THE SMALL CARNIVORES OF UNGUJA

RESULTS OF A PHOTO-TRAPPING SURVEY IN JOZANI FOREST RESERVE, ZANZIBAR, TANZANIA

Helle V. Goldman & Jon Winther-Hansen

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goldman@npolar.no
fax: + 47 77 75 05 01
tel.: +47 77 75 05 00
Norwegian Polar Institute
Polar Environmental Centre
N-9296 Tromsø, Norway

Front cover photograph (ZNZ0309/1): Zanzibar servaline genet photo-trapped on 15 January 2003, southern Jozani Forest Reserve (see Appendix 1).

Table of contents

Executive summary

The authors conducted a 55 night **camera trapping survey** in **Jozani Forest Reserve** from 1 to 29 January 2003, the most intensive photo-trapping yet undertaken in Zanzibar. All of the known **indigenous small carnivores** of Unguja were caught on film (Table 1, below). Three are **endemic subspecies**. Photographs included **the first pictures of the Zanzibar servaline genet**, which was only described in 1998 and has hitherto been known solely from a damaged skin and skull. This animal may be **less rare** than has been assumed. We discuss this and other findings, concluding the report with **recommendations** for further **research** and for enhancing **conservation** initiatives in Jozani.

Table 1. The small indigenous carnivores of Unguja, Zanzibar. Asterisks mark species photo-trapped in a 55 trap-night survey of Jozani Forest Reserve, January 2003.

Common English name	Scientific name	Authority	Status
Zanzibar slender mongoose*	*Herpestes sanguineus rufescens*	Lorenz 1898	Endemic subspecies
Zanzibar bushy-tailed mongoose*	*Bdeogale crassicauda tenuis*	Thomas & Wroughton 1908 [a]	Endemic subspecies
African civet*	*Civettictis civetta*	Ellerman et al. 1953	Not endemic
Zanzibar servaline genet*	*Genetta servalina archeri*	Van Rompaey & Colyn 1998	Endemic subspecies

[a] See Meester & Setzer (1971), Kingdon (1977) and Pakenham (1984).

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Introduction: Unguja's overlooked mammals

Unguja, the main island in the Zanzibar archipelago, lies about 6° south of the equator and 40 km from mainland Tanzania and has an area of approximately 1600 km^2. The deeper soil zone of the western part of the island formerly supported moist forest, while thicket and dry forest covered the coral rag zone of the east and much of the south. The island has been separated from mainland Africa for ca. 10,000–15,000 years, permitting the evolution of several endemic mammal subspecies (Moreau & Pakenham 1941; Pakenham 1984; Kingdon 1989). With about 524,000 inhabitants, Unguja has a rural population density of some 170 persons per km^2 (figures based on United Republic of Tanzania 1991; Zanzibar Revolutionary Government 1992). Rural Zanzibaris make their living from various combinations of cash crop and subsistence cultivation, livestock husbandry, fishing, charcoal and lime production, harvesting and selling fuelwood, and hunting. Tourism plays an increasing role in the local economies of some rural areas.

Apart from measures generally addressing habitat destruction and degradation, mammalian wildlife conservation and research efforts on Unguja have tended to focus on a few currently endangered or potentially threatened species. One is the highly visible endemic Zanzibar red colobus monkey (*Procolobus badius*)[1] (see e.g. Othman & Rijali 1997; Weaber 1997; Struhsaker & Siex 1998; Siex & Struhsaker 1999a, 1999b). A habituated subpopulation of these charismatic primates draws thousands of foreign visitors annually to Jozani Forest Reserve, thereby funding local community development schemes. Far more difficult to observe, the near-endemic Ader's duiker (*Cephalophus adersi*), like the other two species of small antelope found on the island, is of high local salience on account of its prized meat, which features in community rituals in some parts of Unguja. Ader's duiker has received research and conservation attention in the form of population surveys, hunting management plans and a trial translocation (see e.g. Archer 1994; Archer & Mwinyi 1995; Williams et al. 1996; Masoud 1999; Finnie 2002). The Zanzibar red colobus monkey and Ader's duiker are considered Unguja's two most important "indicator species" by the Dept. of Commercial Crops, Fruits and Forestry (S. I. Hamdan pers. comm. 2003).

The Zanzibar leopard (*Panthera pardus adersi*), an endemic subspecies (Pocock 1932; Pakenham 1984; Kingdon 1989), has been the focus of some research aimed primarily

[1] Though some readers may raise sound objections to certain designations employed here, for consistency all scientific names in this report follow the *Check-list of the mammals of East Africa* (Davies & Vanden Berghe 1994). We have noted considerable variation in the literature with respect to scientific names of Zanzibar's wildlife. For example, the Zanzibar red colobus monkey is variously named *Colobus badius kirkii* (Moreau & Pakenham 1941; Burgess et al. 1992; Kingdon & Howell 1993; Van Rompaey & Colyn 1998), *Colobus badius kirki* (Robins 1976), *Colobus kirkii* (Pakenham 1984; Burgess et al. 2000), *Piliocolobus kirkii* (Kingdon 1997), *Procolobus kirkii* (Siex & Struhsaker 1999a, 1999b; IUCN Red List of Threatened Species), *Procolobus pennantii kirkii* (Burgess 2000; CITES Appendix 1) and *Procolobus badius* (Davies & Vanden Berghe 1994).

at documenting indigenous knowledge of, attitudes towards and practices relating to this felid (Marshall 1994; Selkow 1995; Walsh 1996; Goldman & Walsh 1997). In spite of Zanzibaris' assertions that leopards continue to be sighted and occasionally attack livestock, attempts to demonstrate the leopard's survival on Unguja have met with failure (Stuart & Stuart 1997; Goldman & Walsh in press).

In comparison to the colobus, Ader's duiker and leopard, the island's other terrestrial non-volant mammals have received little attention. These include a second monkey species, two or more species of galago, several species of shrew, two species of elephant shrew, several viverrid and herpestid species, one hyrax species, several rodent species and a suid (Moreau & Pakenham 1941; Pakenham 1984; Kingdon 1997; see also Kingdon & Howell 1993; Burgess et al. 1998; Burgess 2000; Burgess et al. 2000). Some are regarded as endemic subspecies or are on the IUCN's Red List of Threatened Species.

As noted above, the island is host to a number of smaller indigenous carnivore species (Table 1), a group of animals which to our knowledge has not been the special subject of any significant research in Zanzibar. These comprise the Zanzibar slender mongoose (*Herpestes sanguineus rufescens*), the Zanzibar bushy-tailed mongoose (*Bdeogale crassicauda tenuis*)—both subspecies endemic to Unguja (Kingdon 1977; Pakenham 1984; Kingdon & Howell 1993), the African civet (*Civettictis civetta*)[2] and the recently identified Zanzibar servaline genet (*Genetta servalina archeri*). Until our study, the Zanzibar servaline genet has been known to science solely on the basis of a single old skin and damaged skull (Van Rompaey & Colyn 1998; R. Glen pers. comm. 2003). Virtually nothing is known scientifically of this animal's behavior, ecology, abundance or distribution on the island. Our knowledge of Unguja's other carnivores is scarcely better. The very recent scientific discovery of the genet on Unguja attests to this: serious research devoted to the island's other carnivores would almost certainly have turned up the genet.

While the servaline genet is not yet mentioned in any Zanzibari legislation, the bushy-tailed mongoose and the slender mongoose are listed in Appendix 1 of The Forest Resources Management and Conservation Act no. 10 of 1996 (hereafter referred to as the 1996 Act). The approximately 90 vertebrate and 13 invertebrate species on this list "are to be totally protected year round and…are to be accorded the highest conservation action and work priority." The African civet appears in Appendix 2[3], a list of about 240 vertebrates and 80 invertebrates "to be protected year round and…to be accorded

[2] Mayles (1997) undertook a modest study of civetries.

[3] In spite of their protected status, African civets regularly appear in summaries of animals killed by the National Hunters (*Wasasi wa Kitaifa*), whose activities are subsidized by the Ministry of Agriculture, Natural Resources, the Environment and Co-operatives. Four civets were recorded killed in 1996, six in 1997 (Jan.–Sept.), four in 1998 (May–Nov.), seven in 1999 (May–July), six in 2001 (July–Aug.), and seven in 2002 (Jan.–June) (Dept. of Regional Administration; summary reports for some years may be incomplete and there is no summary for 2000).

the second highest allocation of protection and law enforcement efforts."

