A Rapid Survey of Small Mammals from the Atewa Range Forest Reserve, Eastern Region, Ghana

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Chapter 11

A apid ur ey of al ammal om he Atewa ange ores eser e, Eas ern egion, Ghana

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SUMMARY

We report on the results of a small mammal survey in the Atewa Range Forest Reserve. A total of 12 bat species were recorded. Composition of bat species clearly reflects a forest assemblage, with no savanna species being observed. Two rarely recorded bat species (*Hypsugo* [*crassulus*] *bellieri* and *Pipistrellus* aff. *grandidieri*) are reported for the first time for Ghana, raising the total number of species for this country to 86. Together with specimens from five localities in West Africa, *Pipistrellus* aff. *grandidieri* from Atewa might represent an undescribed species. *Hypsugo* (*crassulus*) *bellieri* is endemic to the Upper Guinean forests. Zenker's fruit bat *Scotonycteris zenkeri* is ranked on the Red List as Near Threatened (IUCN 2006). The three terrestrial small mammal species recorded during the survey are likewise forest-dependent and include two West African endemics: Edward's swamp rat *Malacomys edwardsi* and the shrew *Crocidura grandiceps*. The latter is ranked as Near Threatened on the IUCN Red List and had not been recorded from Ghana since its description. The overall species composition of small mammals indicates high habitat integrity of the Atewa Range Forest Reserve, which constitutes the most significant block of Upland Evergreen Forest in Ghana. The integral protection of Atewa is an outstanding priority for the preservation of (sub-) montane forests in West Africa, both for the conservation of small mammals and of biodiversity in general. In accordance with international conservation principles on mining and biodiversity (Dudley and Stolton 2002, Miranda et al. 2005), we recommend that exploration concessions for Atewa are cancelled, that its legal protection status is upgraded, that no development is allowed within the forest reserve, and that effective management measures are implemented.

INTRODUCTION

Although West African forests have been reduced to about 15% of their potential extent, the remaining and highly fragmented patches are still being degraded or completely lost at a high rate. Given this threat as well as the exceptional number of species endemic to the Guinean forests of West Africa, this region was ranked as one of 34 global biodiversity hotspots (Bakarr et al. 2004). Within this region, (sub-) montane forests are under particular pressure as montane habitats are extremely restricted in extent. Long-term geological erosion has turned West Africa into a mostly flat landscape that is broken by very few mountain ranges. Significant tracts of montane forest are limited to the Upper Guinea Highlands along the border region of Sierra Leone, Liberia, Guinea and Côte d'Ivoire in the West and the Cameroon Mountain Range in the East. These montane forest areas constitute unique ecosystems with exceptional species richness and high levels of endemism (Bakarr et al. 2001, 2004). In-between this wide geographic hiatus, only the Atewa Range in Ghana, the Volta Highlands between Ghana and Togo and the Jos Plateau in Nigeria harbor significant upland forest patches, however among these three, Upland Evergreen Forest is found only in the Atewa Range. The latter area has had the status of a national forest reserve since 1925 and was recently designated as a Globally Significant Biodiversity Area (GSBA) as well as an Important Bird Areas (IBA) (Abu-Juam et al. 2003). Together

with the highly degraded Tano Ofin, the Atewa Range is one of only two reserves in Ghana where Upland Evergreen Forest occurs (Hall and Swaine 1981, Abu-Juam et al. 2003). The Priority-Setting Workshop for Upper Guinea ranked the Atewa Range Forest Reserve (Atewa) to be of "Very High" priority for overall biodiversity conservation. As a result of the workshop, it was recommended that scientific information for this area be updated through surveys and that measures are implemented to achieve improved protection for the biodiversity of the area (Bakarr et al. 2001).

