CHAPTER 4 Results of Biodiversity Assessment and Mapping

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CHAPTER 4

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Sclater's guenons (*Cercopithecus sclateri*) in Bombax tree, Agpugoeze, Nigeria. This monkey species is endemic to the Gulf of Guinea forests.

As mentioned in Chapter 2, we collected background and distribution information on the species of our study region using the ZMUC database (processed using WORLDMAP) and museum and herbarium records, which we either collated directly from original specimens or acquired from existing databases. We also conducted a broad literature search. This background research yielded no comprehensive datasets on the region's fauna and flora that included the point-locality data needed for accurate species mapping. Consequently, we narrowed our mapping efforts to include only sets of endemic species within certain taxonomic groups, as described in the previous section. Here, we present the results of our mapping efforts and discuss how the species we mapped are connected to broader patterns of diversity within larger taxonomic groups.

MAMMALS

Mammals in general

ZMUC-WORLDMAP data (Figure 5, p. 33) show that this region of Africa is a hotspot for mammalian endemism and has relatively high mammalian species richness, though it is not as species-rich as parts of eastern Africa with more mosaic habitats that include open woodland (also noted by Brooks *et al.* 2001). Patterns evident in the ZMUC-WORLDMAP data, however, are probably biased because, in all likelihood, collection and systematic study have focused on the vertebrates of eastern and southern Africa more than west and central Africa.

Of the world's 4,763 mammal species (IUCN compilation as cited by Hilton-Taylor 2000), Mittermeier *et al.* (1999) estimate that 551 occur in the "Guinean forests of West Africa" biodiversity hotspot, which includes our study region and extends much further west, to Sierra Leone. Mittermeier *et al.* cite the Kingdon field guide (1997) as the source for this estimate, but that publication does not give distributions for many species of small mammal.

In his careful analysis of the vertebrate fauna of Bioko Island and the immediately adjacent section of western Cameroon, Eisentraut (1973) lists 136 mammal species. Eisentraut lists a total of 64 mammal species for the island of Bioko (2,017 km^2), of which 18 are represented on the island by endemic subspecies. This total is surprisingly small given the island's forest habitat, its combination of lowland and montane environments, and the likelihood that it was connected to the mainland relatively recently. Bioko is particularly poor in large mammals; no apes, antelopes larger than duikers, or elephants have ever been recorded on the island, and the largest mammal species known from Bioko, the forest buffalo (*Syncerus caffer nanus*), is now extinct (Eisentraut 1973).

For the Oban Hills area of Nigeria, Reid (1989) lists 127 mammal species as recorded or almost certain to occur. Usongo (1997) lists 103 mammals known from Korup.

In the last decade a number of new species of small mammal have been named from this region, including several endemics (see, e.g., Dieterlin & van der Straeten 1992, Hutterer & Schlitter 1996, Verheyen *et al.* 1997). At least six endemic mammal species are found on Mt. Oku alone (Maisels *et al.* 2001).

Primates

Our own analysis of mammal distribution has focused on primates. In terms of primate species richness and, especially, endemism (Table 2, p. 34, and Figure 6, p. 35), the study region stands out as a hotspot within Africa. The region also contains a large number of threatened primate taxa. For instance, the Cross River gorilla (*Gorilla gorilla diehli*), the local subspecies of chimpanzee (*Pan troglodytes vellerosus*), the drill (*Mandrillus leucophaeus*), Sclater's guenon (*Cercopithecus sclateri*), Preuss's guenon (*C. preussi*), and three subspecies of red colobus monkey (*Procolobus pennantii pennantii*, *P. p. epieni*, and *P. p. preussi*) are all restricted to this region and are among Africa's most endangered primates (IUCN 2000).

Using point locality data, we produced distribution maps for all the monkey and ape species that inhabit the forests of our area (Figure 7, pp. 36–38), revealing several distinct patterns. First, three species that are present on the immediately adjacent mainland are not found on Bioko, including *Cercopithecus mona*, *Cercocebus torquatus*, and *Pan troglodytes*. It is not clear if these species never reached Bioko or were once present but have gone extinct, although the absence of *C. mona*, a highly adaptable species that has thrived on the islands of Principe and São Tomé after being introduced by humans, suggests that it may never have reached the island. Among Bioko's monkey species, all but one (*Cercopithecus pogonias*) are represented on the island by endemic subspecies. *C. p. pogonias* occurs on both Bioko and the mainland, but the pelage differences between mainland and island populations may justify their subspecific separation (Gautier-Hion *et al.* 1999).

Second, major rivers appear to act as boundaries between several taxa (as noted in earlier analyses, e.g., Oates 1988). *Cercopithecus sclateri* occurs only between the Niger and the Cross. *C. erythrotis* and *Mandrillus leucophaeus* occur only between the Cross and the Sanaga (with the exception of a small area inhabited by *C. erythrotis* immediately south of the Sanaga). *C. satanas* occurs only south of the Sanaga and on Bioko, and different subspecies of chimpanzee (*Pan troglodytes*) occur north and south of the Sanaga.

Third, in general, the species occurring between the Cross and Sanaga Rivers show no clear preferences for lowland or montane areas, except for *Cercopithecus preussi*, which is more associated with uplands.

Finally, several taxa in the area have very localized distributions. These include the Cross River gorilla (*Gorilla gorilla diehli*), found only in a limited area west of the Bamenda Highlands, the three subspecies of red colobus (*Procolobus pennantii*), and the olive colobus (*P. verus*), which is apparently restricted to the upper Niger Delta and the Niger valley. In addition, the gray-cheeked mangabey (*Lophocebus albigena*) has only been recorded near Takamanda Forest Reserve in the center of the range of Cross River gorillas. However, no recent surveys in Takamanda have encountered *L. albigena*, indicating that it may have become locally extinct.

Other mammals

Figure 8 (p. 39) presents ZMUC-WORLDMAP data on the species richness and endemism of duikers of the genus *Cephalophus*. Along with parts of Upper Guinea, Central Africa, and the Albertine Rift, our study region is one of only a few areas containing at least eight duiker species. Duiker endemism in the region is also high, but not as pronounced as in Upper Guinea.

Figures 9 and 10 (pp. 40–41) present ZMUC-WORLDMAP data on rodents as a whole, and squirrels in particular. Our area is not especially rich in rodent species, which is not surprising, given the ecology of many rodent species. (The woodland zone of East Africa is the area richest in rodent species on the continent.) Our area does have significant rodent endemism, however, because of the presence of several endemic montane species. Among rats and mice, these endemics include *Hybomys*

eisentrauti, Hylomyscus grandis, Lamottemys okouensis, Lemniscomys mitttendorfi, Lophuromys dieterlini, L. eisentrauti, L. roseveari, Otomys occidentalis, and *Praomys hartwigi* (Hutterer *et al.* 1992, Verheyen *et al.* 1997, Maisels *et al.* 2001). In contrast to the area's relative sparseness of rodents in general, squirrels of the family Sciuridae show pronounced species richness and endemism in our study region and in the forests immediately south. Species of this particular family of squirrels show more richness and endemism here than in the central Congo basin.

BIRDS

ZMUC-WORLDMAP data (Figure 11, p. 42) show that, in relation to other parts of west and central Africa, this region has the highest bird-species richness and endemism, due in part to the overlap of Upper and Lower Guinea species here. However, throughout the continent, eastern Africa and especially the Rift Valley are the regions where bird species are richest. These regions also contain many concentrations of restricted-range bird species.

The IUCN Red List records a worldwide total of 9,946 bird species (Hilton-Taylor 2000), and Mittermeier *et al.* (1999) estimate that 514 birds species occur in the Guinean forests of West Africa, including our area. Given that more than 400 bird species are known to occur in Korup alone (see below), 514 is probably an underestimate of the total bird species in the Guinean forests.

Eisentraut (1973) lists 293 bird species occurring on Bioko Island and in the immediately adjacent section of western Cameroon. Reid (1989) lists 296 species in the area of the Oban Division of Cross River National Park (CRNP) in Nigeria. However, these lists must represent only part of the avifauna, for careful studies in the adjacent Korup National Park (1,240 km^2) and its surrounding Korup "project area" (which includes the forest reserves of Ejagham, Nta Ali, and Rumpi Hills) have revealed a total of 407 species, including waterbirds (Rodewald *et al.* 1994, Green & Rodewald 1996). Of this total, at least 233 are "true lowland rainforest birds," compared with 250 and 242, respectively, from the better-known sites of Makokou and Taï (Rodewald *et al.* 1994). Obot (2000) reports more than 300 bird species from the Okwangwo Division of CRNP.

