March, whereas rain falls steadily between April and August. September to November are the driest months, receiving on average 481 mm (8%) of the annual rainfall recorded from 1991–96 (Thorstrom *et al.* 1997).

The Madagascar Serpent-Eagle is a forest-dependent species that is easier to detect from its vocalization than by sightings. Locating calling serpent-eagles was difficult because several other animals, including couas and treefrogs, make similar vocalizations, and moving through, and access to, the Masoala forest can be accomplished only on foot, or in dugout canoes and boats. Listening surveys for serpent-eagles were conducted along trails and in trail-less terrain. Serpent-Eagles were located during morning listening searching sessions. When an individual or pair of birds was heard, we searched for them to determine the site of the vocalization and make observations of the birds' behaviour. Where birds were detected, we returned to these sites on consecutive days searching for signs of potential breeding activity. The nest we describe was discovered using this technique. We broadcast serpent-eagle calls to elicit a response from nearby birds but this method had limited success at drawing them closer to us for detection.

Daily nest observations lasted from 04:30 to 18:00 h and were made from the ground with 10× binoculars from 25–45 m during the incubation period. After the egg hatched, a hide was constructed 25 m above the ground and 35 m from the nest. Observations from the hide were made using a 16–48× spotting scope. Data collected included notes on adult and nestling behaviour, nest attendance, and identification and frequency of prey items delivered to the female, nestling and fledgling. Nest-site and nest tree characteristics were described in distance measurements, degree, diameter-at-breast height (DBH) and percentages.

RESULTS

Distribution and density

From November 1993 to February 1998, at least 15 individual serpent-eagles were detected at nine different localities throughout the Masoala Peninsula (Table 1, Fig. 2). On the west side of the Masoala Peninsula, we located serpent-eagles at sites along a south–north gradient: Ampamovy, Ambodifiraha, Andranobe and Ambanizana. These four sites were separated by distances of 5 km (Ampamovy–Ambodiforaha), 5 km (Ambodiforaha–Andranobe), and 7 km (Andranobe–Ambanizana). The distance in an easterly direction between serpent-eagle sites and Andranobe Field Station and Bedinta was 6 km. The distance between serpent-eagle sightings in the interior of the Masoala Peninsula, from Antafononona to Sahatremo was 6 km. Thus, on average, the distance between assumed neighbours or territorial birds was approximately 6 km.

We observed one serpent-eagle on 14 September 1997 at Zahamena Special Reserve and on 18 September,

Table 1. Distribution of Madagascar Serpent-Eagles in the Masoala Peninsula forests of northeastern Madagascar.

Month/year detected	Location (latitude and longitude)	Detected by	Number detected
Nov 1993	Sarahandrano (15°17′S, 50°18′E)	Vocalization/visual	1
Jan 1994	Andranobe Field Station (15°41′S, 49°57′E)	Captured	1
Jan 1994	Antafononona (15°45′S, 50°11′E)	Vocalization/visual	1
Sep 1994	Andranobe Field Station/Ambodifiraha	Vocalization/visual unbanded	1
Nov 1995	Ihazomay (15°44′S, 50°12′E)	Vocalization	2
Oct 1996	Andranobe Field Station	Vocalization/visual second unbanded	1
Sep 1996	Ampamovy (15°43′S, 49°58′E)	Vocalization/visual	1
Nov 1996	Sahatremo (15°45′S, 50°11′E)	Vocalization/visual	1
Dec 1996	Ambanizana (15°37′S, 49°58′E)	Vocalization/visual	2
Feb 1997	Ampamovy	Vocalization/visual	1
Oct 1997	Bedinta (15°40′S, 49°59′E)	Visual	1
Nov 1997	Antsamanara (15°18′E, 15°14′E)	Vocalization/visual	1
Jan 1998	Sahatremo	Adult and fledgling	1
Total	9 sites		15

a serpent-eagle pair was observed for three hours calling, chasing and moving together as if they were a breeding pair but exhibiting no signs of nesting activity. On 19 September at 07:00 h, the pair was detected 500 m north of the previous days' observation site. After 19 September, the pair was not located again.