The target of our study was a survey of small mammals of Atewa, namely bats (Chiroptera), rodents (Rodentia) and shrews (Soricomorpha). Sampling of these groups was conducted at each of the three study sites, but survey effort focused on bats due to logistical constraints. In tropical communities, bats usually constitute the most species-rich group of mammals. They are regarded as a particularly suitable indicator group to assess habitat conditions and thus to set conservation priorities because of their high diversity, species-specific habitat requirements and patterns of endemism (many species have small distribution ranges). Moreover, they provide important ecosystem services as predators of insects as well as pollinators and seed dispersers of plants. Apart from a few occasional bat records (Grubb et al. 1999) and a limited survey of terrestrial small mammals (Abedi-Lartey and Guba-Kpelle 2005), Atewa had not previously been sampled for small mammals.

METHODS

Study site

Atewa is located within the moist semi-deciduous forest zone in the Eastern Region of Ghana. The two forest blocks Atewa Range and Atewa Range Extension combined cover an area of 258.3 km^2, with the Atewa Range alone having an extent of 237 km^2. According to the GLC2000 data (Mayaux et al. 2004), the entire Atewa Range represents 33.5% of the remaining closed forest in the Eastern Region. The mountain range, which peaks at 842 m a.s.l. (SRTM90 data), runs roughly from north to south and is characterized by plateaus, which are remnants of a Tertiary peneplain. These plateaus are covered with Upland Evergreen Forest and are dissected by steep ravines. The larger northern part is situated in the wet semi-equatorial climatic zone, with two wet seasons from May to July and from September to October/November and an annual precipitation of about 1650 mm. The forests are home to many endemic and rare species. The unique floristic composition of the Upland Evergreen Forest is generated by the misty conditions on top of the plateaus (Swaine and Hall 1977). The diverse flora contains submontane elements, with characteristic herbaceous species as well as abundant and diverse epiphytes. Many plant species found here are not known to occur elsewhere in Ghana and several butterfly species are strictly endemic to Atewa (Larsen 2006). Seasonal marshy grasslands, swamps and thickets that occur here are also thought to be nationally unique (Hall and Swaine 1981). Invasive species like *Chromolaena odorata* can be found along disturbed sites such as roads or other openings. Despite this disturbance, most parts of the forest reserve are still in good or excellent condition.

Sampling and data analysis

From 7 – 22 June 2006, three sites within Atewa were surveyed by NW. Atiwiredu was visited from 7-10 June, Asiakwa South from 11-16 June, and Asiakwa North from 17-22 June. Sampling was conducted mostly within a 500 m-radius of each camp site. At Asiakwa South and North, two additional sampling sites were visited, but these are not considered further as no specimens were captured there. The location of each site was recorded with a GPS-receiver (Garmin eTrex) (Table 11.1).

Table 11.1. Coordinates and elevation of three sites within the Atewa Range Forest Reserve, Ghana, where bats and terrestrial small mammals were sampled.

Site	Coordinates	Elevation
Atiwiredu	6°12'23"N, 0°34'39"W	817 m
Asiakwa South	6°15'44"N, 0°33'19"W	783 m
Asiakwa North	6°16'16"N, 0°33'53"W	814 m

Field work was conducted during the peak of the first wet season. Bats were captured with 6 m and 12 m mist nets near ground level, following standard methods (Wilson et al. 1996). Each night, at least two and up to seven mist nets were placed opportunistically across potential flyways within the forest, e.g. crossing trails or within treefall gaps. Nets were opened before sunset and checked at least every 30-45 minutes. They were closed at different times, depending on rainfall or overall moisture, and sometimes re-opened in the morning between 3:30-4:00 hrs and 6:00 hrs. Overall sampling effort was 217 net hours in 16 nights (calculated as 12 m-mist net equivalents, Table 11.2). Capture success was calculated as number of individuals captured per net hour. A two-bank harp trap (Bat Conservation & Management, model "G4 Forest Strainer", catch area 3.9 m^2) was employed at Atiwiredu and Asiakwa North. Capture success of the harp trap was nil, probably as a result of different line lengths that made it impossible to achieve sufficient and equal tension. Standard body measurements (body mass, forearm, tail, head and body, ear, hind foot) were taken of each bat specimen and their sex as well as their age class was determined. Identification in the field was aided by Rosevear (1965) and Hayman and Hill (1971). For each species, voucher specimens (12) were collected and preserved in 70% ethanol. They are currently deposited in the research collection of JF at the University of Ulm (see Appendix 7). Tissue samples were taken from all voucher specimens and preserved in 99% ethanol. Additionally, hand-held echolocation calls of rhinolophids and hipposiderids were recorded with a Pettersson D240x bat detector and transferred to a Sony Walkman Professional WM-D6C. The calls were analyzed

with the software Avisoft-SASLab Pro 4.2 to check species identifications of rhinolophids and hipposiderids, in particular those of released individuals. Within these families, the constant frequency (CF) component of the echolocation calls is highly species-specific.