As with mammals, the bird fauna of Bioko is relatively depauperate. Eisentraut (1973) lists only 138 resident land birds on Bioko, including one endemic species (the white-eye, *Speirops brunneus*) and 44 endemic subspecies. Excluding seabirds and a cormorant, the recent compilation by Pérez del Val (1996) lists 178 Bioko species, of which 143 are apparently resident (Pérez del Val *et al.* 1994). Surprisingly, only one species of hornbill, the black-casqued (*Ceratogymna atrata*), is known from the island, compared with nine species from the Korup area. In updating Eisentraut's list, Pérez del Val *et al.* (1994) recognize two bird species endemic to Bioko (*S. brunneus* and the flycatcher *Batis poensis*) and 43 endemic subspecies. Some other ornithologists regard *Batis poensis* as a species with relatively wide distribution, occurring both on the West Africa mainland and on Bioko (e.g., Elgood *et al.* 1994); in this case, the Bioko form is an endemic subspecies, *B.p. poensis*. All the region's restricted-range birds are montane forest and grassland species, a feature no doubt related to the dispersal abilities of birds which allow them to readily traverse barriers that limit other vertebrates (e.g., the rivers which form barriers for many lowland forest primates).

The 26 endemic species we have mapped are listed in Table 3 (p. 43), and their ranges based on point-locality data are shown in Figure 12 (pp. 44–48). Among these endemics *Poliolais* (Sylviidae) and *Urolais* (Sylviidae) are monotypic endemic genera. Our maps indicate that only a few of the endemic montane birds are restricted to a single mountain. This may be a consequence of the distribution of uplands in our region. North of Mount Manengouba there is more or less continuous terrain above 1,200 m, and to the south of Manengouba the highlands of Kupé, Mount Cameroon, and Pico Basilé are all relatively proximate for birds. However, there are few consistent distribution patterns among the montane birds. Some are found in many montane forests in our region (e.g., *Columba sjostedti*, *Nectarinia oritis*, *Phyllastrephus poensis*, *Andropadus montanus* and *A. tephrolaemus*, and *Urolais epichlora*). Others have a broad but patchy distribution (e.g., *Cisticola discolor* and *Malaconotus gladiator*), while several occur at just a few sites (e.g., *Telophorus kupeenesis* and the Bamenda Highland endemics *Tauraco bannermani*, *Platysteira laticincta*, and *Apalis bamendae*). The only species recorded from a single mountain are the Mount Cameroon francolin, *Francolinus camerunensis*, found only on that mountain, and the white-eyes *Speirops* spp. (one endemic species on Pico Basilé and one on Mount Cameroon). The genus *Speirops* is restricted to Mount Cameroon, Bioko, and other Gulf of Guinea islands.

Five of the restricted-range birds in this region are rated as endangered by IUCN (2002): *Kupeornis gilberti, Telephorus kupeensis, Tauraco bannermani, Francolinus camerunensis,* and *Platysteira laticincta*. The Mount Kupé bush-shrike (*Kupeornis gilberti*), once considered restricted to Mt. Kupé, has in recent years also been observed in the Bakossi Mountains and in the highlands in the south of Banyang-Mbo Sanctuary. A sixth endangered bird species in this region, Monteiro's bush-shrike (*Malaconotus monteiri*), also occurs in montane forest in Angola.

REPTILES AND AMPHIBIANS

ZMUC-WORLDMAP data show that this area has high snake-species richness compared to most other parts of West Africa (though it is not as rich as the western rift of East Africa or parts of southeastern Africa), and high snake-species endemism (Figure 13, p. 49). Data on lizards were not available to us (the ZMUC database we used included only snakes and chelonians). With regard to amphibians (Figure 14, p. 50), this region is a hotspot of both species richness and endemism. Of the world's 7,970 reptile and 4,950 amphibian species (IUCN Red List cited in Hilton-Taylor 2000), 139 reptiles and 116 amphibians are estimated to occur in the Guinean forests of West Africa, including our area (Bakarr *et al.* in Mittermeier *et al.* 1999). Eisentraut (1973) lists 52 reptile and 32 amphibian species from Bioko island, and Reid (1989) lists 64 reptile and 61 amphibian species

from the Oban Division area of Cross River National Park in Nigeria.

Lawson's (1993) evaluation of herpetofauna in the Korup area is probably the most comprehensive ever conducted of any one part of this region. Lawson collected samples in the Korup National Park and Korup project area in 1991, and then augmented his records with data from the literature and from collections made in 1990 by the WCI (now the Wildlife Conservation Society) research team in Korup. His final assessment lists 83 reptiles and 90 amphibians, numbers which strongly suggest that Reid's list for the immediately adjacent Oban area is only a partial account of the herpetofauna in that part of Nigeria. Bakarr *et al.* (in Mittermeier *et al.* 1999) acknowledge that their estimate of 116 amphibians occurring in the Guinean forests is preliminary. Indeed, Lawson's numbers suggest that if at least 90 amphibians occur in the Korup area alone, many more than 116 must occur in the Guinean forests as a whole.

Drawing on data from the literature as well as the ZMUC database and WORLDMAP, we produced a list of 52 anuran amphibian species (frogs and toads) that appear to be restricted to our project region. These are listed in Table 4 (p. 51). Noteworthy among these amphibians are the toad genera *Didynamipus*, *Werneria*, and *Wolterstorffina* (Bufonidae). With the exception of *Werneria preussi*, which occurs in both southwest Cameroon and Togo, these genera are restricted to this region and appear to be members of an archaic radiation dating to before the separation of Africa and South America (Gartshore 1984). The genus *Cardioglossa* (Arthroleptidae) is particularly speciose in our study region and includes several species with highly restricted distributions. The frog genera *Petropedetes* and *Phrynobatrachus* (Ranidae) also have relatively large numbers of endemic species in this region. Interestingly, the region contains rather few endemic treefrogs (Hyperolidae), although treefrog species are notably rich.

The results of amphibian locality mapping are shown in Figure 15 (pp. 52–56). This mapping revealed that eight species (*Astylosternus diadematus, A. schioetzi, Cardioglossa elegans, C. nigromaculata, Pedropedetes parkeri, Phrynobatrachus steindachneri, Werneria mertensi*, and *Wolterstorffina parvipalmata*) have been found in Cameroon south of the Sanaga River. Although, like *Werneria preussi*, they are not absolutely restricted to our study region, we nonetheless mapped them because their limited distributions are concentrated in this region.

The frogs and toads of this region show a highly diverse set of distributions. Although many are limited to upland areas, others (such as *Astylosternus diadematus*, *Cardioglossa nigromaculata*, and *Petropedetes cameronensis*) are predominantly lowland forms. The species in our study that cross the Sanaga tend to be lowland species, for which the Sanaga is presumably not a serious barrier to dispersal. Some species are known from many localities (e.g., *Pedropedetes parkeri* and *Wolterstorffina parvipalmata*) and others have been recorded at only one site (e.g., *Cardioglossa trifasciata* and *Phrynobatrachus manengoubensis* from Mount Manengouba).

This diversity of amphibian distribution patterns in this region was recognized by Gartshore (1984) in her analysis of the Cameroon montane herpetofauna. Gartshore recognized seven distributional categories, including a group in "submontane" vegetation (defined as 1,000–1,800 m), two montane groups, and the Manengouba endemics. However, these are clearly not exclusive categories: the categories themselves have considerable overlap, and members of different distributional categories often occur in the same habitat. For instance, species from three different categories occur together on the Obudu Plateau. Hofer *et al.* (1999) draw the same conclusion from their study of the herpetofauna of Mt. Kupé, namely, that Cameroon amphibians occur in groupings of species that are not exclusive. Gartshore notes the particular species richness (16 forms) of the submontane group of endemics, a phenomenon that she attributes to the persistence of submontane vegetation in this area during a glacial maximum. Hofer *et al.* (1999) also recognize a characteristic amphibian fauna at intermediate altitudes on Mt. Kupé (1,100–1,500 m), a fauna that includes not only species centered at this elevation, but also lowland and montane species.

Probably at least in part due to relatively low levels of collecting, only four of the region's endemic anurans have so far been recorded from Bioko, and many of the Nigerian species have not yet been recorded. For instance, the University College London 1964 expedition to Bioko collected a red and black *Cardioglossa* (pictured on the front cover of this volume) in Moka that has yet to be identified, and may be a new species (R. Drewes, personal communication). Similarly, Fa (1992) notes an endemic skink (*Scelotes poensis*) and a caecilian (*Schistometopum garzonheydti*) from the island. Most of the Nigerian records for the endemic amphibians we mapped are from the Obudu Plateau, which herpetologists have visited much more frequently than other localities in southeastern Nigeria.

FISH

Because the environmental features limiting fish distributions are different from those that limit the distributions of terrestrial vertebrates, the biogeographical patterning of fish species is different from the other groups we have analyzed. While the Niger, Cross, and Sanaga Rivers form distributional barriers to many terrestrial vertebrates, they and their drainages contain different fish faunas, and the distributional barriers for the fish are typically the watersheds between the drainages.

