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Data presented in this report were collected by Michele Menegon and Hamidu Seki. The project was conceived by Michele Menegon, Michael Bungard and Andrew Bowkett. All authors contributed to compiling the report.

Suggested citation:

Seki, H.A., Bowkett, A.E., Bungard, M.J., Doggart, N. and Menegon, M. 2011. Current status of three endangered hyper-endemic amphibian species in the Uzungwa Scarp Forest Reserve, Tanzania. Tanzania Forest Conservation Group and Whitley Wildlife Conservation Trust, Dar es Salaam, Tanzania. Pp. 1-12

Front cover: Critically Endangered Wendy's forest toad. Credit H. Seki, 2011.

Executive Summary

The biodiversity of the Uzungwa Scarp Forest Reserve, as one of the highest-ranking sites in the Eastern Arc Mountains for both endemic and threatened vertebrate species, is globally important. This unique fauna includes numerous strictly endemic amphibians including species known only from tiny areas (< 1 km²) (Menegon & Davenport, 2008). The potentially 'hyper-endemic' status of these species leaves them highly vulnerable to environmental change and one species, the Kihansi spray toad, is already extinct in the wild. This report summarizes survey-work undertaken in the first half of 2011 targeting three threatened hyper-endemic amphibian species: Wendy's forest toad *Nectophrynoides wendyae* (Critically Endangered), Poynton's forest toad *N. poyntoni* (Critically Endangered) and Kihanga reed frog *Hyperolius kihangensis* (Endangered).

The survey team successfully found Wendy's forest toad in the previously known area and at a new site 0.5 km away in a separate valley. This small distance significantly extends the known area of occupancy for this species, which was previously estimated at less than 1 km². However this new information does not merit a change in IUCN Red List status from Critically Endangered.

Poynton's forest toad and Kihanga reed frog were not encountered during the study despite surveying the known distribution areas for both species. This result is especially concerning for Poynton's forest toad as the only known site was surveyed on four occasions throughout the study period. In addition the sympatric Tornier's forest toad *N. tornieri* was also absent from this site despite being recorded as common there previously. Heavy rains may have affected the single survey targeting Kihanga reed frog and both species may normally be more active, and therefore easily detected, at the onset of rains in November-December. **We therefore urgently require further funding to determine whether these two species survive.**

Introduction

The unique biodiversity of the Eastern Arc Mountains in Tanzania mean they are amongst the most important areas for nature conservation on the planet (Burgess et al. 2007; Myers et al. 2005). Moreover the Mountains and their forests are increasingly recognized for their vital importance to human well being through the provision of ecosystem services (Burgess et al. 2009). The endemic species of the Eastern Arcs are valuable indicators of the health of these ecosystems and therefore the effectiveness of management for both biodiversity and human benefit.

The Uzungwa Scarp Forest Reserve (USFR) stands out, even among the Eastern Arc Mountains, for its exceptionally high numbers of endemic and threatened species (Menegon & Salvidio, 2005; Rovero & Menegon 2005; MNR&T 2010). However the reserve's biodiversity faces a crisis due to increasing levels of illegal hunting and forest degradation (Rovero et al. 2010). This situation is exacerbated by the near isolation of USFR from other protected forest in the Udzungwa Mountains (MTSN 2007). This crisis has been recognized by the Forestry and Beekeeping Division, the government management authority involved, and the area has been proposed for Nature Reserve status.

The majority of Eastern Arc endemic vertebrate species found in USFR are amphibians with at least 36 species, of which 8 are endemic to southern Udzungwa forest fragments or to the USFR itself having not been recorded anywhere else (Menegon & Salvidio, 2005, Rovero & Menegon 2005, Michele Menegon unpublished data). Some of these endemics are thought to be restricted to single valleys or sites less than 1 km² and are thus highly vulnerable to changes in their environment. This "hyper-endemic" status has resulted in their listing by the IUCN Red List of Threatened Species as Endangered (EN) or Critically Endangered (CR). The nearby case of the Kihansi spray toad (*Nectophrynoides asperginis*), and its subsequent extinction in the wild, amply illustrates the susceptibility of these highly localized, small amphibian populations to extinction events.