At each site, traplines for terrestrial small mammals were set every night except for the arrival day at each site. Trapping effort consisted of 2-5 Tomahawk traps and 20-40 Sherman live traps during 13 nights altogether. The Tomahawk traps were placed close to burrows, the Sherman traps were set up in traplines of five traps along fallen trees and other structures presumed to channel movement patterns of target groups. Traps were baited with palm nut oil or peanut butter mixed with oats. Ten voucher specimens were collected and preserved as wet specimens in 70% ethanol. They were identified by Rainer Hutterer, Zoologisches Forschungsmuseum Alexander Koenig (ZFMK), Bonn, and deposited in the collections of this institution (see Appendix 8).

A smoothed species accumulation curve was generated for bats with the program EstimateS, Version 7.5 (Colwell 2005). This sample-based rarefaction curve was calculated with the "Mao Tau"-function (Colwell et al. 2004) and the graph was rescaled by individuals. Statistical methods estimating the total number of species from samples (Colwell 2005) were not employed as they require standardized sampling methods. The IUCN Red List status is based on the recent update that followed the Global Mammal Assessment (GMA) of African small mammals in January 2004 (IUCN 2006). Taxonomy follows Wilson and Reeder (2005) if not otherwise stated.

RESULTS

Bats

In total, 27 bats of 11 species belonging to five families were captured during this RAP survey (Tables 11.2 and 11.3, Appendix 7). A twelfth species was observed, heard, and unam-

Table 11.2. Capture effort (nh: total net hours per site, calculated as 12 m-net equivalents), capture success (number of individuals; bats per net hour) and species coverage (Total: all species) of the RAP survey. Mega: fruit bats only. Micro: insect bats only. One species is included in the species total of Asiakwa South that was not captured but was seen and heard.

	Effort [nh]	N° of Indiv.	Mega	Micro	Bats/ nh	Mega/ nh	Micro/ nh	Species Total
Atiwiredu	56.1	11	4	7	0.20	0.07	0.12	6
Asiakwa South	101.6	9	6	3	0.09	0.06	0.03	6
Asiakwa North	59.6	7	0	7	0.12	–	0.12	6
All sites	217.3	27	10	17	0.12	0.05	0.08	12

Table 11.3. Bat species recorded from three sites of the Atewa Range Forest Reserve, Ghana, during this / the RAP survey (numbers refer to captured individuals). Red List: international Red List status (NT: Near Threatened, n.a.: not assessed; IUCN 2006). Habitat: coarse assignment to preferred habitat types (F: forest; S: savannas and woodlands; in brackets: marginally including the respective habitat type).

Species	Sites			Total	Red List	Habitat	
	Atiwiredu	Asiakwa South	Asiakwa North				
Pteropodidae							
Hypsignathus monstrosus *		X		*		F	(S)
Scotonycteris zenkeri	1	2		3	NT	F	
Megaloglossus woermanni	1	3		4		F	
Myonycteris torquata	2	1		3		F	(S)
Nycteridae							
Nycteris grandis		1		1		F	(S)
Rhinolophidae							
Rhinolophus alcyone			1	1		F	(S)
Hipposideridae							
Hipposideros ruber	5		1	6		F	(S)
Hipposideros beatus			1	1		F	
Hipposideros cyclops			2	2		F	
Hipposideros gigas	1	2		3		F	
Vespertilionidae							
Hypsugo [*crassulus*] *bellieri*	1		1	2	n.a.	F	
Pipistrellus aff. *grandidieri*			1	1	n.a.	F	
Specimens total	**11**	**9**	**7**	**27**			
Species total	**6**	**6**	**6**	**12**			

*: species not caught, but two males observed and heard at the edge of the forest towards marshy grassland.

biguously identified as *Hypsignathus monstrosus*. The capture rate of 0.12 bats per net hour was very low (Table 11.2), consisting of 0.05 fruit bats per net hour and 0.08 insectivorous bats per net hour. No day-roosts of bats were found. Comparison between the three sites is highly limited because of the overall low number of captured individuals.