Nest description

On 7 November 1997, we found the first serpent-eagle nest in primary forest on Masoala Peninsula at 420 m asl and inside the new national park. The nest was situated in a large epiphytic fern *Asplenium nidus* 20.1 m above the ground in a 36.2-cm DBH *Potameia capuroni*. The epiphyte was supported by three branches, with diameters of 8, 7 and 6 cm, and two vines and was surrounded on all sides by vines and tree branches. The serpent-eagles entered the nest from the east and northwest sides where there was a gap in the vines and branches. Exterior nest dimensions were 80 × 60 cm and interior dimensions were 76 × 57 cm. The exterior nest depth was 18 cm and interior at the centre of the nest was 5 cm. On 10 November 1997, R.T. climbed a nearby tree and saw one large heavily stained white egg resting on freshly cut green leaves with some twigs placed inside the epiphyte to form a nest rim. The epiphyte was situated in the centre and upper branches of the nest tree at canopy height. The nest tree was isolated on the west, south and east sides from other trees by 20–25 m. The nearest tree was 10 m to the north and was inter-connected by vines. The slope at the nest tree was 55% and the nearest permanent water was a creek at 40 m away. The canopy coverage in the centre of the nest (determined from densiometer) was 92%. The nearest trail was 200 m and the closest human disturbance, a *tavy* (cleared land for subsistence agriculture), was southwest at 1.5 km downslope from the nest tree.

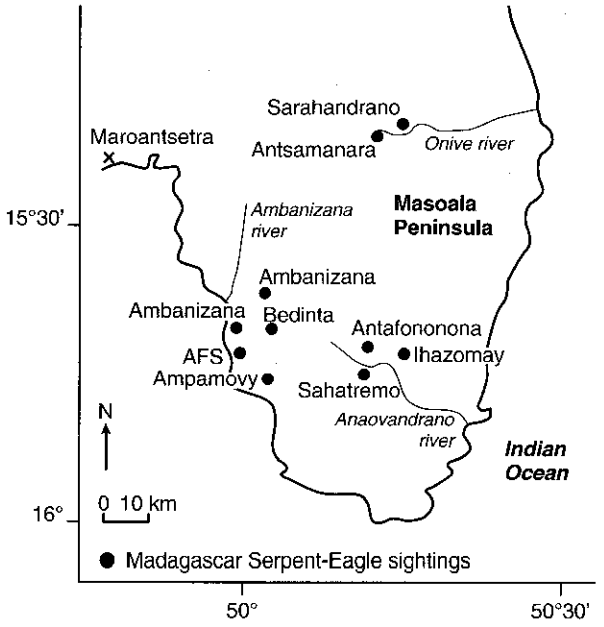

Figure 2. Locality map of Madagsacar Serpent-Eagle sightings on Masoala Peninsula, Madagascar.

Incubation period

The nest was found during the incubation period and was observed for 118 hours from 9–21 November. We

judged from the stained egg that laying occurred at least prior to the three-day heavy rains of 30 October to 1 November, suggesting that the minimum incubation period was 23 days. The total incubation time during the observation period for the male and female was 24.8 h (21%) and 90.8 h (78%), respectively. The female spent several days incubating continuously, unlike the male. The male spent 1.1 (1%) h and the female 1.7 (1%) h off the nest in incubation breaks (nest absences). The average incubation break was 15.8 min for the male (n = 4 observation days, range 16–30 min) and 12.4 min for the female (n = 8 observation days, range 5–29 min). The male delivered greenery (fresh green twigs) 16 times and the female nine times during the incubation period.

Nestling period

The nest was observed for 548 hours during the nestling period from 21 November, when we assumed the egg hatched based on first prey delivery to the nest at 16:00 h, to 22 January at 17:00 h when the young fledged. The female was the sole attendant at the nest during the nestling period. The role of the male was only to deliver prey to the female and nestling. Upon his arrival in the nest vicinity, the male made soft chirp and *scree* calls to alert the female. The female responded to these contact calls with a near voiceless quivering of her mouth until prey delivery, where she aggressively took the prey from the male and then fed herself and the nestling. The female brooded the chick, fed it and delivered greenery 16 times during the first few weeks of the nestling period. The male delivered greenery only once. The female left the nest for longer periods during the second week (nest attendance 93% and nest absence 7%), and her nest attendance decreased rapidly during the later weeks of the nestling period to virtually none prior to the young fledging (Fig. 3).