In addition to these indigenous carnivores, the literature refers to two introduced species on Unguja: the banded mongoose (*Mungos mungo*) and the small Indian civet (*Viverricula indica*) (Moreau & Pakenham 1941; Mansfield-Aders 1967 [1920]; Kingdon 1977; Pakenham 1984; Nahonyo et al. 2002). Both of these species are named in Appendix 4 of the 1996 Act. This is a list of "species which are not protected, are accorded no conservation priority and which may be captured and/or killed."

The purpose of this survey was to contribute toward our knowledge of Jozani's small carnivores, with the larger objective of contributing to their conservation. It is obviously difficult to tailor conservation measures to protect fauna about which little is known, a problem which challenges the Integrated Conservation and Development Section of Zanzibar's Dept. of Commercial Crops, Fruits and Forestry. A general lack of appreciation for the islands' wildlife—apart from a few highly salient species—is currently as much a problem as the lack of information. International attention to particular species or groups of species generates interest in those animals among relevant local officials. It is hoped that this will in turn lead to better formulated and better implemented conservation measures. The listing of many mammal (and other) species in appendices 1 and 2 of the 1996 Act has been a crucial step, but there is more to do.

Methods

The study area

Zanzibar forms part of Conservation International's Eastern Arc Mountains and Coastal Forests, one of the organization's 25 global "Biodiversity Hotspots" (www.biodiversity hotspots.org/xp/Hotspots). The native vegetation of Zanzibar has been classified as Zanzibar–Inhambane regional mosaic as defined by White (see Burgess et al. 1992; Clarke 2000), and more recently as Eastern African Coastal Forest, of which there are several subcategories (Clarke 2000).

Jozani Forest Reserve was selected as the study area (see the Map). The reserve encompasses Unguja's only remaining natural, older-growth forest (Robins 1976; Williams et al. 1998; Box 5.5.4 in Rodgers & Burgess 2000) and also comprises a mosaic of other habitats, including coral rag thicket, bracken fields, saltmarsh grassland and mangrove forests. While people do make illegal use of the reserve, it is generally believed that Jozani is under less human pressure than surrounding areas which are afforded no legal protection or are under the control of local communities. Therefore, mammalian wildlife is thought to be at least as abundant and species-rich in Jozani as elsewhere on Unguja—and probably more so.

Jozani Forest Reserve is in the south-central part of Unguja, pinched between Chwaka Bay to the north and Uzi Bay to the south. It measures approximately 25 km^2, of which up to 4 km^2 is groundwater forest which floods during the annual rains and is dominated by *Eugenia* sp. and *Calophyllum inophyllum*, with *Pandanus* sp., *Vitex doniana*

and *Elaeis guineensis* as subdominants (Robins 1976; see also Beentje 1990; Burgess et al. 1992; Nahonyo et al. 2002). This part of the reserve can be classed under Coastal Riverine/Swamp/Groundwater Forest in Clarke's classification scheme (Clarke 2000). Adjacent to the natural older-growth forest is a former *Calophyllum inophyllum* plantation and a stand of *Casuarina equisetifolia*.

Roughly two-thirds of Jozani Forest Reserve consists of thicketed coral rag, including such species as *Euclea racemosa*, *Polysphaeria parvifolia*, *Pachystela brevipes*, *Maytenus mossambicensis*, *Rus natalensis*, *Macphersonia gracilis*, *Annona senegalensis* and *Flueggia virosa* (Leskinen et al. 1997). This vegetation cover would be classed as Eastern African Coastal Scrub Forest (Clarke 2000). The thicket's marked variation in its density, height and patchiness across the reserve is probably related to soil depth and quality (the soils are generally very shallow and poor; fossil coral outcroppings are common) and the level of human pressure. In some areas of thicket cattle are being grazed and wood is being extracted; other areas are evidently recovering from exploitation; yet other areas do not seem to have been disturbed in a very long time.

Upgrading the reserve's status to that of a national park was approved by the Government of Zanzibar on 31 December 2002 (T. S. Masoud and S. I. Hamdan pers. comm. 2002). This will entail a change of name, an increase in size, and the application of a different set of laws. The Jozani–Chwaka Bay National Park will be about 50 % larger than the former Jozani Forest Reserve, embracing more land to the west and northwest. Whereas Jozani Forest Reserve has been regulated by the 1996 Act (see Part IV), the new Jozani–Chwaka Bay National Park will fall under legislation contained in The Environmental Management for Sustainable Development Act, 1996 (see Part VII).

Temperatures on Unguja are generally between 21 and 34 °C. The islands receive about 1600 mm of rain annually. Most precipitation falls during two rainy seasons in November–December and March–May. Humidity varies between 75 and 83 %. During the first two weeks of our survey, which was timed to take place between the two rainy seasons, there were occasional brief, light showers in the mornings. Throughout the study, some days were overcast, especially in the early part of the day. In January, the sun rises at about 06:15 and sets at about 18:45; it begins to become light about 20 minutes before sunrise and it remains light for about 20 minutes after sunset. Daylight length varies by less than an hour during the year.

Camera trapping

In camera trapping, an animal is photographed when it triggers a specially rigged camera. Bait and scent lures are often employed to increase the chances of success and to attract particular kinds of animals. Camera trapping is a relatively non-intrusive method to assist in determining species distribution and abundance, and can also yield important information pertaining to the behavior and morphology of particular individuals or populations. The technique is especially useful for surveying rare, elusive or nocturnal animals which inhabit remote areas, difficult terrain or dense forest/brush inhibit-

ing direct observation (Taylor-Ide 2000; Revkin 2001; Harder 2002; Spalton 2002; Yoon 2002). Camera trapping has revealed the presence of animals not previously known to exist in certain areas or thought to have been extirpated from them (Dunkel 2002; Wildlife Conservation Society 2003).[4]

Studies have shown that success can take a large number of trap-nights. It took 561 trap-nights to obtain three snow leopard photographs (Jackson & Hillard 1986); two weeks passed before any photographs of a leopard were produced in Java (Plage & Plage 1985); and only 31 usable tiger photographs were obtained during a 12 month effort (Ullas Karanth 1995).

Our equipment consisted of two weather-proof 35 mm cameras, one TrailMaster TM550 passive infrared monitor and one TrailMaster TM1050 active infrared monitor (see www.trailmaster.com for diagrams and descriptions). These four units made up two camera traps, one with the "active" and one with the "passive" monitor.

In the active system, an infrared beam passes between the transmitter and the receiver. The monitor records an "event" and the camera is triggered to take a photograph when the beam is interrupted for a preset time span. By controlling the time span the beam must be blocked and the height of the beam above the ground, it is possible to ensure that animals below a certain size are not photographed. The monitor records the date and time of each event and photograph. Film can be conserved by increasing the delay between the recording of an event and when a photograph is taken (with greater camera delay values, more non-photo events are recorded by the monitor).

The passive system, in contrast, is sensitive to temperature differentials and motion, with a field of sensitivity extending out in a large wedge from the transmitter. In this case, the camera is triggered when an animal enters this field of sensitivity. Similar to the active monitor, a number of settings allow one to increase or decrease the sensitivity of the monitor. With the passive system, this is done by adjusting the number of pulses that must be broken within a preset time span before an event is recorded. The width of the field of sensitivity can be narrowed by physically shielding the monitor's sensor, allowing the monitor's zone of sensitivity to be matched to the camera's lateral range. Like the active monitor, the passive monitor records the date and time of each event and photograph.

There are advantages to each system, as the experience gained through this study showed. One of the advantages of the passive type is that the subject does not have to enter a small target area. Thus, an animal can be photographed using the passive system even if it remains somewhat distant from the bait and the camera trap. Another advantage of the passive system is that only one tree trunk (or other vertical base) is required

[4] In June 2002, the photo-trapping of a Lowe's servaline genet (*Genetta servalina lowei*), a mainland Tanzanian subspecies which had apparently not been detected in 70 years (Wildlife Conservation Society 2002), made conservation headlines on many internet sites. However, a Lowe's servaline genet had in fact been trapped, measured and photographed two years previously, in July 2000 (Brink et al. 2002).

to mount the equipment (the camera can be attached to the same support). A disadvantage is that photographs can be taken in response to sun-warmed vegetation moving in the breeze or slight motion of the trunk to which the monitor is attached. This problem can be reduced by decreasing the sensitivity of the monitor.