Four species (*Nycteris grandis*, *Rhinolophus alcyone*, *Hipposideros beatus*, *Pipistrellus* aff. *grandidieri*) were captured only once. The other species were captured in small numbers, with six being the highest number of individuals per species in *Hipposideros ruber*. At each site six species were recorded, whereby Asiakwa North had the highest number of species found only there (*Rhinolophus alcyone*, *Hipposideros beatus*, *H. cyclops*, *Pipistrellus* aff. *grandidieri*; Table 11.3). No fruit bats were recorded at Asiakwa North. Two species (*Hypsugo* [*crassulus*] *bellieri*, *Pipistrellus* aff. *grandidieri*) constitute first records for Ghana, raising the total number of bat species for this country from 84 to 86 (J. Fahr unpubl. data).

The 12 species encountered during the RAP survey depend exclusively (seven species) or largely (five species) on forest habitat and not a single species preferring savanna habitat was recorded (Table 11.3). Among the fruit bats, *Scotonycteris zenkeri* is ranked on the Red List as Near Threatened (IUCN 2006). The captured insectivorous bats belong to the families Nycteridae, Rhinolophidae, Hipposideridae and Vespertilionidae. High-flying species from the families Emballonuridae and Molossidae are completely lacking from the species list, which is most likely the result of captures being restricted to near ground level. The combined species accumulation curve for Atewa does not reach a plateau but rises steeply (Figure 11.1), indicating that sampling of the bat fauna during this short study was incomplete.

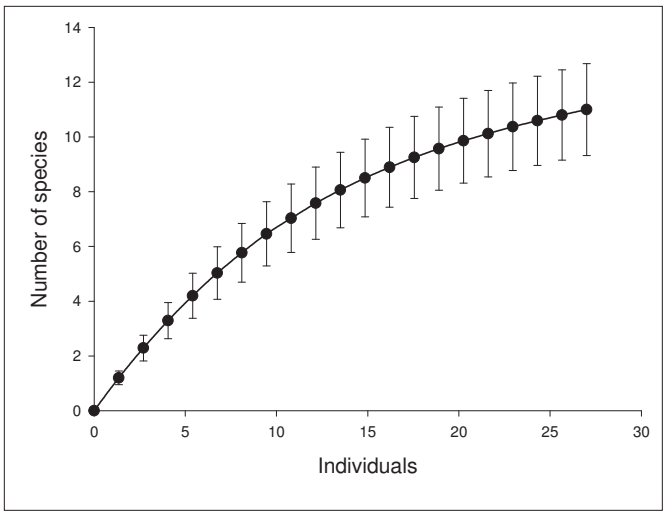

Figure 11.1. Smoothed species accumulation curve for bats captured during the RAP survey in the Atewa Range Forest Reserve, Ghana. Line and dots: sample-based rarefaction curve, rescaled by individuals ("Mao Tau"-curve, Colwell et al. 2004), vertical bars: ± 1 *SD*.

Terrestrial small mammals

In total, 11 individuals of three species of terrestrial small mammals were captured (Table 11.4, Appendix 8). Due to the small number of captures, comparison between sites cannot be made. Both rodent species and the shrew species depend on rainforest. Both Edward's swamp rat (*Malacomys edwardsi*) and the shrew *Crocidura grandiceps* are endemic to West Africa. The latter is ranked on the Red List as Near Threatened (IUCN 2006). Tullberg's soft-furred mouse (*Praomys tullbergi*) had previously been recorded from the Atewa Range (Abedi-Lartey and Guba-Kpelle 2005; see Appendix 9).