This report focuses on three USFR endemic species: Wendy's forest toad *Nectophrynoides wendyae* (Critically Endangered), Poynton's forest toad *N. poyntoni* (Critically Endangered) and Kihanga reed frog *Hyperolius kihangensis* (Endangered). Whether the hyper-endemic status of these species is genuine or the result of historical sampling bias is crucial to determining their conservation status. This report summarizes the first six months of surveying during the main wet season of 2011. It is hoped that these results will help identify critical sites for protection under management of the proposed Nature Reserve.

Methods

Study site

The USFR (207 km²) is found in the southern part of the Udzungwa Mountain range within Iringa and Morogoro Regions. The Reserve is characterized by steep continuously forested slopes rising from 300 m at the edge of the Kilombero Valley to over 2000 m above sea level. USFR represents one of the largest areas of closed-canopy forest in the Udzungwa Mountains. Survey sites for this project were accessed via the villages of Chita and Ikule on the eastern side of the Reserve.

Amphibian surveys

Surveys were carried out between 27th January and 3rd June 2011 during the main wet season in southern Tanzania. Visual encounter surveys were carried out along predetermined transect lines and within quadrat plots. Specimens were not collected as species identification was based on photographs and body measurements (see below).

Nine survey sites were selected including all known sites for each target species and nearby areas of similar altitude and habitat. Each site was surveyed along two to four transect lines 50m long and 2m wide. Transect lines were positioned to include predominant vegetation types and likely amphibian habitat such as streams etc; and were at least 50m apart. Each transect was walked at least once during the day (starting between 9.00hrs to 16.00hrs) and once at night (19.00hrs to 22.00hrs). Five 5 m by 5m quadrats were sampled at each survey site during the day and night. Quadrat sampling involved careful searching of each plot for 30 minutes and was designed to record cryptic leaf litter species that could potentially be missed by transect sampling. Opportunistic encounters with amphibians during general fieldwork were also recorded.

Species identification

Amphibian species identification is potentially problematic and therefore a coding system was employed to reduce cases of misidentification. All first encounters with an amphibian species on each transect or quadrat were photographed and allocated a unique code. For the target species every individual was photographed. High-resolution digital photographs were taken using a Pentax Optio W90 digital camera and at least one whole body shot was taken *in-situ* with additional close-up lateral and ventral shots for captured individuals of target species. A series of measurements were also taken for captured individuals using Vernier dial calipers (see Table 1).