Our study area includes parts of the drainages of three major or medium-sized river systems—the Niger-Benue, the Cross, and the Sanaga—as well as several smaller rivers. Southwestern Cameroon also contains a series of intriguing volcanic crater lakes that are home to some unique fish.

G.M. Reid's study of the hydrobiology and fish fauna of the Korup area in Cameroon, based on a 1989 survey (Reid 1989), is, to our knowledge, the only detailed evaluation of fish taxonomy, ecology, and zoogeography in the forest rivers and streams within our study region. Reid lists a total of about 140 species of fish from the Korup area, distributed among the Upper Cross, the Akpa-Yafe/Upper Ndian, and the Lower Ndian river systems, each with a different fish fauna. About 90 species were found in the Upper Cross drainage, about

27 in the Akpa-Yafe/Upper Ndian system, and about 40 in the Lower Ndian. Interestingly, although the Upper Ndian and Upper Cross drainages draw quite near to one another in northern Korup (the Cross draining east and north, the Ndian south), they share only ten species. Reid notes that the fish fauna of Korup is extremely diverse when compared to some principal African rivers, which have fewer total species. The Niger, for instance, has 134, the Nile has 115, and the Sanaga and other coastal rivers of southeastern Cameroon have 110. Moreover, many of the fish found by Reid in Korup rivers were not readily identifiable and probably new to science.

Within Korup, the fish of the Lower and Upper Ndian show intriguing differences that Reid attributes to the presence of a shear waterfall and historical (perhaps catastrophic) events. The Lower Ndian is dominated by species from marine families, while the most common fish families in the Upper Ndian and Akpa-Yafe drainages were the Cyprinidae (7 species), Cyprinodontidae, and Cichlidae (each with 5 species). Of the 27 fish found in these river systems, 13 could not be identified with certainty to species and, in several instances, may be new to science (Reid 1989). The Akpa-Yafe drainage also includes a large section of the eastern part of the Oban Division of Cross River National Park in Nigeria. With so many potential new species found in Korup, it appears that Oban would repay further ichthyological research—so far, only preliminary surveys have been conducted, by J.C. Reid.

In addition to Reid's report on the fishes of parts of the Upper Cross drainage, the Teugels *et al.* treatise (1992) on the fishes of the Cross River Basin as a whole summarizes the special features of this community. Teugels *et al.* note that the Cross River Basin contains a minimum of 166 fish species. Even after excluding species with marine affinities, this represents 36–47 percent more freshwater species than have been recorded from other hydrographically comparable West African river basins (such as the Comoé and Sassandra). Teugels *et al.* speculate that this relatively large total number of species may relate to the former persistence of a forest refuge in the basin. They note that at least 11 of the Cross Basin species are probably endemic, but if we consider fish included in their analysis that occur both in the Cross and in other river systems or water bodies in the region (including the Niger Delta), then the number of endemics increases to at least 19. In a correspondence analysis, Hugueny and Lévêque (1994) found the Cross River Basin fish fauna to be most closely related to that of the Niger Delta. Their analysis places these two faunas in a cluster that includes major West African rivers such as the Senegal, Volta, and Niger. This cluster is distant from that of Lower Guinea river systems, including the Sanaga.

The crater lakes in southwestern Cameroon include Barombi-Mbo (also known as Kumba Lake and Elefanten-see), Soden, Kotto (or Barombi Kotto), Mbwandong (or Mboandong), and Bermin. Two of these are rich in endemic cichlids: L. Barombi Mbo and its inflowing stream, which contains 17 fish species, 12 of them endemic (11 of them cichlids) (Trewavas *et al.* 1972); and L. Bermin, which has 11 species, including a "flock" of nine endemic cichlids (Stiassny *et al.* 1992). Lake Soden has only four species, including an endemic cyprinodont (*Procatopus lacustris*), and Lake Kotto has fish endemism only at the subspecific level (Trewavas 1974). Trewavas (1974) also describes a number of new species from the Meme and Mungo river systems, which drain some of these lakes as well as the Mount Cameroon area.

As with other groups, the freshwater fish fauna of Bioko is depauperate compared with the mainland. Castelo (1994) lists 43 species from the island, three of which occur only on Bioko and around Mount Cameroon. An analysis by Thys van den Audenaerde (1967) found only 12 Bioko species to be true freshwater fishes with little or no salt tolerance, and all of these also occur around Mount Cameroon. The crater lakes of Bioko do not contain fish.

INVERTEBRATES

The invertebrate fauna of our study region is inevitably less well-known than the vertebrate fauna. Although some groups of insects (including Lepidoptera and Odonata) have been moderately well studied at a few localities, most of the invertebrates remain very superficially investigated.

Butterflies

Among the Lepidoptera, butterflies are especially well known in our region through the work of Torben Larsen, who has drawn many important biogeographical, taxonomic, and conservation conclusions from his studies. Larsen has collected in both the Oban (3 visits) and Okwangwo (2 visits) divisions of Cross River National Park; on the Obudu Plateau (2 visits); and in the Korup area (1 visit). In his first visit to Oban in 1995, he collected almost 600 species (1995a); he also estimated that this section of the park probably supports around 950 species, and the park as a whole more than 1,000 species, which would be the highest number reported from any one locality in Africa. Table 5 (p. 57) summarizes Larsen's collections.

Through his subsequent research, Larsen concluded that the butterfly fauna of Oban, together with Korup (where he collected 400 species in 1997), is indeed the richest in all of Africa (Larsen 1997c). This area contains well over 1,000 lowland rainforest species, equivalent to six percent of all butterflies described worldwide and almost one third of all species known from continental afrotropical Africa. These numbers represent more species than are found in either peninsular Malaysia or in New Guinea, and only parts of upper Amazonia show higher local species richness.

Larsen (1997c) notes that Oban and Korup are very similar, and may be treated as a single biogeographical unit. Although similar to the western equatorial forests, the Oban-Korup unit contains a distinctive set of species that are endemic to the area between the Cross and Sanaga Rivers. Larsen ascribes this endemism (and the area's species richness) to a long-existing series of forest refuges in the area.

Extrapolating from butterfly richness to total species richness, Larsen estimates that the Oban-Korup area may contain

500,000 to 1 million invertebrate species, and perhaps many more.

For the Okwangwo and Obudu area in Nigeria, Larsen (1997a) estimates a butterfly fauna of about 950 species, more than 100 of which are not present in the Oban Hills. Half of these are essentially submontane species (from the Obudu Plateau and environs), and the remainder are specialists of the drier forests and savannah characteristic of the margins of the Okwangwo Division of CRNP.

The Obudu Plateau is probably the best-studied site for butterflies in this region. Larsen's collections from the plateau supplement those of several previous visitors, such as R. St. Leger (Larsen 1995b, 1997b). Larsen lists 203 species from the plateau, including four that have been collected nowhere else: *Pseudathyma legeri*, *Liptena priscilla*, a *Ceratrichia* sp., and a *Gorgyra* sp. The *Ceratrichia* has since been named *C. lewisi* (Collins & Larsen 2000). What Larsen calls the "submontane element" from Obudu consists of a group with affinities to the highland fauna of East African mountains such as the Ruwenzoris, Kivu, Burundi (Larsen 1997b). Larsen compares the Obudu butterflies with other areas in the Cameroon-Nigeria highlands in our region and identifies a total of 14 endemic species and 21 endemic subspecies (Table 6, p. 57).

Larsen (1997b) notes that the number of butterfly species recorded from the Obudu Plateau is much higher than for any of the single Cameroon montane localities studied by Libert (who recorded 74 species from Mt. Tabenken and from Mt. Manengouba).

Larsen (1997b) comments also on the montane butterfly fauna of the Mambilla Plateau. This is very similar to that of the Obudu Plateau, but because Mambilla is higher than Obudu, several montane species are known from there that are absent (or have not been collected) from Obudu. Finally, Larsen (1997c) has reported on collections by associates in the Rumpi Hills; he notes that this collection suggests that above 1,100 m these hills are a very important submontane refuge that will repay further study.

Dragonflies

Odonata have been surveyed in southwest Cameroon by Vick (1999), who has carried out field work at several sites over three years, and examined literature and museum records. Vick lists 179 known species and estimates that the fauna probably contains at least 200 species. He speculates that "few parts of Africa of equivalent area can match" the dragonfly species richness of S.W. Cameroon—he notes that Belize (similar in area to southwest Cameroon) has 170 recorded species and that Kenya (which is 24 times larger) has 194 species. He also observes that the area is rich in ancient relicts and endemics, although he does not list them specifically.