DISCUSSION

Bats

The present survey raised the number of bat species known to occur in Ghana from 84 to 86 despite the fact that Ghana is well-sampled compared to other West African countries. The very short survey and low capture numbers do not allow differentiating between single sampling sites, hence only a general assessment of species richness and composition of Atewa is possible. During the present RAP study, 12 bat species were recorded. Prior to our study, only seven bat species were claimed to occur in the area, all of them fruit bats (Pteropodidae: *Epomophorus gambianus*, *Micropteropus pusillus*, *Hypsignathus monstrosus*, *Nanonycteris veldkampii*, *Scotonycteris zenkeri*, *Megaloglossus woermanni*, *Eidolon helvum*) (Harris and Baker 1959, pers. comm. D. Smith and L. Grimes in Grubb et al. 1999, Abedi-Lartey and Guba-Kpelle 2005). Out of these species, we did not record *Epomophorus gambianus*, *Micropteropus pusillus*, *Nanonycteris veldkampii*

Table 11.4. Small terrestrial mammals recorded at three sites of the Atewa Range Forest Reserve during the 2006 RAP survey (numbers refer to captured individuals). Red List: global Red List status (NT: Near Threatened; IUCN 2006).

Species	Sites			Total	Red List
	Atiwiredu	Asiakwa South	Asiakwa North		
Soricomorpha					
Crocidura grandiceps	2			2	NT
Rodentia					
Praomys tullbergi	1	1	1	3	
Malacomys edwardsi	1	2	3	6	
Total specimens	**4**	**3**	**4**	**11**	
Total species	**3**	**2**	**2**	**3**	

or *Eidolon helvum*. During the wet season, both *Nanonycteris veldkampii* and *Eidolon helvum* are migrating to the North (Thomas 1983), hence these species might have been absent during our study period. However, *Epomophorus gambianus* as well as *Micropteropus pusillus* are species mainly found in savanna habitats (Fahr and Ebigbo 2003, 2004). We suspect that the latter records might either represent misidentifications of *Epomops* spp. and *N. veldkampii*, respectively, or that they were encountered in highly degraded and converted habitat along the periphery of the forest reserve where farmbush species might have invaded the forest zone. Surprisingly few fruit bats (Pteropodidae) were recorded during the present RAP survey, possibly due to a seasonal lack of fruiting trees in the vicinity of the sampling sites.

The species accumulation curve for Atewa rises steeply and does not reach an asymptotic plateau, indicating that our sampling of the bat fauna is far from being complete. Decher and Fahr (2007) estimated that 35-40 bat species can be expected to locally occur in forest reserves of southern Ghana. As this figure is about three times higher than the 12 species we encountered, extended surveys are necessary for a near-complete inventory of the bat fauna. Incompleteness of the present bat survey is also demonstrated by the occurrence of 2-4 additional species that were recorded in Atewa prior to but not during this RAP survey (see above). The discrepancy between our results and the expected number of species is based on several factors. During short-term inventories like RAP surveys, sampling is largely opportunistic and limited both in temporal and spatial coverage. This study focused on the plateau areas of Atewa and future assessments should include slope habitat. Recent surveys showed pronounced species turnover between sites that differ in altitude and vegetation (Fahr et al. 2006). Furthermore, Atewa has never been the target of an extended study covering all seasons. Previous surveys demonstrated that additional sampling methods such as a (functional) harp trap and canopy nets reveal species that are missed with mist nets set near ground level (Fahr and Ebigbo 2004, Monadjem and Fahr 2007).