One of the active monitor's advantages is that it can be set up to be triggered only by animals of certain dimensions. If vegetation is pruned away, pictures triggered by warm, fluttering leaves and swaying trees are much less likely to result with the active monitor than with the passive monitor. The drawback of the active system is that animals must be led into breaking the infrared beam; an animal which approaches the trap but does not actually block the beam will not trigger it. The trap's components should be arranged in relation to vegetation, paths and clearings to raise the probability that animals will enter the narrow zone between the infrared transmitter and receiver. Another disadvantage is that a minimum of two sturdy vertical supports are required to set up the active system. This is a problem in environments where trees with trunks thick enough not to move in the wind are scarce, as is the case in much of Unguja's coral rag thicket.

How camera traps were deployed

Both camera traps were continuously deployed from the afternoon of 1 January to the morning of 29 January 2003, with the single exception of one night during which the active camera trap was not in use. This added up to 27 trap-nights[5] with the active

[5] For the sake of brevity we use the term "trap-nights." Note that traps were typically operating for most of the day-time as well as the night; only rarely were the traps set up at dusk and taken down early in the morning.

Table 2. Sensor type employed at each photo-trap location, habitat of each location, and the number of trap-nights at each location. See Appendix 1 and the Map.

Location	Sensor type	Habitat	# trap-nights
1	passive	coral rag thicket	3
2	active	groundwater forest	4
3	passive	groundwater forest	1
4	passive	coral rag thicket	1
5	passive	coral rag thicket	9
6	active	coral rag thicket	3
7	active	coral rag thicket	5
8	active	groundwater forest	1
9	passive	coral rag thicket	14
10	active	coral rag thicket	14

system and 28 trap-nights with the passive—55 trap-nights in total (Tables 2, 3). By the end of the survey, camera traps had been set up at 10 locations (Table 2, Appendix 1, Map). Nights in one location ranged from 1 to 14 (Table 2).

Traps were usually checked each day or second day. The dates and times of photo-events were read off from the monitor and recorded before clearing it. Changes at the trap site and its vicinity were noted, such as pugmarks and scratchmarks on the tree to which the bait was secured. The condition of the bait was also noted, particularly whether it had become maggotty and if it had been partly or wholly consumed. If most or all of the frames of the film had been exposed, or if we had another reason to check the results, the film was collected and replaced with a new 36 frame roll (ISO 200). We retrieved and developed film often in order to identify and rectify faults in our set-up.

Bait was added or replaced during trap checks. Old bait was usually left in the traps. Selected to attract carnivores, bait included beef leg and rib bones with meat attached, whole goat heads, chicken heads, fresh fish scraps, cooked fish remains, tinned tuna fish in vegetable oil, cod liver oil and synthetic musk-scented oil (Appendix 1).

To avoid theft or damage, we did not set up traps in areas frequented by people (except on two occasions, when traps were set up on tourist trails in the evening and dismantled again early in the morning). Camera traps were usually sited some distance from tracks so that they were not visible from them. The equipment was not camouflaged. None of the equipment was tampered with during our survey.

After the first week, placement of the cameras was partly dictated by our attempts to evade the domestic dogs and cattle which roamed the eastern part of the reserve. Two locations were eventually abandoned because of interference from these animals. Dogs continued to be photo-trapped, but when we began to tie up the bait considerably higher in the trees they did not stay long enough to use up much film; their (mostly day-time) visits did not seem to deter other carnivores from visiting the camera traps (see locations 9 and 10 in Appendix 1).

Survey effort was concentrated in the coral rag thicket: 49 trap-nights were accumulated in the thicket and 6 in the groundwater forest (Table 3). Jozani Forest Reserve's thicketed areas—proportionally much larger than the groundwater forest—appear to be under the heaviest human pressure. Because we believed documenting the wildlife in the more threatened habitat was of higher priority, trapping effort was concentrated in the thicket.

Table 3. Summary of data presented in Table 1: trap-nights in the groundwater forest and the coral rag thicket; trap-nights with the active sensor and the passive sensor.

	Groundwater forest	Coral rag thicket	Total trap-nights
Active sensor	5	22	27
Passive sensor	1	27	28
Total trap-nights	6	49	55

No attempt was made to survey the reserve systematically, e.g. by siting camera traps at regular (or random) intervals along transects, keeping camera traps at each location for predetermined, equal durations, or sampling particular vegetation zones proportionally to their extents within the reserve.

Results

Detailed logs of each of the ten camera trap locations are presented in Appendix 1. Sixteen rolls of film were used, yielding 73 photographs of wild mammals representing seven species: four carnivores, one primate, one rodent and one insectivore (Table 4, Appendix 1). In addition, two domestic species were photo-trapped. No birds or other animals were photo-trapped.

More species were photo-trapped in the coral rag thicket (all 7 species) than the groundwater forest (3 species) (Table 4). This could have been a function of the greater number of trap-nights in the thicket. Considering that the camera traps were in the groundwater forest for only 6 out of a total of 55 trap-nights, it is noteworthy that almost half the species photo-trapped during the entire survey were photo-trapped in the groundwater forest (3 species out of 7). Three of the four wild carnivore species photo-trapped during the survey were photo-trapped in the groundwater forest. All carnivore species photo-trapped in the groundwater forest were also photo-trapped in the thicket.

Four species were photo-trapped using the active system; all 7 were photo-trapped with the passive system (Table 4). Note that two of the additional mammal species photo-trapped with the passive system—the shrew (species?)[6] and the red bush squir-

[6] Readers who can identify this animal (see Appendix 2) are asked to kindly contact the authors.

Table 4. Species photo-trapped with the active and passive sensors, in the groundwater forest and coral rag thicket.

Sensor type	Groundwater forest	Coral rag thicket
Active	*Herpestes sanguineus* *Bdeogale crassicauda* *Genetta servalina*	*Bdeogale crassicauda* *Civettictis civetta* *Genetta servalina*
Passive	*Genetta servalina*	*Cercopithecus mitis* *Paraxerus palliatus* shrew sp. *Herpestes sanguineus* *Bdeogale crassicauda* *Civettictis civetta* *Genetta servalina*

rel (*Paraxerus palliatus*)—are the two smallest bodied mammals photo-trapped in our survey. When mounting the active system, we routinely set the height of the beam at least 20 cm above the ground. Consequently, the active system would have missed recording any visits by shrews, squirrels or other animals in that size range.

Six of these species (including 3 of the carnivores) were photo-trapped during the first 4 trap-nights of the survey, at the first 3 locations established (Appendix 1). It then took a further 12 trap-nights to obtain photographs of the seventh species—the African civet (*C. civetta*) (Appendix 1).

The number of species photo-trapped in a single location ranged from 0 to 4 (Table 5). Three locations yielded no photographs of wild species. One location yielded photographs representing 4 mammal species, all carnivores: between 22 and 26 January all 4 carnivores visited one camera trap at location 9. In fact, 3 species came within a few hours of one another during a single night/early morning at this location: on 23 January the servaline genet came at 01:22, the bushy-tailed mongoose came at 02:06, and two slender mongooses arrived at 06:26 (Appendix 1).

Trap-nights per species photo-trapped at each location ranged from 1 to 7 (Table 5). Trap-nights per species were greatest at the locations at which the camera traps stayed

Table 5. Number of trap-nights, number of species photo-trapped at each trap location and trap-nights per species.

Location (sensor type, habitat)	# trap-nights	# species photo-trapped	trap-nights per species
1 (passive, thicket)	3	3	1
2 (active, groundwater)	4	2	2
3 (passive, groundwater)	1	1	1
4 (passive, thicket)	1	0	–
5 (passive, thicket)	9	0	–
6 (active, thicket)	3	1	3
7 (active, thicket)	5	0	–
8 (active, groundwater)	1	1	1
9 (passive, thicket)	14	4	3.5
10 (active, thicket)	14	2	7

the longest: camera traps were at locations 9 and 10 for 14 trap-nights each, with 3.5 and 7 trap-nights per species, respectively. The two locations which produced photographs of the largest number of species were locations 9 (with 4 species photo-trapped and 3.5 trap-nights per species) and 1 (with 3 species photo-trapped and 1 trap-night per species).