PLANTS

As with other groups of organisms, the montane flora in our region has many differences from that in the lowlands. The flora of Mount Cameroon has been especially well documented by Cable and Cheek in *The Plants of Mount Cameroon* (1998), where they provide a checklist of the vascular plants of Mount Cameroon together with its foothills and surrounding lowlands, a total area of about 2,700 km^2. Their study recorded 2,435 species (both indigenous and naturalized) in this area, which they compare with 1,693 species from the Korup project area and 842 from Bioko. Cable and Cheek note that the Korup project area lacks the habitat diversity and altitudinal range of Mount Cameroon, and that Bioko lost much of its lower altitude forest before it could be properly enumerated. Schmitt (1996) lists approximately 1,570 plant species as occurring in the Oban area of Nigeria. Brenan (cited in Richards 1996) has estimated a total of 30,000 vascular plant species for the whole of tropical Africa.

Cable and Cheek (1998) list 49 plant taxa (species, subspecies, and varieties) endemic to Mount Cameroon. Eleven of these species occur in lower montane (also referred to as "submontane" or "cloud") forest between 800 and 1,800 m, and 29 in lowland forest. Of the lowland species, 17 are newly discovered, and Cable and Cheek guess that the number of lowland forest endemics will rise with further study. Although Bioko clearly has fewer species than the mainland (a pattern we see in all taxonomic groups), Cable and Cheek's species number appears to be an understatement—Figueiredo (1994) says that the island has 1,105 species of angiosperms alone, 40 of which are endemic.

As described in Chapter 2, we studied the distribution patterns of a small sample of the region's plants. Of the 353 Mount Cameroon species that Cable and Cheek list as only occurring in Bioko, Nigeria, or Cameroon, we selected the 55 tree species that reach at least 10 m in height. Seven of these are caesalpinioid legumes (family Leguminosae, subfamily Caesalpinioideae). After further analysis we removed the following eight species from this list: *Vitex* "sp. A" and "sp. B" (Verbenaceae), *Isolona* sp. nov., *Polyceratocarpus* sp. nov., and *Piptostigma* sp. aff. *glabrescens* (Annonaceae), which were regarded as insufficiently known to have useful locality records available; *Monopetalanthus letestui* (Caesalpinioideae), which has been subsumed under the species *Bikinia letestui* that ranges to Congo-Brazzaville (Wieringa 1999); *Uapaca staudtii* (Euphorbiaceae), which was found to occur as far south as Gabon (and far west in Nigeria); and *Oxyanthus speciosus* (Rubiaceae), which extends to central Africa. We also added to our database a new genus and species, *Korupodendron songweanum* (Vochysiaceae), so far known only from Korup National Park and described during the preparation of this volume (Litt & Cheek 2002). In addition, we would have added *Tetraberlinia korupensis* (Caesalpiniaceae), apparently also known only from Korup (Wieringa 2000), had we learned of its existence before we completed our analysis. Our final set of 48 large trees is listed in Table 7 (p. 58), and their distributions are shown in Figure 16 (pp. 59–63).

If we had followed the same selection procedure we applied to birds, we would have had to exclude many of the plant species included in our final mapping because we found records of their occurrence south of the Sanaga River or west

of the Niger. We included these species, however, because their distributions appear to be centered on our study region, and some of their more distant records may eventually prove to represent members of different species.

We examined distribution in relation to elevation of the 25 larger tree species strictly endemic to our region and found that five species span a wide altitude range, 11 appear to be largely restricted to lowland forest, six to lower montane forest, and three to upper montane forest. Of these 25 endemics, three are caesalpinioid legumes restricted to lowland forest: *Crudia bibundina*, *Daniellia oblonga*, and *Microberlinia bisulcata*. Thus, the distribution pattern we found in relation to elevation is that lowland forest contains the largest number of endemics, followed by the lower montane forest. Caesalpinioid legumes are also a characteristic feature of the forests in this region. This pattern, albeit based on a limited sample, is consistent with the observations of Letouzey (1968) and Cable and Cheek (1998). Letouzey characterized the lowland forest in this area (his "Biafran forest") as having a high species richness of Caesalpinioideae.

This pattern strongly suggests (as do our analyses of the primate, amphibian, and butterfly faunas) that both lowland and montane forest refuges have existed in this region in the past, as have refuges for forest types similar both to today's lower montane (or submontane) forest and to today's upper montane forest. The long generation times of large trees, together with the low-dispersal abilities of large-seeded caesalpinioid legumes (Hart *et al.* 1989), hint at a possibly very ancient lowland forest refuge in the area. Indeed, Maley and Brenac (1998) found peaks of caesalpinioid pollen in Lake Barombi Mbo sediments corresponding to the wetter climate phases of the last 28,000 years.

Cheek *et al.* (2000) consider whether the Cross-Sanaga "interval" should be classified as a special phytogeographic unit. They recognize its especially high plant species richness and considerable endemism (although much of the endemism is restricted to the Cameroon Highlands). While a few plants appear to be limited by the Sanaga River, more have their southern boundary at the Nyong River, just south of the Sanaga. Cheek *et al.* note that the Sanaga may once have had its mouth at the Nyong.

In addition to their checklist, Cable and Cheek (1998) provide a "red data list" for Mount Cameroon plants. Among the species in the tree sample we have analyzed, they classify *Anthonotha leptorrhachis*, *Crudia bibundina*, and *Microberlinia bisulcata* as Critically Endangered, noting that *C. bibundina* was last collected in 1928. However, Cable and Cheek are incorrect in stating that *M. bisulcata* is restricted to southwest Cameroon and that "records of it occurring elsewhere are spurious." The Missouri Botanical Garden collection contains a specimen from Oban; Schmitt (1996) also recorded it in the Oban Division of Cross River National Park. In addition, we have observed it as an upper-canopy dominant near Ekonganaku in the Oban Division in 2000, we encountered it at Afi Mountain in 2002, Sunderland *et al.* (2002) observed it in Takamanda Forest Reserve, and we have encountered it in Korup National Park, where it is said to be associated with sandy soils that have low available phosphorus concentrations (Newbery & Gartlan 1996). Among other red-list species, Cable and Cheek include five species of shrubs and small trees in the genus *Cola*, including three undescribed species. We observed a high diversity of *Cola* species in the Oban Hills, and we suspect that many Nigerian range extensions of plants considered restricted to Cameroon would probably be revealed by more botanical explorations of the Oban Hills.

The trees of the lowland and montane forests in our region are not the only ones that show special features. Mount Cameroon, for instance, has some montane grassland endemic tree species (Cable & Cheek 1998), and important high-altitude *Sphagnum* bogs are found in the Bakossi Mountains and on Mount Oku summit (Maisels *et al.* 2000).

CONCLUSIONS FROM BIODIVERSITY ASSESSMENT

Our analysis makes clear that this region is indeed a "hotspot" of global importance, in terms of the species richness and endemism apparent in many taxonomic groups. Using a similar analysis to our own, Brooks *et al.* (2001) have also recently shown the importance of the Cameroon Highlands.

Several key features of the hotspot emerged from our analysis. First, compared to the rest of Africa, the Niger-Sanaga region (and especially the Nigeria-Cameroon border area) has high mammalian endemism, especially high primate richness and endemism, high snake endemism, and very high amphibian richness and endemism. Relative to comparable areas of west and central Africa, this region also has high bird richness and endemism, and the Cross River Basin is very rich in fish species relative to comparable West African river basins. Southwestern Cameroon also has a unique fauna of crater-lake fish. For butterflies, the Oban-Korup forest may be the richest locality in Africa, and the Obudu Plateau is particularly rich in endemic butterflies. Dragonflies also show high species richness in the region.

Second, the island of Bioko, although separated from the mainland by a sea channel of less than 40 km, has a depauperate fauna in all taxonomic groups examined. On the other hand, many of the Bioko taxa are endemic to the island, although most of this endemism is at the subspecies rather than species level.

Third, given the different habits and dispersal abilities of different taxonomic groups, patterns of endemism vary taxonomically in this region. For instance, among the groups we have examined carefully, four patterns are apparent:

- Most anthropoid primates do not show a restriction to lowland or montane forest, with the exception of Preuss's guenon (*Cercopithecus preussi*), which is particularly associated with (though not restricted to) lower montane forests. On the other hand, some primates are not found at the highest elevations in the region, notably the red colobus (*Procolobus pennantii*). More than the other taxa we have studied, the primates tend to be limited by major rivers, presumably because many forest primates do not readily take to water.

- No doubt because they readily fly over rivers, lowland birds do not show any notable endemism in our region. However, montane birds do, probably because the mountains in our study region are so far from any other similar region in Africa. Only a small number of the montane bird species are restricted to just one or a few mountains, probably because the mountains in our region are relatively close to each other. Notable exceptions to the generally broad montane distributions are the white-eyes (*Speirops* spp.), found only on Bioko and Mount Cameroon; the Mount Cameroon francolin (*Francolinus camerunensis*); the Mount Kupé bush-shrike (*Telophorus kupeenesis*); and the Bamenda Highland endemics *Tauraco bannermani* and *Apalis bamendae*.