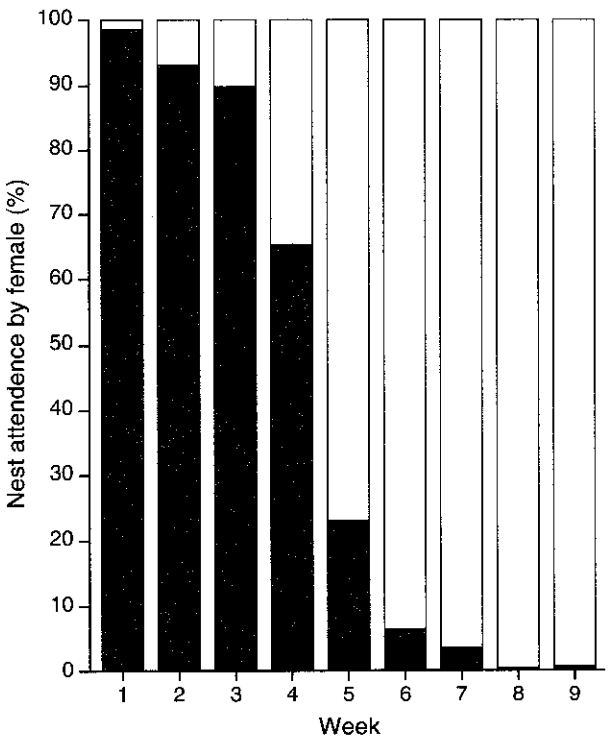

Figure 3. Nest attendance and absence by female Madagsacar Serpent-Eagle during the nine-week nestling period on Masoala Peninsula, Madagascar (based on average percentage per observation week). □, Off nest; ■, on nest.

Nestling growth and behaviour

The nestling hatched on 21 November 1997 and developed slowly. We assumed it was a male by its weight and small size in comparison to the adult female. One noticeable change in the development of the nestling was the change in iris colour from brown at the chick stage to light grey at fledging, which occurred on 22 January 1998 at 62 days of age (see Table 2).

Post-fledging period

During the first night after fledging, the young roosted 20 m north of the nest. On 23 January 1998, the young was located 70 m west of the nest tree in another tree. At 08:00 h, one adult passed a prey item to him and he ate it in a tree 20 m above the ground and perched the rest of the day calling and moving from tree top to tree top. On 23 January 1998, the young was attacked by a Red-ruffed Lemur *Varecia variegata rubra*, which flushed him from his perch. On 24 January 1998, the young was struck and knocked off his perch by a Madagascar Buzzard *Buteo brachypterus* and fell 5 m until stopping in a tree top. He remained motionless for 30 min at this spot. After an hour had passed, he flew a short distance to the top of another tree and began calling. The first weeks after fledging, the young remained perched at the top of trees calling constantly, and waiting for prey deliveries. Gradually, the young began descending to the ground after feeding. On 18 February 1998, the young was located on the forest floor where he accepted prey deliveries from the adults. The young was last observed on 2 March 1998.

Table 2. Chronology of the development and behaviour of the nestling Madagascar Serpent-Eagle.

Nestling age (days)	Date	Nestling growth and behaviour
Day 0	Nov 21	Hatched with downy white feathers, dark brown pupil, grey cere, black bill and talons, and light yellow tarsi
13 days	Dec 04	First observed preening and wing-flapping
15 days	Dec 06	First food begging calls heard, a soft *scree-scree-scree*
17 days	Dec 08	Iris colour light brown/grey
18 days	Dec 09	Wing follicles and body feathers emerging, and nestling begins standing
24 days	Dec 15	Begins walking in the nest
28 days	Dec 19	First observed trying to feed itself
30 days	Dec 21	Iris colour very light brown/grey
32 days	Dec 23	Begins first wing-begging behaviour, feathers emerging on the neck, crown, abdomen and tarsi; begins swallowing whole pieces of prey (lizards's legs and tails); pulls nape and crown feathers up when startled
34 days	Dec 25	Iris colour light grey and begins feeding itself
40 days	Dec 31	Hops inside the nest
42 days	Jan 02	Measured and ringed; weighed 635 g, measured 26.0 mm for bill-length, 218 mm for wing-length, 102 mm for tail-length, and facial skin and cere colour medium grey
43 days	Jan 03	Begins calling typical serpent-eagle calls
44 days	Jan 04	Wing exercising, and biting and attacking nesting material
52 days	Jan 12	Begins hopping one metre above the nest
57 days	Jan 17	Climbs to top of the nest tree, food solicits and waits for prey deliveries
62 days	Jan 22	Fledges at 17:00 h and not seen again at the nest

Diet

Prior to prey delivery to the nest, the adults flew to a perch within the nest vicinity with prey in one foot or bill and they always transferred prey from foot to bill before landing at the nest. Prey items were transferred at the nest by bill to the female or nestling, which also accepted the prey with the bill. We observed the delivery of 155 prey items during the nestling period, 133 of which we identified to some level (Table 3). Because most of the 22 unidentified prey items were probably lizards, the diet is most accurately described as percentage of identified prey rather than total prey. Of the identified prey, 110 were lizards (82.7%), 21 were frogs (15.8%) and two were snakes (1.5%).