The species which proved "easiest" to trap was the servaline genet (*G. servalina*) (Table 6). This viverrid was photo-trapped at four locations: two in the coral rag thicket and two in the groundwater forest. However, of the carnivore species, the servaline genet was the species which appeared in the fewest photographs: only 6 images (Table 7). Inversely, the species photographed most often—31 photographs—was one of the two carnivore species photo-trapped at only two locations: the slender mongoose (*H. sanguineus*) (Tables 6, 7). The other was the African civet (*C. civetta*). Of the species photo-trapped, the slender mongoose seemed to be least disturbed by the camera. Other species tended to flee after one or two pictures were taken (although they sometimes returned later the same night). We assume the flash and perhaps also the sound of the camera alarmed them. Because slender mongooses were active by day the flash may have been less disturbing to them.

Defining night-time on Unguja in January as the hours of darkness from 19:00 to 06:00 and day-time as 06:01–18:59, we can say that no carnivore species were photo-trapped during both day-time and night-time (Table 7). Based on their visits to the traps, we can infer that all species were either completely nocturnal or completely diurnal.

Slender mongooses (*H. sanguineus*) triggered the traps only during daylight, from 06:26 to 18:53 (Table 7). This diurnal activity pattern is consistent with previously published findings (Kingdon 1997; Estes 1999). Looking more closely at the timing of slender mongoose photographs shows that of 31 pictures, only 5 were taken after 07:29 in the morning and before 17:00 in the afternoon (Table 7). This suggests a preference for mornings and afternoons, perhaps because of cooler temperatures or the activity patterns of prey. However, our own field activity peaked during the middle hours of the day and this may have inhibited slender mongooses from moving about near the traps at that time. The slender mongoose was the only carnivore which we actually sighted during the course of our study (Appendix 3).

Table 6. Number of locations in the coral rag thicket and the groundwater forest at which each carnivore species was photo-trapped.

Carnivore species	# thicket locations at which photo-trapped	# groundwater forest locations at which photo-trapped	Total # locations at which photo-trapped
Herpestes sanguineus	1	1	2
Bdeogale crassicauda	2	1	3
Civettictis civetta	2	0	2
Genetta servalina	2	2	4

Bushy-tailed mongooses (*B. crassicauda*), in contrast, were photo-trapped throughout the night, starting at 19:31, about half an hour after darkness fell, and ending at 05:41, about half an hour before sunrise (Table 7). This nocturnal activity pattern accords with scanty published information; little is known about this animal (Stuart in Mills & Hes 1997, p. 210). Both herpestids were photo-trapped at two of the same locations (locations 2 and 9). Their visits to the camera traps were always separated by at least 38 minutes (Appendix 1).

Whereas bushy-tailed mongooses were photographed throughout the hours of darkness, African civets (*C. civetta*) were photo-trapped during more limited night-time hours, starting at 20:09 and ending at 03:42 (Table 7). The nocturnal habits of the African civet are well-documented (Kingdon 1977; Randall in Mills & Hes 1997, p. 205; Estes 1999).

The photo-trapping pattern for servaline genets (*G. servalina*) was similar to African civets: servaline genets were photographed starting at 19:56 and ending at 03:24 (Table 7).

The two shortest intervals between recorded visits by different carnivore species was 38 minutes separating visits by the two mongoose species and 44 minutes dividing visits

Table 7. Times photographs of the carnivores were taken, and total number of photographs of each species. Shading highlights night-time (i.e. hours of darkness from 19:00 to 06:00) photographs.

Carnivore species	Times of photographs							Total # photographs
Herpestes sanguineus	06:26 06:29 06:31 06:32 06:35 06:36 06:41 06:43 06:49 06:53 06:56 06:57 06:58 06:58	07:01 07:03 07:09 07:12 07:18 07:19 07:22 07:26 07:29	10:08 10:10	15:20	16:06 16:06	17:00	18:52 18:53	31
Bdeogale crassicauda	01:01 01:04 01:37 01:44 01:46	02:06 02:35	03:20 03:26 03:29	05:41	19:31	20:06	23:21 23:21 23:22 23:31 23:37	18
Civettictis civetta	00:26	01:11	03:14 03:42		20:09 20:19		22:32 22:40	8
Genetta servalina	00:31	01:22	02:45	03:24	19:56	20:23		6

by a servaline genet and a bushy-tailed mongoose (Appendix 1).

Mammals were usually photo-trapped singly. There were two exceptions: three Sykes' monkeys (*Cercopithecus mitis*) were photo-trapped together at location 1, and two slender mongooses were photo-trapped together at location 9 (Appendix 1). Like other monkeys, Sykes' monkeys are well-known to be highly social animals (Kingdon 1997; Lawes in Mills & Hes 1997, p. 111; Estes 1999). The two apparently adult-sized slender mongooses photo-trapped together may have been siblings, parent and adult or adolescent offspring, a mating pair, or perhaps a coalition of males (Kingdon 1977; Creel in Mills & Hes 1997, p. 213).

Two domestic species entered the camera traps (Appendix 1). Domestic cattle were photo-trapped at location 7, where resulting photographs showed the herd clustering closely around the beef bait and investigating it. What was probably the same herd had been encountered 5 days previously, near location 4. The approximately 20-head herd were in good condition on both occasions, indicating that they were feeding well. Dogs were photo-trapped at locations 5, 7, 9 and 10. The same individual dog visited multiple traps. A pack of dogs visited one camera trap. Most dogs were photo-trapped during daylight hours. The sleek and relatively well-fed condition of some dogs contrasted with the underfed, scruffy appearance of other dogs. This suggests that some dogs were feral whereas others belonged to hunters. These incidents were reported to officers at Jozani Station and Dept. of Commercial Crops, Fruits and Forestry headquarters.

Discussion

This study was intended to contribute to our knowledge of Unguja's carnivores. Our survey produced photographs of all four of the smaller indigenous carnivores known to be found on the island. As far as we are aware these are the first photographs of these animals on Unguja. The only native carnivore not photo-trapped was the Zanzibar leopard, an elusive felid whose continued presence on Unguja is unconfirmed (Goldman & Walsh in press). Two non-carnivores were also photo-trapped. Mammals were photo-trapped in both the coral rag thicket and the groundwater forest.

These results compare favorably with the only other camera trapping effort we know to have been undertaken in Jozani Forest Reserve (Stuart & Stuart 1997), which produced photographs of only the African civet and the crested guinea fowl (*Guttera pucherani*). Camera traps employed in that three week survey were triggered when an animal trod upon a plate concealed under leaves and other debris. Scent lures were used to attract animals, but not meat bait. Cameras remained stationary at the two locations throughout the study (see the Map). The higher success of our effort can be attributed to improved technology combined with a strategy of baiting the camera traps with meat and fish and deploying them at a variety of locations.

It is worth noting that our survey did not produce any photographs of the two introduced wild carnivore species said to be present on Unguja: the banded mongoose

(*Mungos mungo*), which is a mainland African species, and the small Indian civet (*Viverricula indica*), of Asian origin. Weighing this against the quantity of photographs of the other small carnivores, the lack of banded mongoose and small Indian civet pictures suggests that these animals are less common than has been assumed, at least in the Jozani area. However, the report of a recent nine day biodiversity inventory carried out in Jozani characterizes small Indian civets as "common" (Nahonyo et al. 2002, p. 80). The grounds for this assessment are not stated: the authors do not provide details of the type, quantity or distribution of small Indian civet evidence they encountered.

Nahonyo et al. record the presence of the banded mongoose (Appendix VII in 2002)—the other introduced species which we did not photo-trap—but there is no information offered as to their abundance or the type of banded mongoose evidence which Nahonyo et al. found. On the other hand, Nahonyo et al.'s Appendix VII does *not* list the bushy-tailed mongoose as having been recorded present by the researchers, while we photo-trapped this native herpestid at three locations.

Nahonyo et al. are ambiguous on the question of servaline genets: *Genetta servalina* does not appear at all in Appendix VII, but elsewhere genets are mentioned in passing as one of the species which the team "recorded from signs" (Nahonyo et al. 2002, p. 48). See Table 8 for a comparison of the results of recent surveys in the Jozani area.

In our view, the most significant results of our study are the photographs of the Zanzibar servaline genet (*G. servalina archeri*), a subspecies formally described in 1998 (Van Rompaey & Colyn). These are the first photographs of live Zanzibar servaline genets. Six photographs were produced from four locations, demonstrating the genet's distribution in both the groundwater forest and the thicket within the Jozani Forest Reserve. Until now, the Zanzibar servaline genet has only been recorded from Kitogani (2.5 km SSE of Jozani; see the Map), the origin of the type specimen (Van Rompaey & Colyn 1998).