The total of 12 species and the capture rate of 0.12 (0.09-0.20) bats per net hour is at the lower bound of previous RAP surveys (0.02-1.92 bats/nh: Fahr and Ebigo 2003, 2004; Decher et al. 2005b; Decher and Fahr 2006; Fahr et al. 2006; Monadjem and Fahr 2007). Most of these previous studies covered several forest reserves and forest edge as well as adjacent village areas. During the present RAP survey, sampling was conducted exclusively within the forest interior of Atewa. The surroundings of Atewa were not sampled as they were outside of the boundary of the reserve and therefore not the target of this study. Undisturbed rainforest habitat generally yields low capture rates compared to habitat mosaic or forest edges (Monadjem and Fahr 2007), hence the low captures of the Atewa survey do not indicate degraded habitat conditions. The number of 12 recorded species is remarkably high in proportion to the low number of 27 captured individuals (Table 11.3), again reflecting undisturbed rainforest habitat where many species occur in low abundance and with overall high evenness.

Terrestrial small mammals

During previous RAP surveys in West Africa, the number of shrew species recorded per sampling site was 0-5 species for a total of 2-7 species per RAP survey. Corresponding numbers for rodents (excluding anomalurids, squirrels and porcupines: not covered in our survey) are 1-8 species per sampling site for a total of 1-16 rodent species per RAP survey (Decher 2004; Decher et al. 2005a, 2005b; Norris 2006; Monadjem and Fahr 2007). The very low capture success of terrestrial mammals in Atewa, both in terms of individuals and species, is only comparable to that encountered during the Liberia RAP survey where trapping was largely conducted on a limited basis due to logistical problems (Monadjem and Fahr 2007). The field period for the present RAP survey was even more limited than in previous RAPs and the species list is certainly far from being complete. Unfortunately, previous species lists for Atewa (Abu-Juam et al. 2003, Abedi-Lartey and Guba Kpelle 2005) indicate substantial misidentifications and/or sampling in highly disturbed areas around Atewa (see Appendix 9). Only the reported *Praomys tullbergi* (also recorded during the present survey), *Thryonomys swinderianus* and *Cricetomys emini* seem sufficiently likely to accept their reported occurrence in Atewa.

Significant species

The fruit bat *Scotonycteris zenkeri* is ranked Near Threatened on the most recent Red List (IUCN 2006). This species depends on rainforest and shows a disjunct distribution pattern, with populations occurring in Upper Guinea, Lower Guinea, and Central Africa. It is known from several locations in Ghana, including Atewa (Grubb et al. 1999), but always represents a small percentage of all fruit bat captures (Fahr in press-a). Recent records were exclusively made in undisturbed forests and it is likely that this species has disappeared from many previous localities as a result of forest degradation and loss.

Hypsugo [*crassulus*] *bellieri*, a bat endemic to the Upper Guinean forests, was recorded for Ghana the first time. The taxon *bellieri* is currently recognized as a subspecies of *Hypsugo crassulus* (Heller et al. 1995, Simmons 2005). It has a very restricted distribution within Upper Guinea and probably represents a distinct species (Fahr in press-b). Due to its current taxonomic status as a subspecies, it has not yet been assessed for the IUCN Red List although it is likely to be threatened by habitat degradation and loss. The recognition of *bellieri* as a distinct species would qualify it as Vulnerable according to the Red List criteria (A4c; see Monadjem and Fahr 2007).

The large-sized "pipistrelle" captured in Asiakwa North cannot be referred to any described species known to occur in West Africa. It agrees in measurements and characters with four unpublished specimens from Ivory Coast, a single specimen from southwestern Cameroon and two specimens from western Liberia referred to *Pipistrellus* aff. *grandidieri* by Monadjem and Fahr (2007). Although these specimens agree in measurements and characters with *Pipistrellus grandidieri*, which was described from Zanzibar, the large distri-

butional hiatus between West and East Africa raises the possibility that West African specimens represent a distinct and undescribed species. Further morphological and genetic data are necessary to answer this question. The record of *Pipistrellus* aff. *grandidieri* from Atewa is the first for Ghana.