Table 3. Frequency of prey items delivered to the Madagascar Serpent-Eagle nest in Masoala Peninsula, Madagascar (percentages based on identified prey items).

Prey item	Frequency *N* (%)
Lizards	
Chameleons (*Furcifer* and *Calumma* spp.)	66 (49.6)
Leaf-tailed Geckos (*Uroplatus* spp.)	43 (32.3)
Gerrhosaurids (*Zonosaurus* sp.)	1 (0.8)
Total lizards	110 (82.7)
Frogs	
Treefrogs (*Boophis* spp.)	5 (3.8)
Others	16 (12.0)
Total frogs	21 (15.8)
Snakes (*Stenophis* sp.)	2 (1.5)
Total identified prey	133
Unidentified prey	22
Total prey	155

Chameleons *Calumma* sp. and *Furcifer* sp., and leaf-tailed geckos *Uroplatus* sp. were the most frequently captured lizards, and one skink-like gerrhosaurid *Zonosaurus* sp. was taken. Frogs were represented by *Boophis* and *Mantidactylus* and snakes by *Stenophis* sp. The female serpent-eagle began hunting and delivering prey items to its nestling at 18 days of age. The male delivered 75% (116) of prey items and the female 25% (39) during the nine-week nestling period. The male delivered two to five times more chameleons than leaf-tailed geckos and frogs, and the female delivered two to three times more leaf-tailed geckos and frogs than chameleons. All prey delivered by the adults to the nest was decapitated. Weekly prey delivery rates increased only slightly from the start of the nestling period at 2.5 per observation week to 2.8 at the end of the nestling period. During the post-fledgling period we observed seven prey items delivered; including three leaf-tailed geckos, two chameleons, one bat and one unidentified item.

DISCUSSION

The endangered Madagascar Serpent-Eagle is known only from the eastern rainforest of Madagascar. Nearly all previous records were based on museum

specimens collected at seven sites in four major areas (Ampasimaneva, Analamazoatra, Fito and Maroantsetra) between 1874 and the 1930s (Collar & Stuart 1985, Dee 1986, Langrand 1989) and one unconfirmed sighting at Farafangana in 1929 (Rand 1932). These four major sites of museum specimens were distributed from the south at Ampasimaneva (19°24′S, 48°04′E) to Maroantsetra (15°13′S, 49°35′E) in the north, a distance of 440 km (Dee 1986, Sheldon & Duckworth 1990). There were several possible sightings by a forest guard in the Marojejy Reserve during 1964–77 (Collar & Stuart 1985) and a detailed sighting at 850–900 m at Marojejy Reserve (14°21′S, 49°38′E) in 1988 (Sheldon & Duckworth 1990) (Fig. 1) but there has been no conclusive evidence of serpent-eagles since these reports even though World Wide Fund for Nature (WWF) Madagascar has been working in the area for nearly 10 years. Thiollay (1998) describes a bird from Réserve Spéciale d'Anjanaharive-Sud at 700 m elevation, hearing one individual give a three-note call sounding like a cuckoo while flying low over the forest.

On Masoala Peninsula, a serpent-eagle was first observed in November 1993, and later the first live capture was made on 14 January 1994 near AFS with repeated sightings in the following years (Thorstrom *et al.* 1995, Thorstrom & Watson 1997, pers. obs.). From this captured and radiotagged bird, we learned about serpent-eagle behaviour, activity and ranging area, and we were able to make recordings of its vocalizations (Thorstrom *et al.* 1995).

We have had two responses coming from the distribution of tapes of the serpent-eagle vocalization: one in October 1995 at Zahamena Special Reserve (A. Andrianarimisa pers. comm.) and another in October 1997 at Mantady National Park (18°49′S, 48°28′E) (V. Manuel pers. comm.). We confirmed the Zahamena sighting in September 1997 but have not had the chance to verify the observation in Mantady National Park. This species has been detected along the eastern rainforest zone from Zahamena Special Preserve and possibly Mantady National Park in the south to Masoala Peninsula in the north since distributing the tapes of Madagascar Serpent-Eagles.