The presence of the servaline genet on Unguja is somewhat remarkable consider-

Table 8. Small carnivores recorded by recent surveys in the Jozani area.

Species	Stuart & Stuart 1997	Nahonyo et al. 2002	This study
Herpestes sanguineus	yes	yes	yes
Bdeogale tenuis	yes	no	yes
Civettictis civetta	yes	yes	yes
Genetta servalina	yes[a]	no (?)	yes
Mungos mungo **(introduced)**	no	yes	no
Viverricula indica **(introduced)**	yes	yes	no

[a] Tracks at one locale.

ing that the nearest mainland population is Lowe's servaline genet (*G. s. lowei*), located some 400 km away in Tanzania's southern highlands (Kingdon 1977; Van Rompaey & Colyn 1998; see also Brink et al. 2002; Wildlife Conservation Society 2002). Servaline genets are widely distributed west of Lake Victoria and across Central Africa's Congo Basin, but they exist in small, isolated pockets in East Africa outside of Uganda (Kingdon 1977, 1997; Van Rompaey & Colyn 1998). These enclaves occur at moist, forested mountains. This suggests that the servaline genets there may be relicts of a once continuous population that inhabited a formerly wetter and more thickly forested East Africa.[7]

The pictures produced by our survey add not only to our knowledge of the Zanzibar servaline genet's distribution but also to what we know of its appearance. Van Rompaey & Colyn describe the holotype of this genet subspecies as endowed with a

> "closely spotted, rather velvety pelage without a medial dorsal stripe. The numerous, medium-sized, black spots on the back are mostly separate and occasionally coalesce on the spine. The throat and the ventral part of the insides of the fore- and hindlegs are a clear, smoky grey, whereas the lower outside parts are light coloured and carry small spots. The tail is relatively short-haired and soft-furred, and annulated with 10 light-coloured rings, these being narrower than the 9 intermediate darker rings...The tip of the tail is absent...In contrast to *G. s. bettoni* and *C. s. lowei* from continental East Africa, *G. s. archeri* has no 'yellower base colour' (Kingdon 1977)." (Van Rompaey & Colyn 1998)[8]

This generally accords with our photographs of the Zanzibar servaline genet (see front cover, Appendix 2). For example, the delicate spotting on the lower forelimbs can be seen in photograph ZNZ0309/1 (front cover). We discern 11–14 dark and 10–13 light annulations on the tails of the genets photo-trapped, indicating the range of variation in the markings of this subspecies. We also note a rich, almost rufous, coloration to the coat, particularly of the upper body. This recalls Kingdon's description of the background color of *G. s. lowei* as "yellower" than other servaline genets (except *G. s. bettoni*) or even "peculiarly orange" (1977, p. 154). Though caution must be used when interpreting photographs, particularly those produced by camera trapping—inferior film quality, artificial lighting, the vagaries of film processing, digitalization and printing distort actual colors—we nevertheless question the non-yellow base color proposed by Van Rompaey & Colyn as a general characteristic of the Zanzibar servaline genet. Individual variation must be considered. It is also possible that the age and condition of the holotype skin—it was very dry and apparently old (R. Glen pers. comm. 2003)—

[7] See Kingdon (1989), Kingdon & Howell (1993) and Burgess et al. (1998) for discussions of the possible causes of endemism among East Africa's mammals.

[8] A photograph of the type specimen (97047M1, Royal Museum for Central Africa, Tervuren, Belgium) illustrates Van Rompaey & Colyn's description of the subspecies (1998).

have contributed to its paler, more neutral color. This effect can be readily observed, for example, in the faded mounted specimens at Zanzibar's Museum of Natural History.

The very recent scientific discovery of the Zanzibar servaline genet is puzzling. It is not a very small animal. Kingdon (1997) gives the weight of servaline genets as 1–2 kg, head and body length as 41–50 cm and tail length as 35–44 cm. The notoriety on Unguja of a chicken-killing animal roughly fitting the servaline genet's description indicates that it makes forays into settlements.[9] Although earlier observers referred to the presence of a "genet" on Unguja (Burton 1967 [1872], p. 198; Mansfield-Aders 1967 [1920], p. 329; Ingrams 1967 [1931], pp. 295 and 427), it seems that they actually had the small Indian civet in mind.[10] That an animal of the servaline genet's dimensions and striking appearance can remain undocumented on a relatively small, flat and densely inhabited island is challenging to explain. In any case, the discovery highlights the need for more and better research on Zanzibar's fauna.

Recommendations

(1) We hope that this survey stimulates the further study of Unguja's carnivores as well other hitherto overlooked mammals in Zanzibar. A number of these are endemic subspecies, including three of the carnivores photo-trapped during our survey. Differences between Unguja's populations and mainland African conspecifics should be documented through investigations of free-living animals: we would argue strongly against the capture of wild carnivores for research purposes.

Our findings prompt a range of initial research questions concerning Unguja's carnivores. Spatio-temporal distribution and other aspects of inter- and intra-specific competition and habitat use are potentially fruitful avenues of investigation. Prey bases, including the extent to which those of the different carnivores overlap, should also be investigated. We recommend studies of mammalian abundance and species richness within Jozani Forest Reserve compared to outside it, and systematic comparisons of species richness and abundance in the groundwater forest and the coral rag thicket. Further research should aim at achieving a better understanding of the potential threats to the survival of indigenous fauna, particularly endemic species and subspecies.

(2) The Zanzibar servaline genet (*Genetta servalina archeri*) should be placed on Appendix 1 of Zanzibar's 1996 Act, thereby extending to it total protection "year round

[9] Indeed, the type specimen is said to have been shot while attacking chickens (Van Rompaey & Colyn 1998).

[10] Pakenham & Moreau (1941) and Pakenham (1984) compounded the confusion by assuming that the referent was the African civet. We are grateful to Martin Walsh for bringing these early references to our attention.

and…the highest conservation action and work priority." Until it has been shown that this animal is abundant, widely distributed on Unguja and in no danger of extirpation, it should be placed on international protected wildlife lists which apply, as well as the IUCN's Red List of Threatened Species (which includes subspecies).

(3) The importance of protecting Jozani's thicket cannot be overstated. Unlike the visually impressive groundwater forest, generally regarded as the "core" of the reserve, the coral rag thicket does not attract tourists. Yes, as our study highlights, it is a key habitat for wildlife. Remains of poachers' fires, shell casings, stacks of cut wood, dogs (which suggests poaching) and cattle were signs we encountered of ongoing prohibited activities in the thicketed parts of Jozani, but illegal exploitation of the reserve has apparently decreased in recent years partly as a result of improved patrolling routines and enforcement of the tougher 1996 legislation (S. I. Hamdan and T. S. Masoud pers. comm. 2003). Although town-based poachers and wood-cutters are known to be a problem, there are indications that pressure on the reserve comes predominantly from the communities immediately surrounding it (H. A. Shaban pers. comm. 2003). The Jozani–Chwaka Bay Conservation Project has initiated measures to improve the welfare of Jozani area residents and at the same time to relieve pressure on the plants and animals of the reserve. Initiatives include the sharing of tourism-generated revenues with local communities through the Jozani Environmental Conservation Association, the construction of a tourist facility in the mangroves south of Jozani with proceeds going to the village of Pete, financial compensation for crop damage purportedly caused by colobus monkeys, and helping Jozani area communities develop management plans for tracts of thicket and mangroves with respect to which their traditional rights have been officially recognized.

Jozani-based staff have special insights into the problems affecting the reserve and these merit recognition. Some of their suggestions—such as more frequent unscheduled night patrols (H. A. Shaban pers. comm. 2003)—should be supported by the Department. The boosting of Jozani's status to Zanzibar's first national park presents an excellent opportunity to improve all aspects of its management.

A long-term view of the Jozani area's natural environment and human population should be taken. With Zanzibar's population expanding at a rate of over 3 % annually (Nyanje 2003), the growing demands of people around Jozani for farm and grazing land, building material, fuelwood, charcoal and bushmeat may eventually lead to the extirpation of endemic native fauna and a reduction in local living standards. The promotion of family planning should top the agendas of health and education authorities as well as foreign donors and international aid organizations. The enforcement of protected area regulations and the further development of sustainable use management plans for areas outside the Jozani–Chwaka Bay National Park should remain paramount priorities for Zanzibari environmental authorities and their international partners.