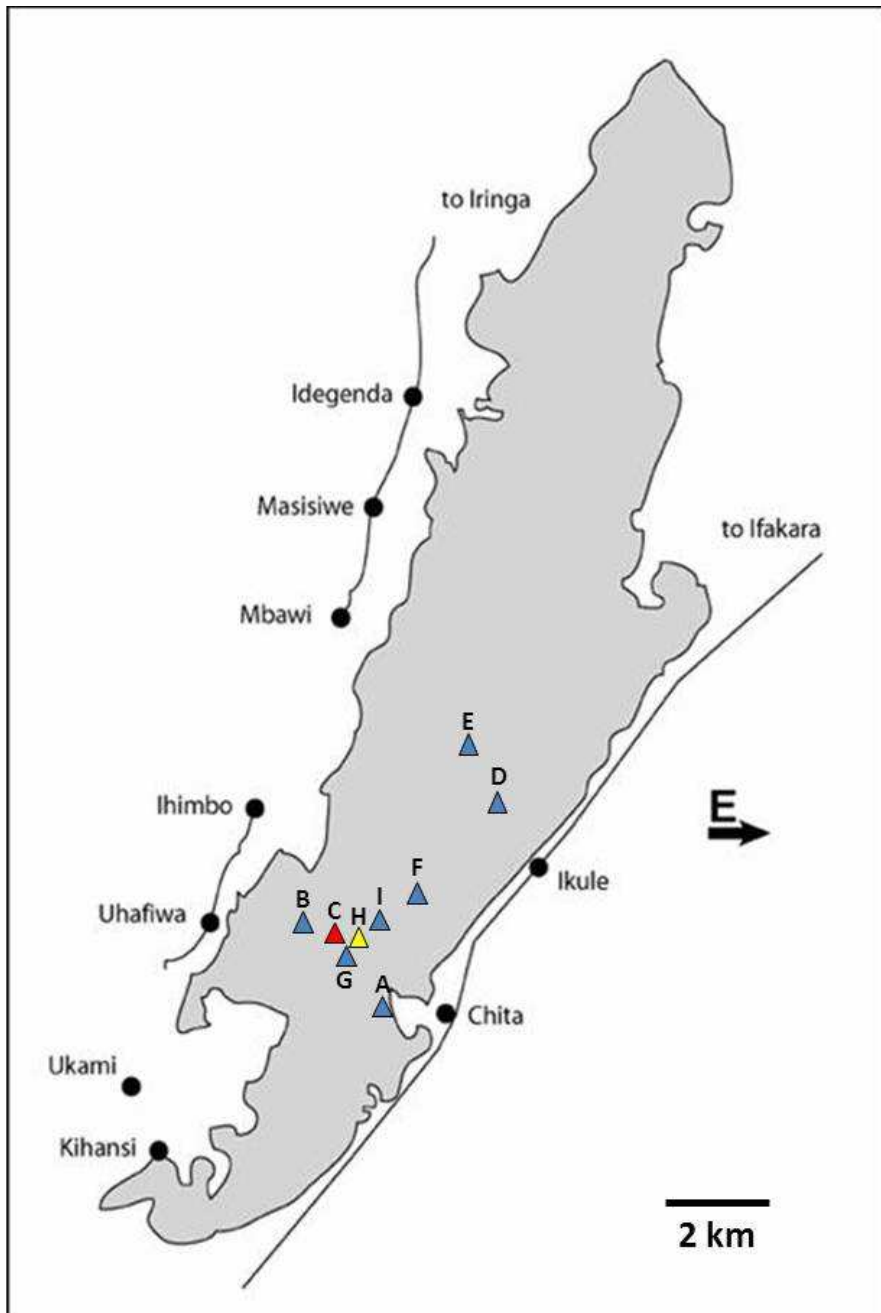


Figure 1. The Uzungwa Scarp Forest Reserve and adjacent villages. Triangles = hyper-endemic amphibian survey sites, red triangle = historical site for *Nectophrynoides wendyae*, yellow triangle = new records for *N. wendyae* (this study).

For each species encounter (or individual of target species) the vegetation or substrate on which found, height off ground, time and distance along transect were also recorded. All captured amphibians were released at the point of capture.

Habitat description

Habitat data was recorded every 10m along each transect line within a 2m radius or within each quadrat. The ten nearest trees were allocated to one of five tree architecture categories following Bibby et al. (1998). This method allocates trees according to branching pattern ranging from A (branching above half of tree height) to D (branching below half height with vertical growth) with an additional category for dead wood and stumps (E).

Percent vegetation cover was estimated for canopy (>2.5 m), shrub 0.5-2.5 m) and herb (<0.5 m) layers. Floor substrate was estimated as percentage cover in the following categories: soil, leaf litter, gravel/sand, dead wood, water, cobbles (>50mm and <250mm) or rocks (>250mm).

Altitude was recorded using the GPS altimeter and angle of slope measured at each habitat point using a clinometer. Weather conditions were noted at the start of each survey.

Bio-security and camp protocol

Due to the potential for amphibian pathogens to be transmitted between sites or populations bio-security measures were strictly enforced. Latex gloves were used when handling amphibians and a new pair used for each site. Field equipment including calipers, boots and ground sheets were cleaned and disinfected between sites using sodium hypochlorite (0.05% solution for ten minutes) and then washed with fresh water.