The shrew *Crocidura grandiceps* is ranked as Near Threatened on the Red List (IUCN 2006). This species was described from Krokosua Hills in Ghana (Hutterer 1983). Since then, only a few specimens have been recorded, mostly in undisturbed primary rainforest in southeastern Guinea (Decher 2004), western Ivory Coast (Meylan and Vogel 1982 [as *C.* cf. *nimbae*], Churchfield et al. 2004, Quérouil et al. 2005), southern Benin (Bekker and Ekoué 2004), southern Nigeria[1] (Hutterer and Happold 1983, Iyawe 1989, Angelici and Luiselli 2005 [as *C.* cf. *grandiceps*]), and possibly from southwestern Cameroon (Hutterer and Schlitter 1996) (Fig. 11.2). This species is threatened by loss and degradation of suitable rainforest habitat. A recent RAP survey of three forest reserves in southwestern Ghana, including the type locality Krokosua Hills, did not record *C. grandiceps* (Decher et al. 2005b) and our record from Atewa is the second for Ghana since its description.

CONSERVATION RECOMMENDATIONS

Overall species composition of small mammals within Atewa as assessed during the RAP survey clearly reflects an assemblage of forest-dependent species, including several globally threatened species, and underlines the ecological integrity of the surveyed area. Our findings confirm the results of the West Africa Priority-Setting Workshop, which ranked Atewa to be of "Very High" priority for overall biodiversity conservation in West Africa (Bakarr et al. 2001).

A study of the effects of habitat fragmentation on birds in Ghana revealed dramatic influence of patch size on species composition and only the largest fragments harbored area-sensitive species (Beier et al. 2002). Negative effects of climatic alterations as a result of fragmentation were demonstrated by Hill and Curran (2003), who furthermore emphasized the detrimental impact of fire on smaller forest fragments in Ghana. Both studies stressed the importance of maintaining larger intact forest blocks like Atewa to protect the last strongholds of forest-dependent species in Ghana. Montane areas are a particular case: as a result of orographic precipitation, they have offered long-term environmental stability and acted as refuges during drier times in the past. At the same time, adaptation to predictable conditions might confer a higher susceptibility of local populations to disturbance (Fjeldså and Lovett 1997). In line with this argument, Ricketts et al. (2005) predicted that future extinctions will be mainly found in species that are restricted to mountains. Atewa Range is the only significant Upland Evergreen Forest that remains between the Upper Guinea Highlands in the West and the Cameroon Mountain Range in the East. These mountainous areas are distinguished by a large number of endemic and threatened species. If Atewa is severely disturbed by large-scale impacts such as industrial surface mining, it is highly likely that the majority of specialized forest species will be lost, at least those species most vulnerable to altered habitat conditions.

Between 1990 and 2005, the deforestation rate in Ghana was very high (2.0%) compared to other countries in West Africa, resulting in the loss of 25.9% (1,931,000 ha) of Ghana's forest cover during 15 years (FAO 2006). Degradation and depletion of forests through logging, bushmeat hunting, encroaching agriculture and mining activities has severely reduced and fragmented the country's forest cover. Only designated forest reserves still contain significant forest blocks that serve as source areas for a broad variety of animal and plant species, protect watersheds and maintain Ghana's climate, thereby providing essential goods and ser-

[1] The record from Ilashe was erroneously given by Hutterer and Happold (1983) as 7°30'N, 6°30'E. However, the correct locality is "Idoforo, 4 mi S Ilashe, 6 mi