All serpent-eagles observed on Masoala Peninsula have been extremely wary, contrasting with the description of being 'relatively fearless' by Sheldon and Duckworth (1990). Thiollay (1998) also described the serpent-eagle's behaviour as elusive when trying to approach it for a better view. This wariness was more pronounced during the nesting season. The adults were extremely secretive around the nest, especially when leaving and returning to the nest, and rarely vocalized in the nest vicinity. The cryptic nest placement in an epiphyte and their unobtrusive nesting behaviour explains why this species has been extremely difficult to locate.

We suggest that their wariness and secretive behaviour around the nest may be a predator-avoidance strategy. This behaviour contrasts with the clamorous nesting behaviour of the Henst's Goshawk *Accipiter henstii*, a raptor commonly mistaken for the Madagascar Serpent-Eagle. Goshawk nestlings were the victims of nest predation by another raptor, the Madagascar Harrier Hawk *Polyboroides radiatus*, during the female's nest absence period (René de Roland *et al.* 1996). This may be one of the reasons why serpent-eagles are so secretive at the nest, but does not explain why they are wary away from the nest.

Despite our focus and considerable time spent in the field searching for serpent-eagles in Masoala forests, the first nesting attempt was finally observed after four years of search effort. In our earlier years of searching for nesting serpent-eagles, we were looking for a typical large eagle nest, i.e. a large visible stick nest. If other breeding serpent-eagles use similar nesting situations like the one we have documented here, then we expect new nesting pairs will also be difficult to find.

One interesting aspect of the breeding behaviour of this bird was incubation exchanges followed by both sexes feeding away from the nest. This is commonly seen in many species of kites and vultures where both parents share in nesting duties more or less equally from incubation to brood rearing but in the majority of raptor species, from small falcons to large eagles, the male plays no part in incubation or may only incubate after food provisioning (Newton 1979). Male incubation may have some phylogenetic significance, perhaps indicating a relationship to kites, particularly the genera *Aviceda*.

We observed delivery of greenery on 25 occasions during incubation and on 17 occasions during the nestling period, and we suspect that during the courtship period serpent-eagles participate minimally in nest construction. The principal provider of greenery during the incubation period was the male (16 occasions) whereas the female (16 occasions) delivered all but one green twig during the nestling period. This pair of serpent-eagles slowly and continuously constructed a major portion of their nest *after* the egg was laid, probably another strategy for predation avoidance.

Newton (1979) suggested that greenery may be a form of nest-sanitation, for maintaining humidity, or

for advertisement. Although this is the first observed nesting of serpent-eagles, we did not find the humidity maintenance theory plausible because of the already extremely high humidity in this rainforest setting. Additionally, the advertisement strategy is not likely because of the concealment of the nest. Nest-sanitation might figure in the delivery of greenery but serpent-eagles consume their entire prey (bones, skins, tails and viscera) and only the excreta would need covering; however heavy rainfall in this region always washed away the excreta.

Rodgers *et al.* (1988) demonstrated that Wood Storks *Mycteria americana* in Florida added greenery to insulate nest contents in a porous twig structure. In Madagascar, the serpent-eagle pair broke off green branches within a 30 m radius of the nest tree. After delivering greenery to the nest, they frequently cut off the leaves and placed them in the nest bowl and then positioned the leafless branch on the exterior to form a nest rim inside the epiphyte. The cut-off leaves may provide a softer and elevated substrate for protection of the egg and nestling during egg position change, adult movements and from flooding during heavy rains. We suggest that greenery provided insulation and protection for the egg and nestling, and the positioning of the twigs into a nest rim created a border for maintaining the egg and young in the centre of the nest. In Wood Storks, new additions of greenery decreased as the nestlings matured and developed self-thermoregulation at 1–2 weeks of age (Rodgers et al. 1988). For serpent-eagles, greenery was added on 12 occasions during the first two weeks and decreased to five occasions during the rest of the nestling period, with the last twig delivered on 26 December, when the nestling was 34 days old.