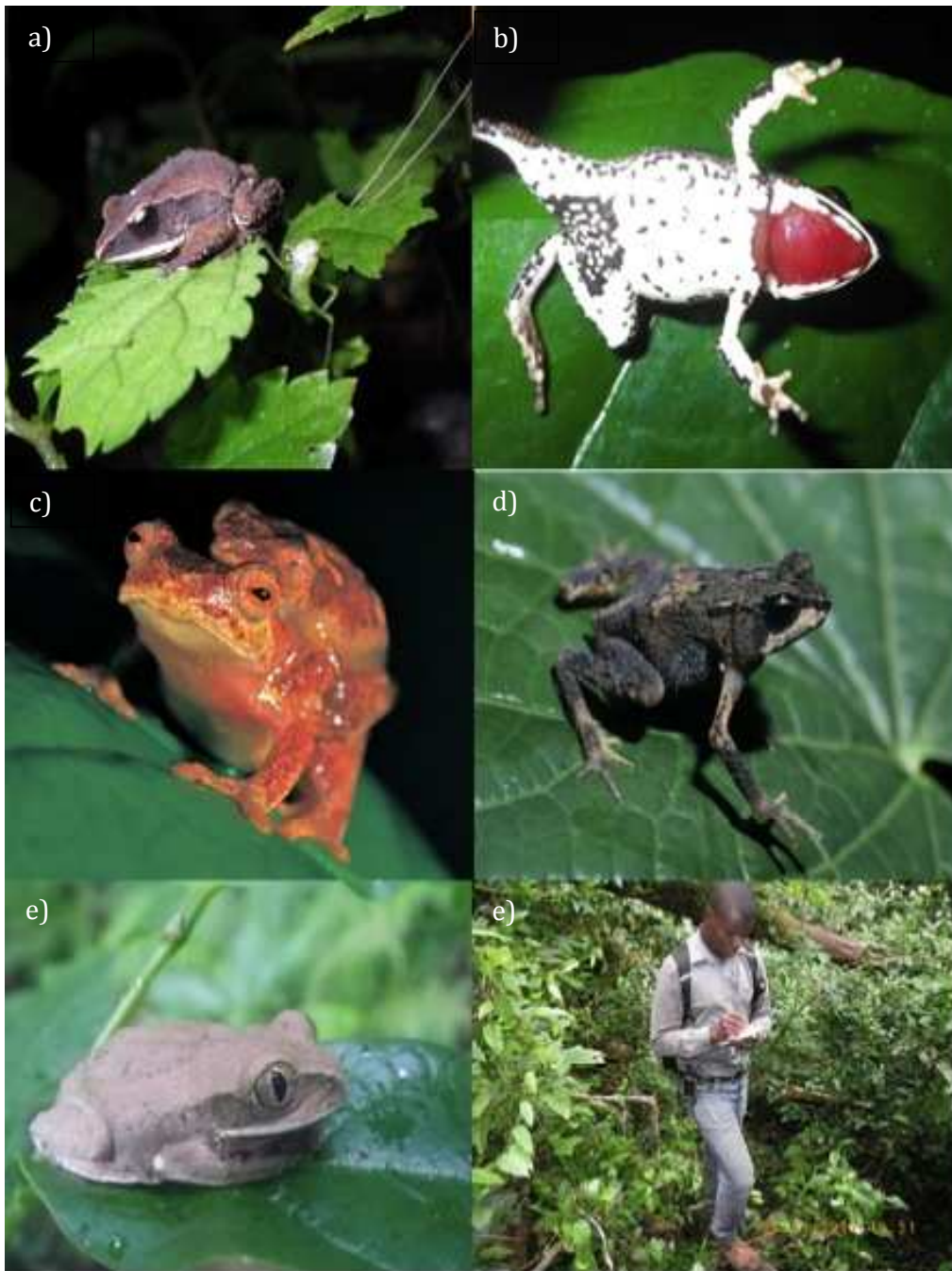


Figure 2. a) *Nectophrynoides wendyae* at a new locality for the species in USFR. b) Male *N. wendyae*, ventral view showing crimson throat. c) *Hyperolius kihangensis*. d) *N. poyntoni*. e) *Leptopelis flavomaculatus* f) H. Seki in the field. Photo credits: a, b and e H. Seki; c and d M. Menegon; f A. Chitita.