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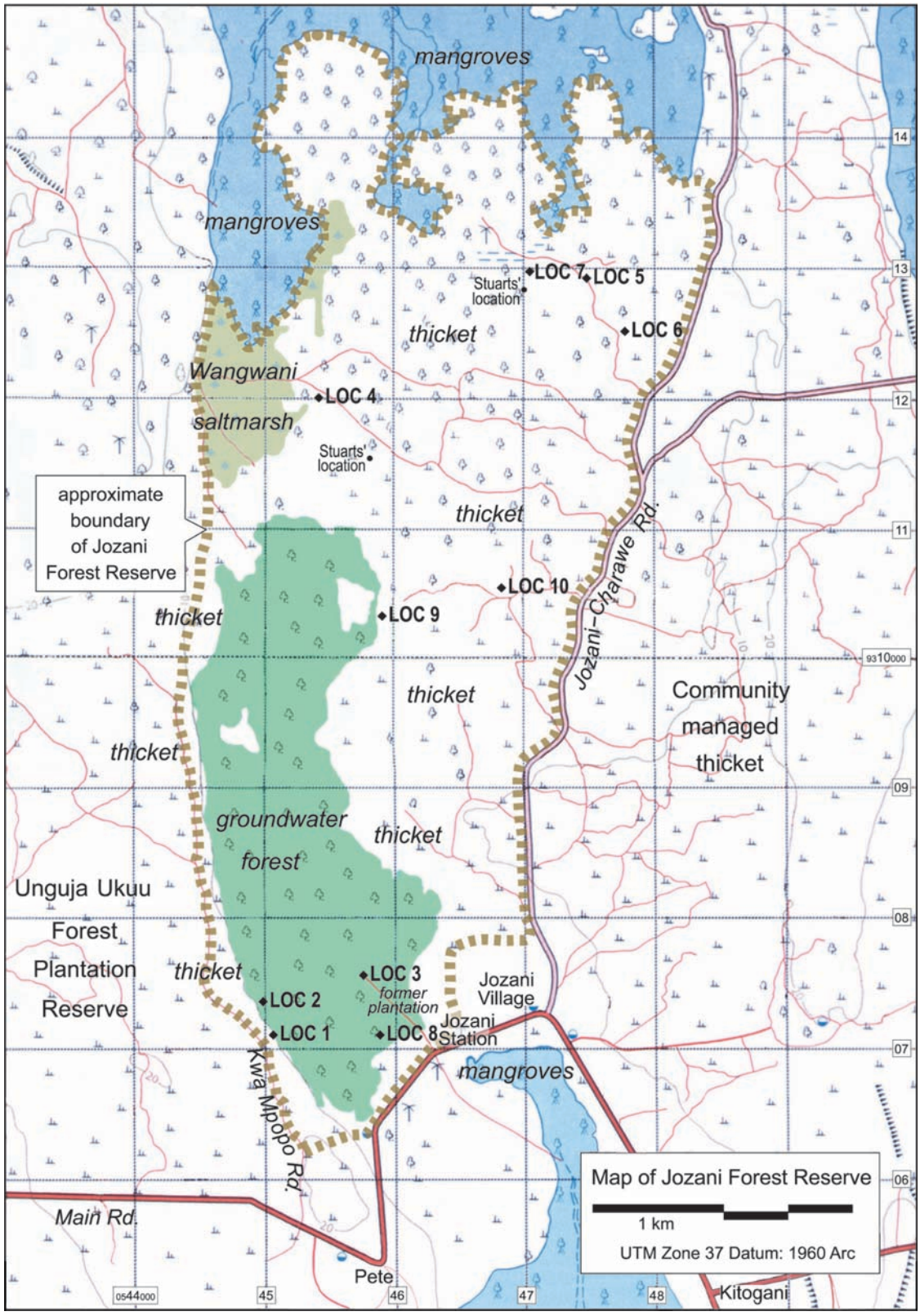
mangroves
mangroves
LOC 7
LOC 5
Stuarts' location
thicket
LOC 6
Wangwani
LOC 4
saltmarsh
Stuarts' location
approximate boundary of Jozani Forest Reserve
thicket
LOC 10
LOC 9
thicket
Jozani–Charawe Rd.
Community managed thicket
thicket
thicket
groundwater forest
thicket
Unguja Ukuu Forest Plantation Reserve
thicket
LOC 3
former plantation
LOC 2
LOC 1
LOC 8
Jozani Village
Jozani Station
mangroves
Kwa Mpopo Rd.
Main Rd.
Pete
Kitogani
Map of Jozani Forest Reserve
1 km
UTM Zone 37 Datum: 1960 Arc
14
13
12
11
9310000
09
08
07
06
0544000
45
46
47
48

Appendix 1. Camera trap logs

Geographical positions accord with the UTM Zone 37 grid (datum: 1960 Arc). WGS 84 coordinates are also given. In the "Species" columns, "x" denotes photographs which did not include an animal. Film/frame identification numbers in boldface are photographs reproduced in this report (front cover, Appendix 2).

Location 1
Position: UTM Zone 37, 0545055 9307131 (06˚16.254'S, 39˚24.490'E)
Description: coral rag high thicket, near border of groundwater forest, area called Tovu
Sensor type: passive infrared
1.1.03 15:30 to 4.1.03 12:00

Date	Time	Film id #/frame	Bait, when added	Species	Remarks
1.1.03	17:06	ZNZ0301/1	cod liver oil, 1.1 15:30	x	
1.1.03	17:07	**ZNZ0301/2**		*P. palliatus*	
1.1.03	17:07	ZNZ0301/3		*P. palliatus*	
2.1.03	06:03	**ZNZ0301/4**		shrew sp.	
2.1.03	11:14	ZNZ0301/5		*C. mitis*	
2.1.03	11:22	ZNZ0301/6		*C. mitis*	
2.1.03	11:22	ZNZ0301/7		*C. mitis*	2 individuals
2.1.03	11:23	ZNZ0301/8		*C. mitis*	
2.1.03	11:23	**ZNZ0301/9**		*C. mitis*	3 individuals
3.1.03	06:03	**ZNZ0304/1**	chicken heads, 2.1 15:00	shrew sp.	
3.1.03	06:03	**ZNZ0304/2**	chicken heads, 2.1 15:00	shrew sp.	
4.1.03	05:02	ZNZ0304/3	cooked fish remains, 3.1 09:35	x	

Location 2
Position: UTM Zone 37, 0544981 9307369 (06˚16.125'S, 39˚24.450'E)
Description: groundwater forest near border of coral rag high thicket, area called Tovu
Sensor type: active infrared
1.1.03 17:00 to 5.1.03 12:00

Date	Time	Film id #/frame	Bait, when added	Species	Remarks
3.1.03	13:15	ZNZ0302/6	cooked fish remains, 3.1 10:45	x	
3.1.03	16:06	ZNZ0302/7		*H. sanguineus*	
3.1.03	16:06	ZNZ0302/8		*H. sanguineus*	
3.1.03	16:17	ZNZ0302/9		x	
4.1.03	01:40	ZNZ0302/10		x	

4.1.03	03:20	ZNZ0302/11		*B. crassicauda*	
4.1.03	03:29	ZNZ0302/12		*B. crassicauda*	
4.1.03	05:41	ZNZ0302/13		*B. crassicauda*	
4.1.03	10:04	ZNZ0302/14		x	
4.1.03	13:40-13:42	ZNZ0304/4-5	live chicken, 4.1 13:40	(test)	Bait attacked by army ants

Location 3
Position: UTM Zone 37, 0545772 9307618 (06˚15.990'S, 39˚24.879'E)
Description: groundwater forest, former *Calophyllum inophyllum* plantation, place called Kwa Joshi
Sensor type: passive infrared
4.1.03 19:00 to 5.1.03 08:05

Date	Time	Film id #/frame	Bait, when added	Species	Remarks
4.1.03	19:00	ZNZ0304/6	50 g tinned tuna, 4.1 19:00	(test)	
4.1.03	19:56	**ZNZ0304/7**		*G. servalina*	

Location 4
Position: UTM Zone 37, 0545406 9312022 (06˚13.600'S, 39˚24.678'E)
Description: grassy clearing, partly encircled by high, dense coral rag thicket, east of Wangwani
Sensor type: passive infrared
5.1.03 17:00 to 6.1.03 17:10