The Madagascar Serpent-Eagle has a longer nestling period, 62 days, than that of the sympatric Henst's Goshawk, 42–48 days, and other similarly-sized raptors (Table 4). Based on our observation of this single nest, we suspect that the serpent-eagle has a breeding strategy characteristic of many tropical raptors, including a long lifespan, small clutch size and long nestling period, like the Barred Forest-Falcon *Micrastur ruficollis* (Thorstrom unpubl. data) and Puerto Rican Sharp-shinned Hawk *Accipiter striatus venator* (Delannoy & Cruz 1988). The Madagascar Serpent-Eagles in this study built a nest inside an epiphyte, laid one egg, both adults incubated, the chick was only fed by the female and during the late nestling period the male only dropped food off for the nestling (never observed feeding the nestling), had a nestling period of nine weeks, a post-fledging period of six weeks, and the young dispersed at 15 weeks of age.

The only previous information reported on food habits of the Madagascar Serpent-Eagle comes from Rand (1936), who found a very large chameleon in the stomach of one collected specimen. The heavily-scaled tarsi and short-broad toes of the serpent-eagle are typical adaptations of a raptor that preys on reptiles. The observations from the breeding pair suggest that they are reptile specialists but, from 1994 to 1996, the radiotagged serpent-eagle at AFS was observed eating one arboreal frog plucked from an epiphyte, one fledgling Green Pigeon *Treron australis* and an unidentified mammal (pers. obs.). Perhaps serpent-eagles may be more opportunistic or use different prey during the non-breeding period.

The serpent-eagle's diet suggests it is mainly a perch hunter and scanner with probable periods of active hunting or 'flush-hunting', where birds used their feet to flush or dislodge potential prey resting or hiding in thick vegetation, epiphytic ferns, branches, trunks and leaf litter (Thorstrom *et al.* 1995). The variation in terrestrial and arboreal prey captured by the serpent-eagles suggests that they are obtaining prey from different strata from the ground up to the canopy within the forest. Chameleons are active during the day, and the serpent-eagles probably perch and actively search for movements made by these lizards. Several species of frogs (*Boophis* and *Mantidactylus*) live in arboreal habitats (Glaw & Vences 1994). We suspect serpent-eagles flush and extract these arboreal

Table 4. Breeding parameters of the Madagascar Serpent-Eagle compared with other similarly sized raptors.

Species	Female mass (g)	Clutch size	Incubation period (days)	Nestling period (days)	Post-fledging period (weeks)
Henst's Goshawk[a] *Accipiter henstii*	960–1140	1–3	40	42–48	5–7
Madagascar Harrier-Hawk[b] *Polyboroides radiatus*	?	2	39	?	?
Collared Forest-Falcon[c] *Micrastur semitorquatus*	792–940	1–3	46–48	46–56	6–9
Northern Goshawk[d] *Accipiter gentilis*	820–1509	1–5	32–34	34–41	4–7
Madagascar Serpent-Eagle[e]	?	1	?40+	62	6

[a]Réne de Roland (in press); [b]Thorstrom (unpubl. data); [c]Thorstrom (unpubl. data); [d]del Hoyo *et. al* (1994), Palmer (1988); [e]this study.

frogs from branches, epiphytes and any structure that supports them in the trees. In contrast, serpent-eagles probably actively search and hunt the nocturnal leaf-tailed gecko while it is sleeping and resting on tree trunks and branches. The one gerrhosaurid lizard and several of the frogs *(Mantidactylus)* delivered to the nest might have come from terrestrial and stream (water) habitat (Glaw & Vences 1994). This also suggests that serpent-eagles search the ground, stream courses and water holes for terrestrial frogs. Adults have been sighted frequently by us on the ground, apparently hunting for prey. Finding the young on the ground during the late post-fledging period suggests that it was also searching the ground for prey.

Although we observed two snakes taken as prey by the nesting pair of serpent-eagles, we suspect that the foot structure of this species is better adapted for taking lizards than snakes. If this is true for the species then 'serpent-eagle' appears to be a misnomer. We suggest that the name of Madagascar Forest Eagle is more appropriate for this species. We recommend further research to determine the distribution of this species, especially its status in the Marojejy and Andapa region, and more information on its breeding biology is needed with emphasis on courtship and nesting habitat.

All of our sightings of Madagascar Serpent-Eagles come from intact forests. On only one occasion have we seen a serpent-eagle as much as 50 m from the main forest block. The serpent-eagle is dependent upon intact forest. Currently, the Masoala National Park is the largest tract of lowland rainforest preserved in Madagascar and contains the greatest number of sightings and known density of Madagascar Serpent-Eagles. It is critical that the pristine primary forests be maintained in Malagasy parks and reserves for the survival of one of the least known and most endangered raptors in the world.

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