- Endemic amphibians in our region show a very diverse range of distributions. Authorities who have studied this region's amphibians have noted that there are groups of lowland, lower montane, and upper montane endemics, with the lower montane group being especially rich. Amphibians probably speciated in this way because many are habitat specialists, and they can maintain viable populations in an area that is very small relative to the area needed, say, for a viable monkey population. Amphibians are expected to have many mountain-living endemics in this region, given the relative isolation of the mountains and the inability of these organisms to fly.

- Endemic large trees show a similar pattern to the primates and an opposite pattern to the birds. As with other plant groups in the region, a majority of endemics are lowland species, with somewhat fewer lower montane endemics and even fewer upper montane species. Lowland plant species are most likely to show local speciation if they have low dispersal abilities; this seems to be particularly true of the caesalpinoid legumes that predominate among the endemic large trees of our region.

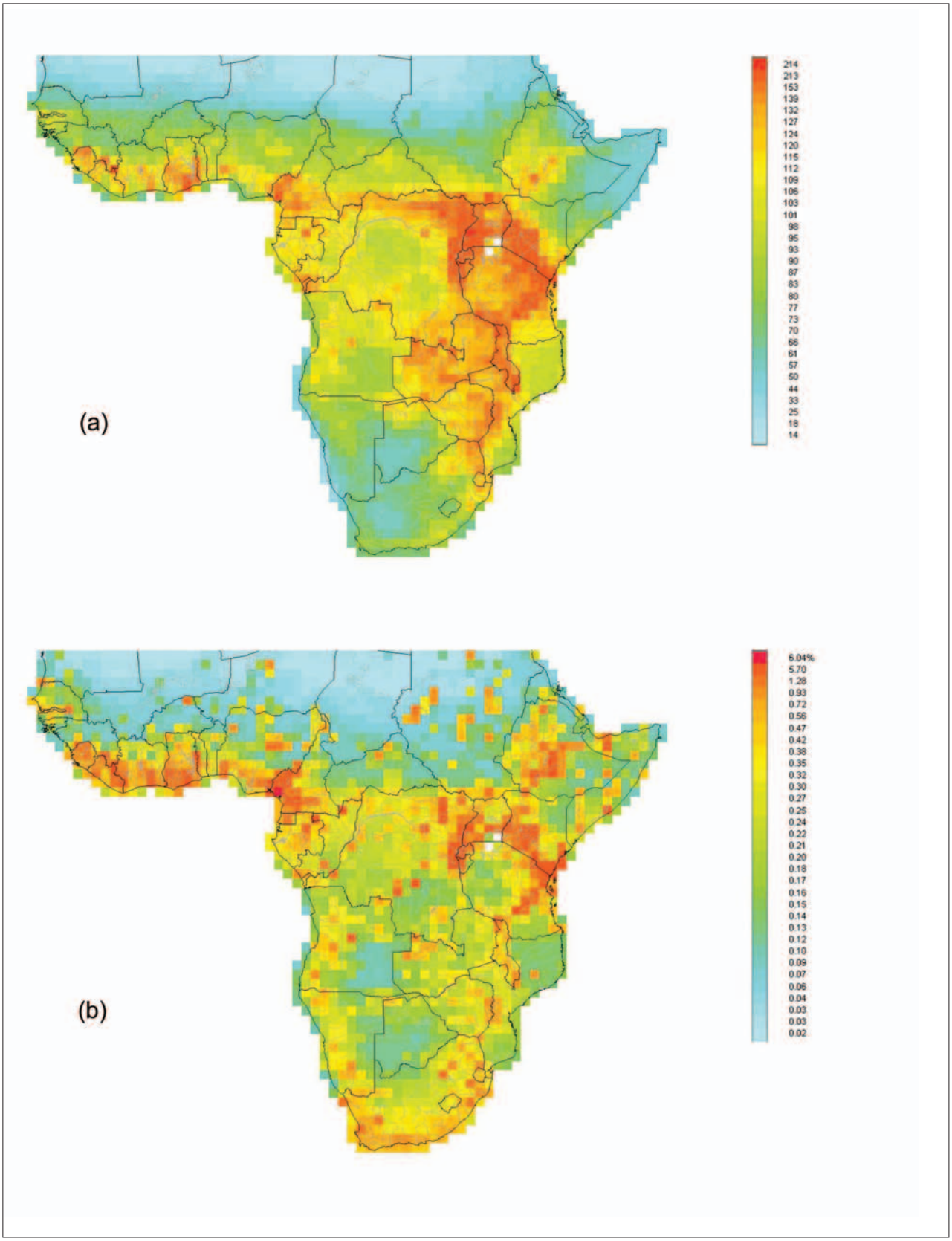


Figure 5. Mammal species (a) richness and (b) inverse range size rarity (endemism) in sub-Saharan Africa. Rarity is measured as the inverse of number of grid cells occupied by a species within the map area. Data from the Zoological Museum, University of Copenhagen (ZMUC) database. Maps generated using WORLDMAP (Williams 2001).

Table 2. Forest primates of the study region and their conservation status.

Taxon	Distribution	IUCN Category (IUCN 2002)
****Arctocebus calabarensis***	Niger-Sanaga	LR
Perodicticus potto edwardsi	Niger-Congo	NT
****Euoticus pallidus pallidus***	Bioko	EN
****Euoticus pallidus talboti***	Niger-Sanaga	NT
****Galago alleni alleni***	Bioko	EN
****Galago alleni cameronensis***	Niger-Sanaga	LR
Galago demidoff murinus	Niger-Congo	NT
****Galago demidoff poensis***	Bioko	NT
Galago thomasi	W.-E. Africa	NT
Cercocebus torquatus	W. Nigeria-Gabon	LR
****Mandrillus leucophaeus leucophaeus***	Cross-Sanaga	EN
****Mandrillus leucophaeus poensis***	Bioko	EN
Lophocebus albigena	S.E. Nigeria-Uganda	NT
****Cercopithecus preussi preussi***	Cross-Sanaga	EN
****Cercopithecus preussi insularis***	Bioko	EN
Cercopithecus erythrogaster pococki	S.W. Nigeria & Niger Delta	EN
****Cercopithecus sclateri***	Niger-Cross	EN
****Cercopithecus erythrotis erythrotis***	Bioko	EN
****Cercopithecus erythrotis camerunensis***	Cross-Sanaga	VU
Cercopithecus mona	E. Ghana-Sanaga	NT
****Cercopithecus pogonias pogonias***	Bioko + Cross-Sanaga	EN
****Cercopithecus nictitans ludio***	Cross-Sanaga?	NT
****Cercopithecus nictitans martini***	Bioko?	EN
Procolobus verus	Sierra Leone-E. Nigeria	LR
****Procolobus pennantii pennantii***	Bioko	EN
****Procolobus pennantii preussi***	Cross-Sanaga	EN
****Procolobus pennantii epieni***	Niger Delta	EN
****Colobus satanas satanas***	Bioko	EN
Colobus guereza occidentalis	E. Nigeria-Uganda	NT
****Gorilla gorilla diehli***	S.E. Nigeria-S.W. Cameroon	CR
****Pan troglodytes vellerosus***	Niger-Sanaga?	EN

(** endemic to study region)
(* endemic to study region plus restricted neighboring area)