Results and discussion

A total of 188 individual amphibians were encountered: 63 on night transects (excluding a spawning aggregation of at least 50 *Arthroleptis* sp.), 4 on day transects, 44 on quadrats and 77 opportunistically.

No individuals of *N. poyntoni* or *H. kihangensis* were encountered during surveys or opportunistically. The historical site where *N. poyntoni* was previously known was visited four times between January and June with transect surveys undertaken on three of those occasions. In contrast *N. wendyae* was encountered on two out of three visits to their historical site (2 out 3 transects) and at a new location for this species approximately 0.5 km away (1 out 4 transects; Figure 2). All individuals were found on the leaves of plants between 9 and 50 cm above ground (average 22.4 cm) and morphometric measurements were taken for six individuals (Table 1). All individuals encountered had crimson throats indicative of males in breeding condition (Channing & Howell 2006, Figure 2b). Both locations were at an altitude of c. 1,500 m.

Table 2 compares habitat features on transects with and without *N. wendyae* records. Statistical analysis was not attempted due to the small sample size but most variables were similar. The only potential differences are in bare soil and rock substrate cover. Tree architecture is only shown for category A (trees branching in the canopy) and E (dead wood and stumps) as B-D showed very little variation across transects. Mean habitat values for each site are given in Appendix 1.

Table 1. Morphological measurements for live *Nectophrynoides wendyae* in Uzungwa Scarp Forest Reserve (n = 6). Values refer to length (mm).

	Snout-vent	Femur	Tibia	Foot	Interorbital
Mean	19.07	6.60	7.77	10.93	2.73
Minimum	17.90	5.60	6.80	9.50	1.90
Maximum	20.50	8.40	8.90	12.60	3.20

Table 2. Habitat details for survey transects with and without *Nectophrynoides wendyae* in Uzungwa Scarp Forest Reserve. Values are means (with standard deviations)

	Present (n = 3)	Absent (n = 23)
Altitude (m)	1412 (294)	1502 (6)
Slope (%)	15 (9)	18 (10)
Canopy (%)	77 (9)	65 (18)
Shrub (%)	41 (27)	43 (17)
Herb (%)	62 (13)	57 (16)
Bare soil (%)	30 (6)	17 (9)
Leaf litter (%)	54 (8)	48 (20)
Dead wood (%)	16 (3)	17 (8)
Rock (%)	0	8 (13)
Tree architecture A (%)	33 (5)	25 (12)
Tree architecture E (%)	4 (4)	11 (8)

The failure of surveys to record *N. poyntoni* and *H. kihangensis* is alarming given their highly restricted recorded areas of occupancy and endangered status. The only known site for *N. poyntoni* was surveyed on four occasions throughout the study period without success. In addition, the sympatric Tornier's forest toad *N. tornieri* was also absent from this site despite being recorded as common there previously. However several factors suggest further research is needed before any conclusions can be made as to whether these species remain extant. Firstly surveys began in January and so missed the November/December period when some amphibian species are more active. Secondly the weather was unusual for the Uzungwa Mountains in 2011 as there was very little rain until March followed by heavy rains extending into June. Both the dry condition of early 2011 and the later heavy rain made amphibian detection more difficult than expected.

Other species

Data were collected for all amphibian species encountered not just the target hyper-endemics reported here. Many of these species are also Eastern Arc endemics such as *Leptopelis ulugurensis* and *L. barbouri* both listed as Vulnerable

by IUCN. Future analysis of survey conditions and habitat features associated with the presence or abundance of these species will also be of conservation interest.