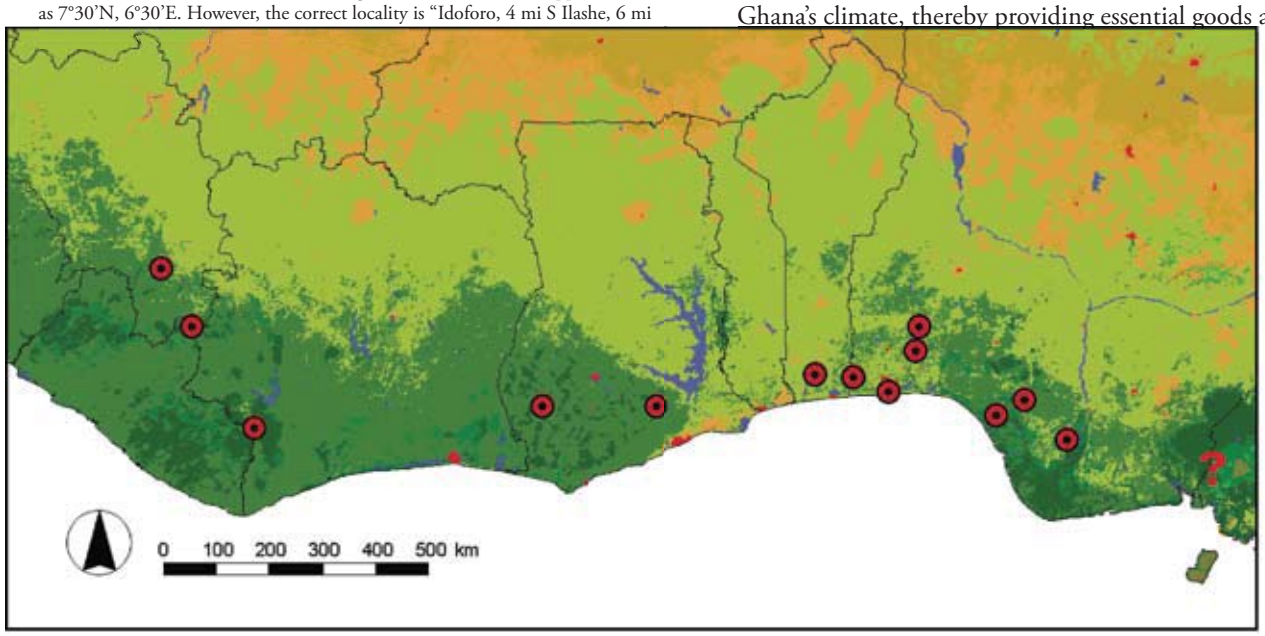

Figure 11.2. Known distribution of *Crocidura grandiceps*. Dark green: closed forest; medium green: degraded forest and farmland; pale green: woodland and humid savannas (GLC2000; Mayaux et al. 2004).

vices for the human population of the country (Agyarko 2001). Atewa constitutes the largest and most intact patch of Upland Evergreen Forest in Ghana, representing 75% of this habitat type countrywide, and was consequently designated one of 30 Globally Significant Biodiversity Areas (GBSA) in 1999. This forest reserve is distinguished by one of the highest levels of biodiversity in Ghana, for some taxa even the highest (Larsen 2006). Despite its pivotal role as one of the most important conservation areas in Ghana, it is still not adequately protected. In 1994, the Government of Ghana formulated a new Forest and Wildlife Policy aiming at both the "conservation and sustainable development of the nation's forest and wildlife resources" (Agyarko 2001). More recently, however, the Government is facing allegations of compromising its own policy by permitting unsustainable exploitation of forest reserves (Hilson and Nyame 2006). In order to reverse this worrying development and to implement Ghana's own strategy within the legally binding framework of the international Convention on Biological Diversity (CBD), we recommend the following points for an integral and long-term protection of Atewa:

- Undertake additional surveys of Atewa to complement the inventory of small mammals.
- Focus in-depth studies on threatened, rare and endemic species, including those that have not yet been assessed for the IUCN Red List.
- Encourage participation by local communities in decision-making regarding the management of Atewa and provide biodiversity education and training in sustainable use of forest resources.
- Prevent of further illegal logging by establishing patrols and enforcing existing regulations.
- Rigorously protect the watersheds of Atewa in order to secure the water supply for surrounding communities and cities.
- Upgrade of the legal status of Atewa to a fully protected conservation area – ideally a national park – in which development activities are prohibited, in recognition of Atewa's global biodiversity significance.
- Withdrawal of exploration concessions for Atewa granted by the Government of Ghana as Atewa represents an irreplaceable area of unique biodiversity, for which large-scale mining impacts could not be compensated by mitigation measures such as offsets (IUCN 2000, Phillips 2001, Dudley and Stolton 2002, Abu-Juam et al. 2003, Miranda et al. 2005).
- Update and implement the management plan established by the Forestry Commission of Ghana (Abu-Juam et al. 2003) and long-term development of Atewa's potential for eco-tourism (Lawson 1970, Larsen 2006).

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