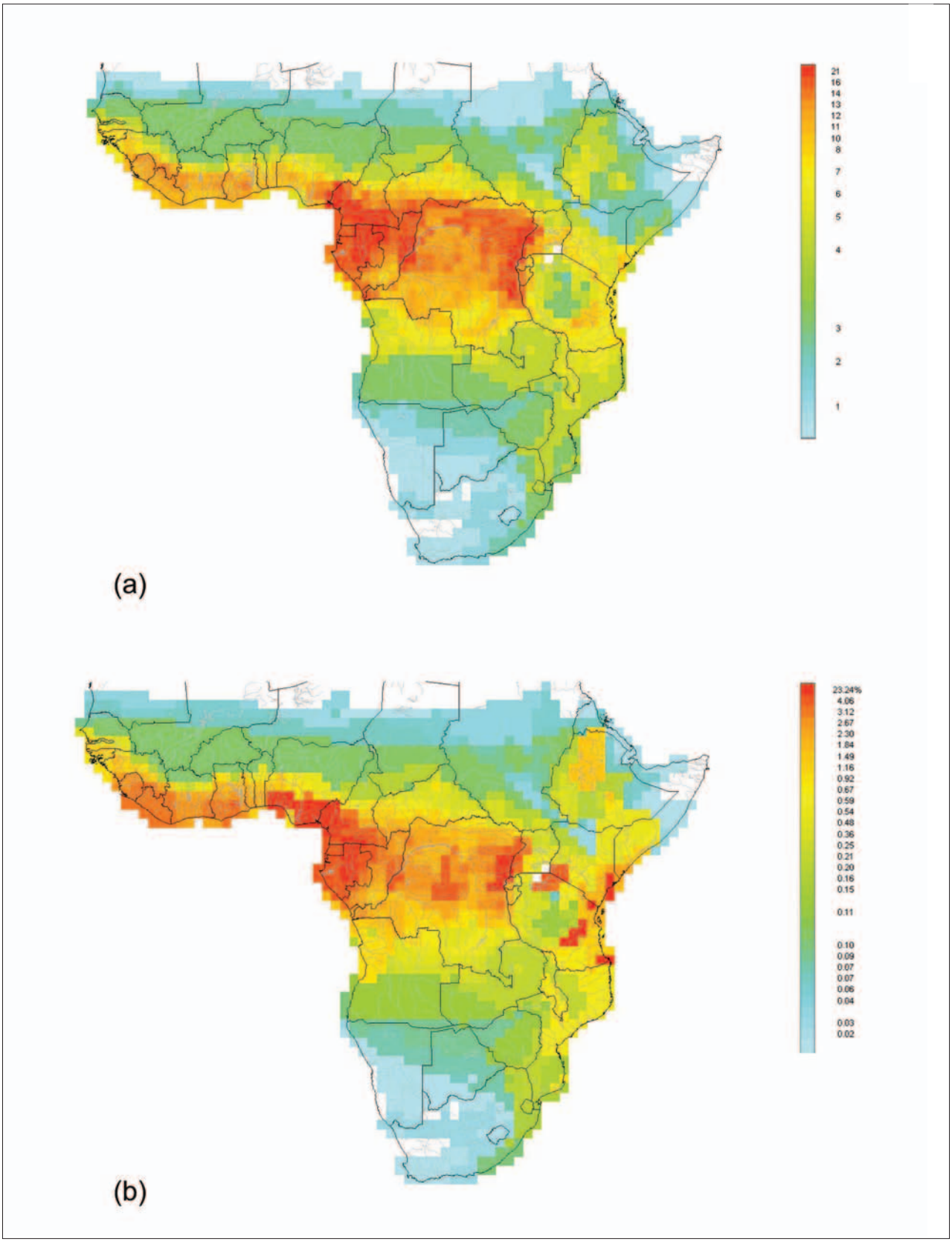


Figure 6. Primate species (a) richness and (b) inverse range size rarity (endemism) in sub-Saharan Africa. Data from the Zoological Museum, University of Copenhagen (ZMUC) database. Maps generated using WORLDMAP (Williams 2001).

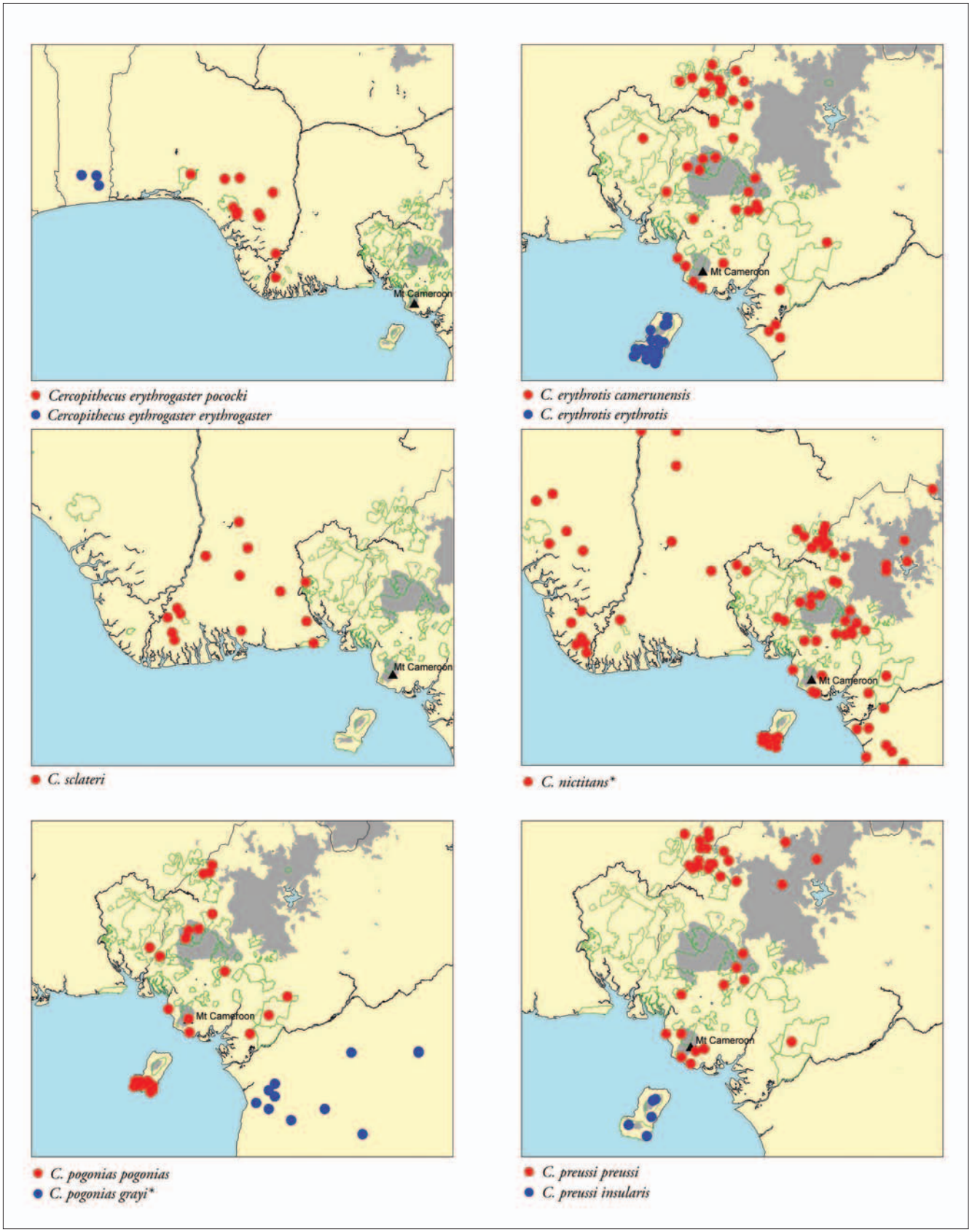
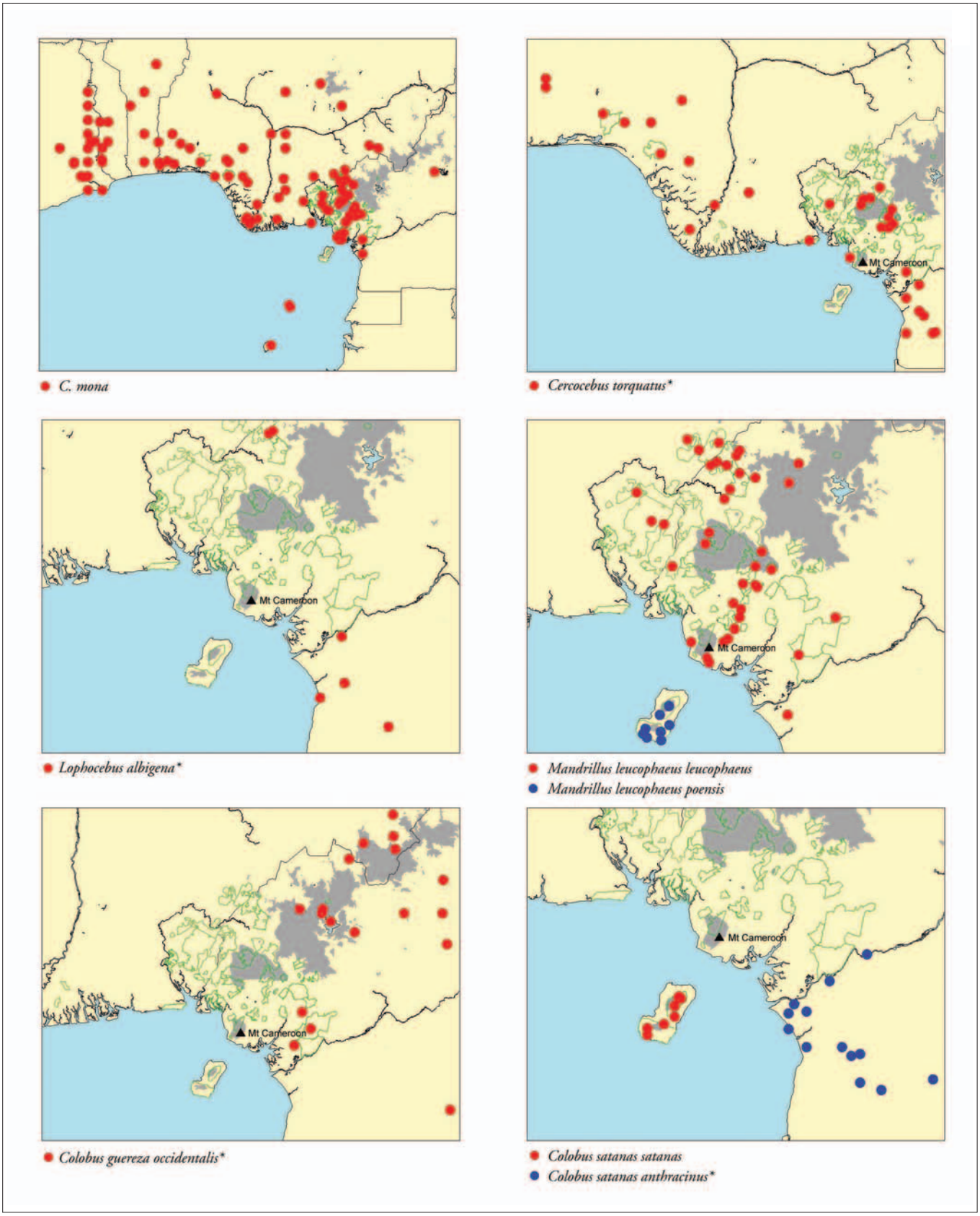