Date	Time	Film id #/frame	Bait, when added	Species	Remarks
6.1.03	08:45-12:32	ZNZ0303/2-37	whole chicken, 5.1 17:00	x	Herd of cattle in the area on film retrieval

Location 5
Position: UTM Zone 37, 0547437 9312943 (06˚13.099'S, 39˚25.779'E)
Description: dense, high coral rag thicket, east of Wangwani
Sensor type: passive infrared
6.1.03 19:00 to 15.1.03 16:40

Date	Time	Film id #/frame	Bait, when added	Species	Remarks
6.1.03	18:45	ZNZ0308/1	5 kg beef bones, 6.1 19:00	(test)	
12.1.03	13:43	ZNZ0308/2	2 kg beef rib, 11.1 13:50	x	
13.1.03	15:15	ZNZ0308/3	synthetic musk-scented oil, 13.1 08:40	x	
14.1.03	08:49-08:53	ZNZ0308/4-5		x	
14.1.03	13:18-13:34	ZNZ0308/6-37		(dog)	

14.1.03	19:05	ZNZ0310/1	one goat head, 14.1 17:30	x	
14.1.03	21:31	ZNZ0310/2		(dog)	
15.1.03	00:22-06:02	ZNZ0310/3-9		(dog)	
15.1.03	12:31-13:16	ZNZ0310/10-15		x	
15.1.03	13:19-13:32	ZNZ0310/16-25		(dog)	
15.1.03	13:41	ZNZ0310/26		x	
15.1.03	13:45	ZNZ0310/27		(dog)	
15.1.03	13:52-14:15	ZNZ0310/28-30		x	

Location 6
Position: UTM Zone 37, 0547770 9312548 (06˚13.313'S, 39˚25.960'E)
Description: dense, high coral rag thicket, east of Wangwani
Sensor type: active infrared
6.1.03 19:30 to 9.1.03 10:30

Date	Time	Film id #/frame	Bait, when added	Species	Remarks
8.1.03	02:45	**ZNZ0304/9**	two goat heads, 6.1 19:30	*G. servalina*	
8.1.03	23:46	ZNZ0304/10		x	
9.1.03	09:10	ZNZ0304/11		x	

Location 7
Position: UTM Zone 37, 0547031 9312998 (06˚13.069'S, 39˚25.559'E)
Description: coral rag thicket, east of Wangwani
Sensor type: active infrared
9.1.03 11:45 to 14.1.03 17:45

Date	Time	Film id #/frame	Bait, when added	Species	Remarks
10.1.03	12:06-20:51	ZNZ0305/2-5	2 kg beef rib, 9.1 11:45	x	
11.1.03	10:43-11:02	ZNZ0305/6-12		x	
11.1.03	21:04-21:17	ZNZ0306/1-37	4 kg beef bones, 11.1 13:00	(cattle)	
13.1.03	16:08-18:48	ZNZ0307/1-37	cod liver oil, 13.1 09:30	(dog)	

Location 8
Position: UTM Zone 37, 0544840 9307150 (06˚16.244'S, 39˚24.374'E)
Description: natural groundwater forest, tourist trail area, southern Jozani forest Reserve
Sensor type: active infrared
14.1.03 19:00 to 15.1.03 06:35

Date	Time	Film id #/frame	Bait, when added	Species	Remarks
15.1.03	03:24	**ZNZ0309/1**	cod liver oil, synthetic musk-scented oil, 14.1 19:00	*G. servalina*	
15.1.03	06:02	ZNZ0309/2		x	

Location 9
Position: UTM Zone 37, 0545815 9310351 (06˚14.506'S, 39˚24.901'E)
Description: patchy coral rag thicket, eastern Jozani Forest Reserve
Sensor type: passive infrared
15.1.03 18:15 to 29.1.03 08:20

Date	Time	Film id #/frame	Bait, when added	Species	Remarks
16.1.03	10:47-14:21	ZNZ0311/1-34	2 kg beef bones, 15.1 18:15	x	
17.1.03	18:15	ZNZ0313/1-2	4 kg beef bones, fish scraps, 17.1 18:15	(test)	
18.1.03	01:03	ZNZ0313/3		(dog)	
18.1.03	23:21	ZNZ0313/4		*B. crassicauda*	
18.1.03	23:21	**ZNZ0313/5**		*B. crassicauda*	
18.1.03	23:22	ZNZ0313/6		*B. crassicauda*	
18.1.03	23:31	ZNZ0313/7		*B. crassicauda*	
18.1.03	23:37	ZNZ0313/8		*B. crassicauda*	
19.1.03	03:26	ZNZ0313/9		*B. crassicauda*	
19.1.03	11:09	ZNZ0313/10	1 kg beef bones, fish scraps, 19.1 11:45	(test)	
19.1.03	11:45	ZNZ0313/11		(test)	
20.1.03	08:49-08:58	ZNZ0313/12-19		(dogs)	
20.1.03	10:55-15:43	ZNZ0313/20-26		x	
20.1.03	17:00	ZNZ0313/27		*H. sanguineus*	
20.1.03	18:52	ZNZ0313/28		*H. sanguineus*	
20.1.03	18:53	**ZNZ0313/29**		*H. sanguineus*	
20.1.03	19:31	ZNZ0313/30		*B. crassicauda*	
21.1.03	01:01	ZNZ0313/31		*B. crassicauda*	
21.1.03	01:04	ZNZ0313/32		*B. crassicauda*	
21.1.03	01:37	**ZNZ0313/33**		*B. crassicauda*	

21.1.03	01:44	ZNZ0313/34		*B. crassicauda*	
21.1.03	01:45	ZNZ0313/35		x	
21.1.03	01:46	ZNZ0313/36		*B. crassicauda*	
21.1.03	06:43	ZNZ0313/37		*H. sanguineus*	
21.1.03	15:37	ZNZ0314/1	3 kg beef bones, 21.1 15:30	(test)	
22.1.03	13:39-14:11	ZNZ0314/2-3		x	
22.1.03	15:20	ZNZ0314/4		*H. sanguineus*	
22.1.03	16:28	ZNZ0314/5	orange-scented oil, 22.1 16:10	(test)	
22.1.03	20:23	**ZNZ0314/6**		*G. servalina*	
23.1.03	00:31	**ZNZ0314/7**		*G. servalina*	
23.1.03	01:22	ZNZ0314/8		*G. servalina*	
23.1.03	02:06	ZNZ0314/9		*B. crassicauda*	
23.1.03	06:26	ZNZ0314/10		*H. sanguineus*	
23.1.03	06:29	**ZNZ0314/11**		*H. sanguineus*	
23.1.03	06:31	ZNZ0314/12		*H. sanguineus*	
23.1.03	06:32	ZNZ0314/13		*H. sanguineus*	
23.1.03	06:35	ZNZ0314/14		*H. sanguineus*	
23.1.03	06:36	ZNZ0314/15		*H. sanguineus*	
23.1.03	06:41	ZNZ0314/16		*H. sanguineus*	
23.1.03	06:49	ZNZ0314/17		*H. sanguineus*	2 individuals
23.1.03	06:53	ZNZ0314/18		*H. sanguineus*	
23.1.03	06:56	**ZNZ0314/19**		*H. sanguineus*	2 individuals
23.1.03	06:57	**ZNZ0314/20**		*H. sanguineus*	2 individuals
23.1.03	06:58	ZNZ0314/21		*H. sanguineus*	2 individuals
23.1.03	06:58	ZNZ0314/22		*H. sanguineus*	2 individuals
23.1.03	07:01	ZNZ0314/23		*H. sanguineus*	
23.1.03	07:03	ZNZ0314/24		*H. sanguineus*	
23.1.03	07:09	ZNZ0314/25		*H. sanguineus*	
23.1.03	07:12	ZNZ0314/26		*H. sanguineus*	
23.1.03	07:18	ZNZ0314/27		*H. sanguineus*	
23.1.03	07:19	ZNZ0314/28		*H. sanguineus*	
23.1.03	07:22	ZNZ0314/29		*H. sanguineus*	
23.1.03	07:26	ZNZ0314/30		*H. sanguineus*	
23.1.03	07:29	ZNZ0314/31		*H. sanguineus*	
23.1.03	10:08	ZNZ0314/32		*H. sanguineus*	
23.1.03	10:10	ZNZ0314/33		*H. sanguineus*	
23.1.03	12:51-15:37	ZNZ0314/34-35		x	
24.1.03	12:33-14:11	ZNZ0314/36-37		x	