Recommendations

Results presented here are preliminary and clearly limited by the short duration of survey work conducted to date. Nevertheless given the critical conservation status of the species concerned and of the USFR itself (Rovero et al. 2005) we present brief recommendations for future work:

- The most urgent priority is to conduct further surveys during 2011/12 for the two target species not found. These should start in November 2011 to ensure sampling of known sites during the early rains.
- Chytrid fungus, *Batrachochytrium dendrobatidis*, is a deadly threat to amphibian populations worldwide. This pathogen was detected in Kihansi spray toads just before the extinction of the wild population (Channing and Howell, 2006). However chytrid appears to be widespread in neighbouring Kenya without causing mass mortality (Kielgast et al. 2010). Therefore, while it is not clear to what extent chytrid represents a threat to narrowly endemic amphibian species in USFR precautionary screening should be carried out as a matter of urgency.
- The known sites for all potentially hyper-endemic amphibian species should be explicitly recognized in the management of USFR including in any plans for the proposed Nature Reserve. Significant environmental changes at these sites could result in the extinction of unique species.

Acknowledgements

The authors thank the Tanzania Commission for Science and Technology (COSTECH research permit RCA 2009-314-ER-98-13), the Tanzania Wildlife Research Institute (TAWIRI) and the village councils of Chita and Ikule for permission to conduct surveys. The European Association of Zoos and Aquaria Amphibian Fund and the Whitley Wildlife Conservation Trust provided funding administered by the Tanzania Forest Conservation Group. We are also grateful to the following individuals for their kind assistance Araft Mtui, Ali Chitita, Deo, Enock Peter and Rashidi Kassim.

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Appendix 1. Habitat details for each transect survey site. Values are means (standard deviation). No transects were surveyed at Site F. See Figure 1. Differences in the mean between survey sites were tested for using the Kruskal-Wallis test (χ) in SPSS. ** $P < 0.01$, * $P < 0.05$.

	Site A (n = 3)	Site B (n = 3)	Site C (n = 3)	Site D (n = 3)	Site E (n = 3)	Site G (n = 4)	Site H (n = 4)	Site I (n = 2)	χ
Altitude (m)	805 (28)	1600 (9)	1501 (5)	1187 (25)	1734 (63)	1525 (13)	1504 (10)	1482 (193)	20.83**
Slope (%)	31.22 (11.77)	15.00 (4.70)	10.11 (10.61)	22.00 (12.49)	15.56 (10.17)	16.00 (6.17)	17.21 (3.38)	9.83 (1.65)	8.72
Canopy (%)	70 (12)	43 (39)	73 (7)	66 (8)	68 (15)	64 (8)	73 (16)	76 (1)	6.29
Shrub (%)	58 (10)	19 (17)	24 (2)	46 (11)	58 (12)	38 (12)	51 (14)	50 (12)	16.01*
Herb (%)	37 (24)	68 (26)	68 (5)	56 (5)	65 (7)	56 (10)	49 (12)	64 (1)	8.94
Bare soil (%)	13 (3)	8 (2)	24 (4)	9 (2)	13 (0)	26 (11)	30 (8)	19 (1)	19.93**
Leaf litter (%)	40 (23)	74 (18)	59 (2)	23 (0)	61 (17)	50 (11)	43 (11)	40 (5)	14.37*
Dead wood (%)	17 (13)	8 (7)	17 (3)	12 (3)	13 (3)	20 (4)	19 (2)	29 (13)	13.49
Rock (%)	28 (11)	2 (4)	0	28 (3)	0	0	0	0	21.76**
Tree architecture: A (%)	22 (2)	19 (8)	33 (6)	21 (3)	48 (12)	26 (8)	25 (6)	13 (8)	14.35*
Tree architecture: E (%)	21 (17)	9 (10)	2 (4)	11 (2)	7 (3)	9 (4)	11 (4)	13 (8)	8.58