Figure 7. Point locality maps of all forest dwelling anthropoid primate species occurring in the study region. Taxa marked with an asterisk also occur outside the map area. Existing and proposed protected areas and reserves shown in green. Land above 1,200 m shown in gray. See text for sources of data. Figure continues on pp. 37–38.



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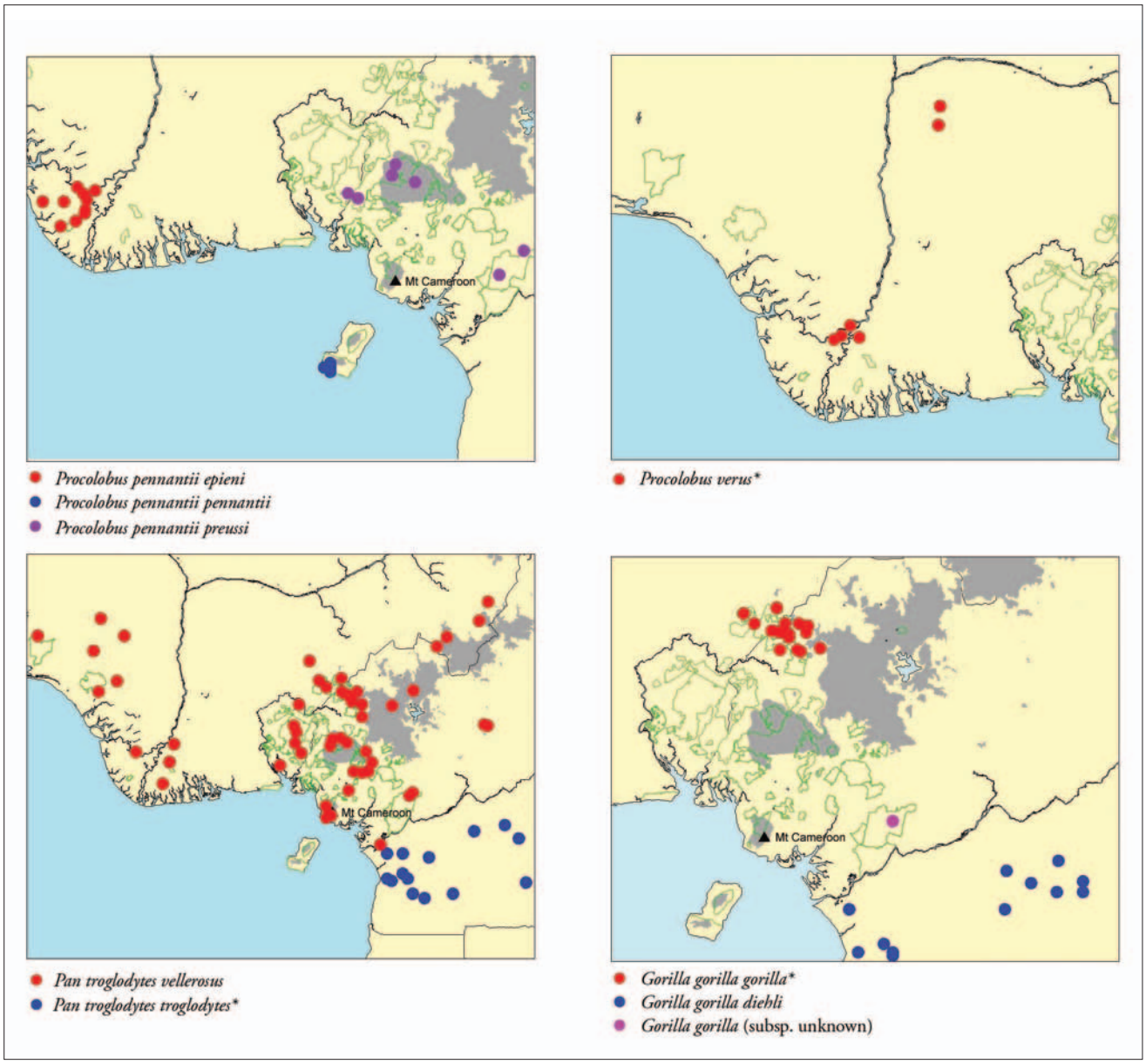

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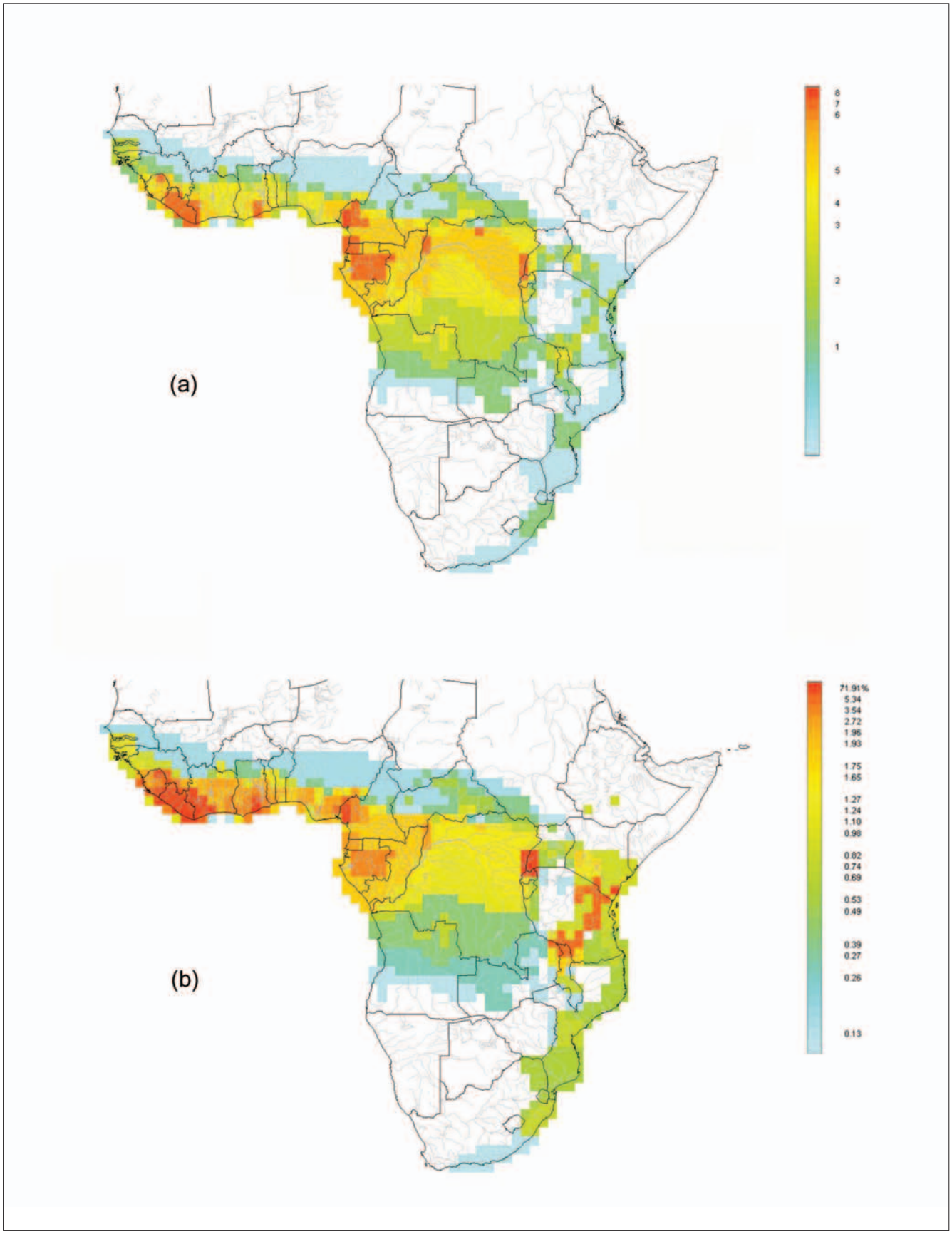


Figure 8. Duiker (*Cephalophus*) species (a) richness and (b) inverse range size rarity (endemism) in sub-Saharan Africa. Data from the Zoological Museum, University of Copenhagen (ZMUC) database. Maps generated using WORLDMAP (Williams 2001).