26.1.03	00:26	ZNZ0315/1	2 kg beef bones, 24.1 15:45	*C. civetta*	
26.1.03	15:27	ZNZ0315/2		x	
26.1.03	20:06	ZNZ0315/3		*B. crassicauda*	
27.1.03	14:33-21:26	ZNZ0315/4-6	4 kg beef bones, 27.1 08:15	(dog)	

Location 10
Position: UTM Zone 37, 0546769 9310556 (06˚14.394'S, 39˚25.418'E)
Description: coral rag thin thicket, eastern Jozani Forest Reserve
Sensor type: active infrared
15.1.03 19:10 to 29.1.03 08:10

Date	Time	Film id #/frame	Bait, when added	Species	Remarks
15.1.03	19:10	ZNZ0309/4		(test)	
15.1.03	21:17	ZNZ0309/5	4 kg beef bones, 15.1 19:10	x	
16.1.03	10:01-12:39	ZNZ0309/6-37		x	
18.1.03	03:42	**ZNZ0312/1**	1 kg beef bones and fish scraps, 17.1 16:55	*C. civetta*	
18.1.03	20:19	ZNZ0312/2		*C. civetta*	
23.1.03	20:09	**ZNZ0316/1**	1 kg beef bones, fish scraps, 19.1 12:10; 2 kg beef bones, 21.1 15:50; orange-scented oil, 22.1 15:55	*C. civetta*	
26.1.03	07:55	ZNZ0316/2		(test)	
28.1.03	02:35	ZNZ0316/3	2 kg beef bones, 24.1 15:00; 3 kg beef bones, 26.1 07:55	*B. crassicauda*	
28.1.03	07:35-08:05	ZNZ0316/4-6		(dog)	
28.1.03	22:32	ZNZ0316/7		*C. civetta*	
28.1.03	22:40	ZNZ0316/8		*C. civetta*	
29.1.03	01:11	ZNZ0316/9		*C. civetta*	
29.1.03	03:14	ZNZ0316/10		*C. civetta*	
29.1.03	06:28	ZNZ0316/11		(dog)	

Appendix 2. Photographs

Identification numbers correspond to frames in Appendix 1. See Appendix 1 for details of camera trap locations, dates and times.

Zanzibar servaline genet (*Genetta servalina archeri*) (ZNZ0304/9).

Zanzibar servaline genet (ZNZ0304/7).

Zanzibar servaline genet (ZNZ0314/6).

Zanzibar servaline genet (ZNZ0314/7). See also photograph on front cover (ZNZ0309/1).

African civet (*Civettictis civetta*) (ZNZ0316/1). Active monitor in background.

African civet (ZNZ0312/1).

Zanzibar bushy-tailed mongoose (*Bdeogale crassicauda tenuis*) (ZNZ0313/33).

Zanzibar bushy-tailed mongoose. (ZNZ0313/5).

Zanzibar slender mongoose (*Herpestes sanguineus rufescens*) (ZNZ0313/29).

Zanzibar slender mongoose (ZNZ0314/11).

Zanzibar slender mongooses (ZNZ0314/20).

Zanzibar slender mongooses (ZNZ0314/19).

Shrew sp. (ZNZ0304/2).

Shrew sp. (ZNZ0304/1).

Shrew sp. (ZNZ0301/4).

Red bush squirrel (*Paraxerus palliatus*) (ZNZ0301/2).

Sykes' monkeys (*Cercopithecus mitis*) (ZNZ0301/9).

Appendix 3. Species encountered incidentally during the survey

The list excludes encounters with primates in the vicinity of Jozani Station. Jozani Forest Reserve is abbreviated to JFR. Geographical positions accord with the UTM Zone 37 grid (datum: 1960 Arc). WGS 84 coordinates are also given.

Date	Time	Position UTM (WGS)	Location description	Encounter type	Species
2.1.03	17:15	0544800 9307200 (06° 16.217' S, 39° 24.352' E)	track through thicket, western JFR	pugmark	? *Herpestes sanguineus*
3.1.03	11:35	0545110 9306400 (06° 16.651' S, 39° 24.520' E)	thicket, western JFR	sighting	*Rhynchocyon petersi*
3.1.03	12:00	0545800 9307500 (06° 16.054' S, 39° 24.894' E)	natural groundwater forest	pugmarks (pig runs common in ground-water forest)	*Potamochoerus porcus*
3.1.03	12:10	0546000 9307300 (06° 16.162' S, 39° 25.003' E)	natural groundwater forest	sighting	*Rhynchocyon petersi*
4.1.03	08:20	0546200 9307250 (06° 16.189' S, 39° 25.111' E)	track, natural groundwater forest	sighting (dead)	*Philothamnus semivariegatus*
5.1.03	14:00	0546290 9307162 (06° 16.237' S, 39° 25.160' E)	near researchers' quarters, Jozani Station	sighting	*Psammophus subtaeniatus*
5.1.03	17:00	0545300 9312100 (06° 13.557' S, 39° 24.621' E)	dense thicket, east of saltwater marsh, northern JFR	sighting	*Procolobus badius*
5.1.03	17:00	0545300 9312100 (06° 13.557' S, 39° 24.621' E)	dense thicket, east of saltwater marsh, northern JFRe	calls	*Cercopithecus mitis*
6.1.03	19:30	0547700 9312300 (06° 13.448' S, 39° 25.922' E)	dense thicket, east of saltwater marsh, northern JFR	calls	*Cercopithecus mitis*
9.1.03	10:45	0547770 9312548 (06° 13.313' S, 39° 25.960' E)	dense thicket, east of saltwater marsh, northern JFR	sighting	*Rhynchocyon petersi*
9.1.03	12:00	0547031 9312998 (06° 13.069' S, 39° 25.559' E)	thicket, east of saltwater marsh, near track, northern JFR	civetry, scent marks	*Civettictis civetta*

9.1.03	13:00	0551509 9309961 (06° 14.715' S, 39° 27.989' E)	dense thicket, south of Charawe/ Ukongoroni	faeces	*Dendrohyrax validus*
14.1.03	16:30	0546700 9307150 (06° 16.243' S, 39° 25.382' E)	Main Rd.	sighting (road kill)	*Philothamnus semivariegatus*
15.1.03	08:10	0538800 9307150 (06° 16.246' S, 39° 21.097' E)	Main Rd.	sighting	*Herpestes sanguineus*
15.1.03	19:15	0546766 9310537 (06° 14.405' S, 39° 25.417' E)	thin thicket, eastern JFR	sighting (pair)	shrew sp.
18.1.03	13:20	0545844 9310488 (06° 14.432' S, 39° 24.917' E)	thin thicket, eastern JFR	sighting	*Procolobus badius*
18.1.03	13:50	0547116 9309265 (06° 15.095' S, 39° 25.607' E)	thicket, Jozani–Charawe Rd.	sighting	*Rhynchocyon petersi*
19.1.03	15:00	0546978 9306343 (06° 16.681' S, 39° 25.534' E)	degraded, sparse thicket/agricultural area south of JFR, near track	civetry	*Civettictis civetta*
24.1.03	16:00	0546928 9310492 (06° 14.430' S, 39° 25.505' E)	thicket, eastern JFR	sighting	*Procolobus badius*
26.1.03	12:00	0547600 9306700 (06° 16.487' S, 39° 25.871' E)	crossing Main Rd.	sighting	? *Herpestes sanguineus*
26.1.03	12:30	0557900 9307500 (06° 16.048' S, 39° 31.457' E)	crossing main road	sighting	? *Herpestes sanguineus*
29.1.03	08:00	0547400 9310000 (06° 14.696' S, 39° 25.761' E)	thicket, crossing Jozani–Charawe Rd.	sighting	*Herpestes sanguineus*
29.1.03	08:05	0547400 9315000 (06° 11.982' S, 39° 25.759' E)	thicket, eastern JFR	sighting (flock)	*Guttera pucherani*
29.1.03	08:30	0547600 9314000 (06° 12.525' S, 39° 25.867' E)	thicket, eastern JFR	sighting	antelope sp.
29.1.03	08:40	0547400 9310000 (06° 14.696' S, 39° 25.761' E)	thicket, crossing JFR	sighting	*Cercopithecus mitis*