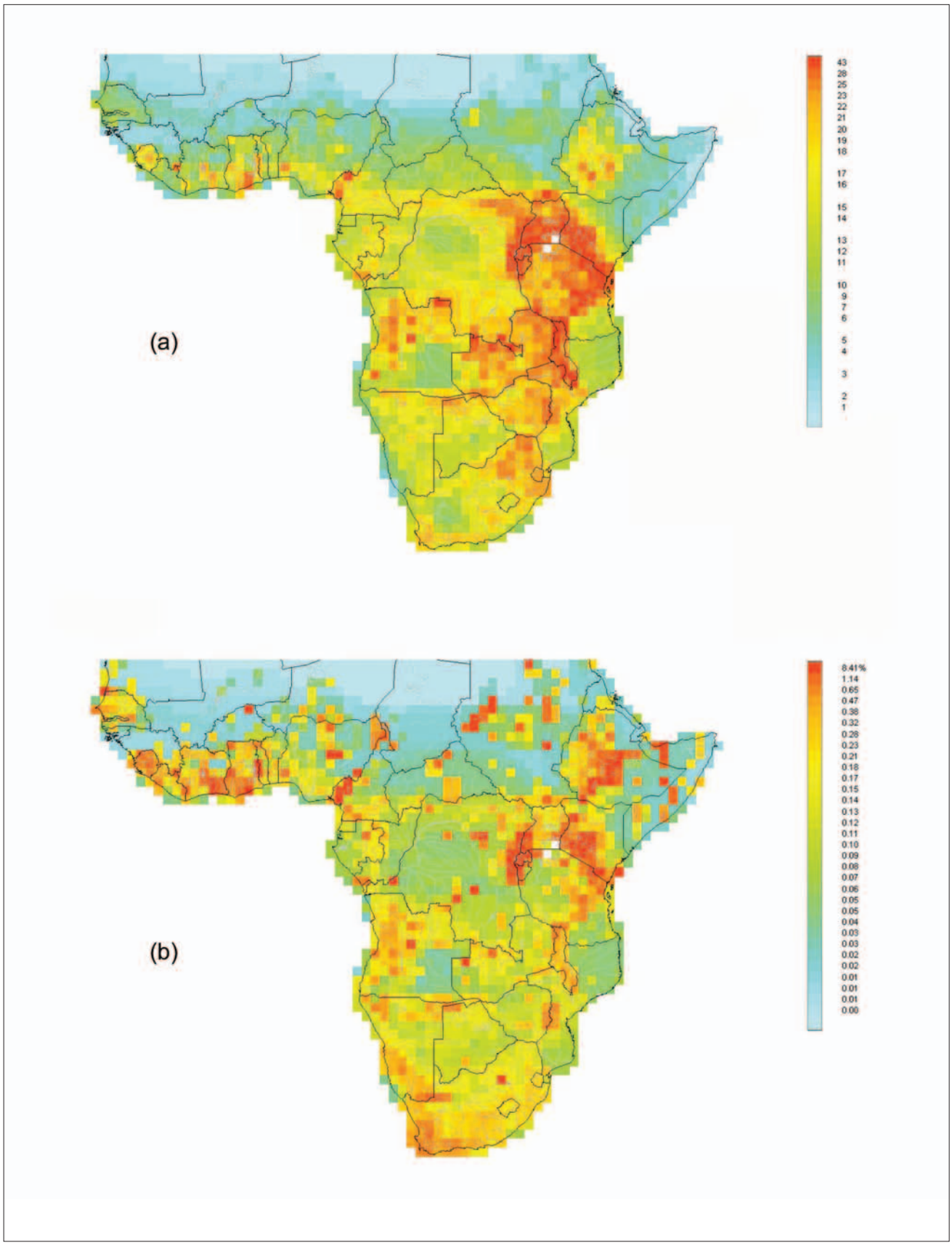


Figure 9. Rodent species (a) richness and (b) inverse range size rarity (endemism) in sub-Saharan Africa. Data from the Zoological Museum, University of Copenhagen (ZMUC) database. Maps generated using WORLDMAP (Williams 2001).

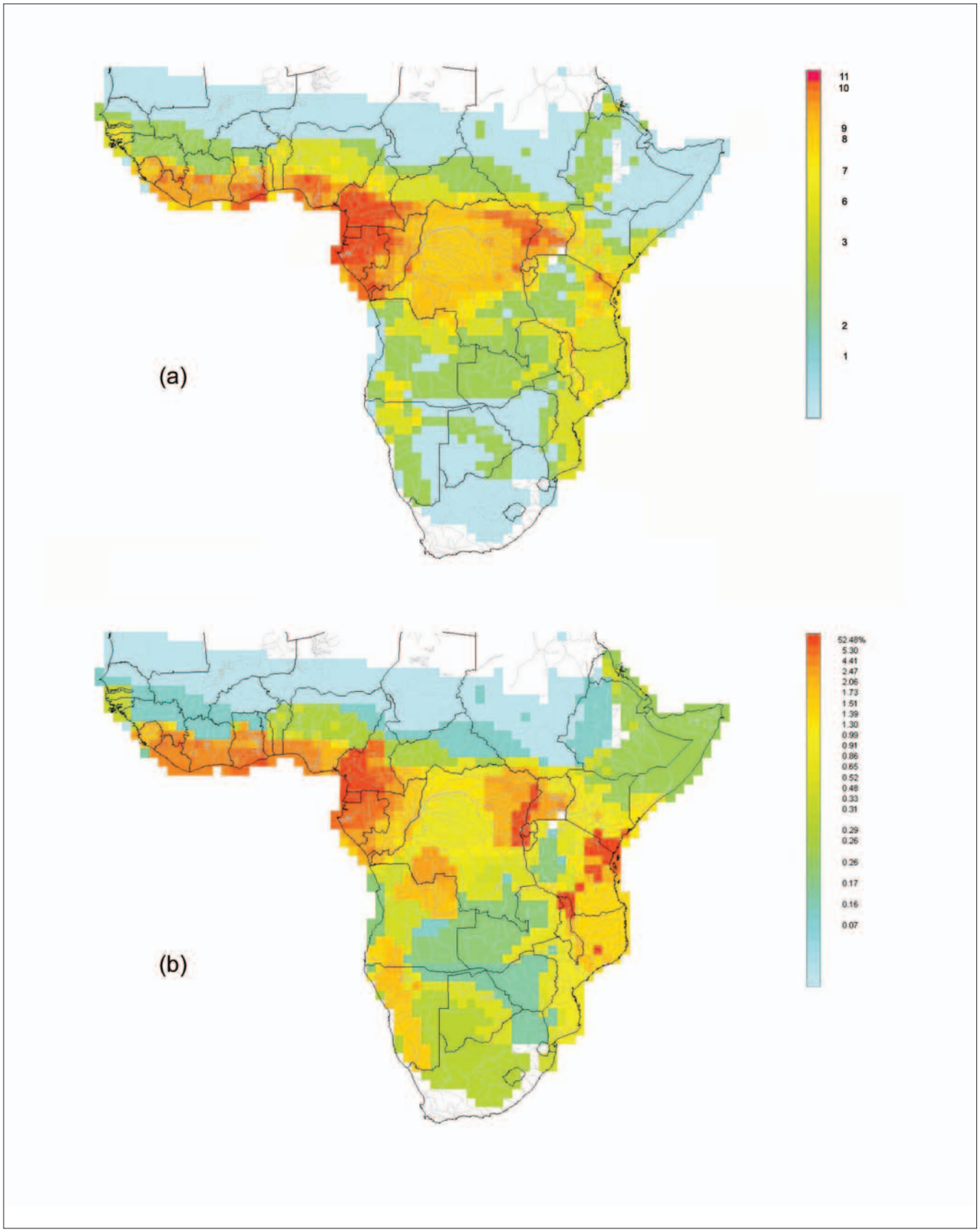


Figure 10. Squirrel (Sciuridae) species (a) richness and (b) inverse range size rarity (endemism) in sub-Saharan Africa. Data from the Zoological Museum, University of Copenhagen (ZMUC) database. Maps generated using WORLDMAP (Williams 2001).

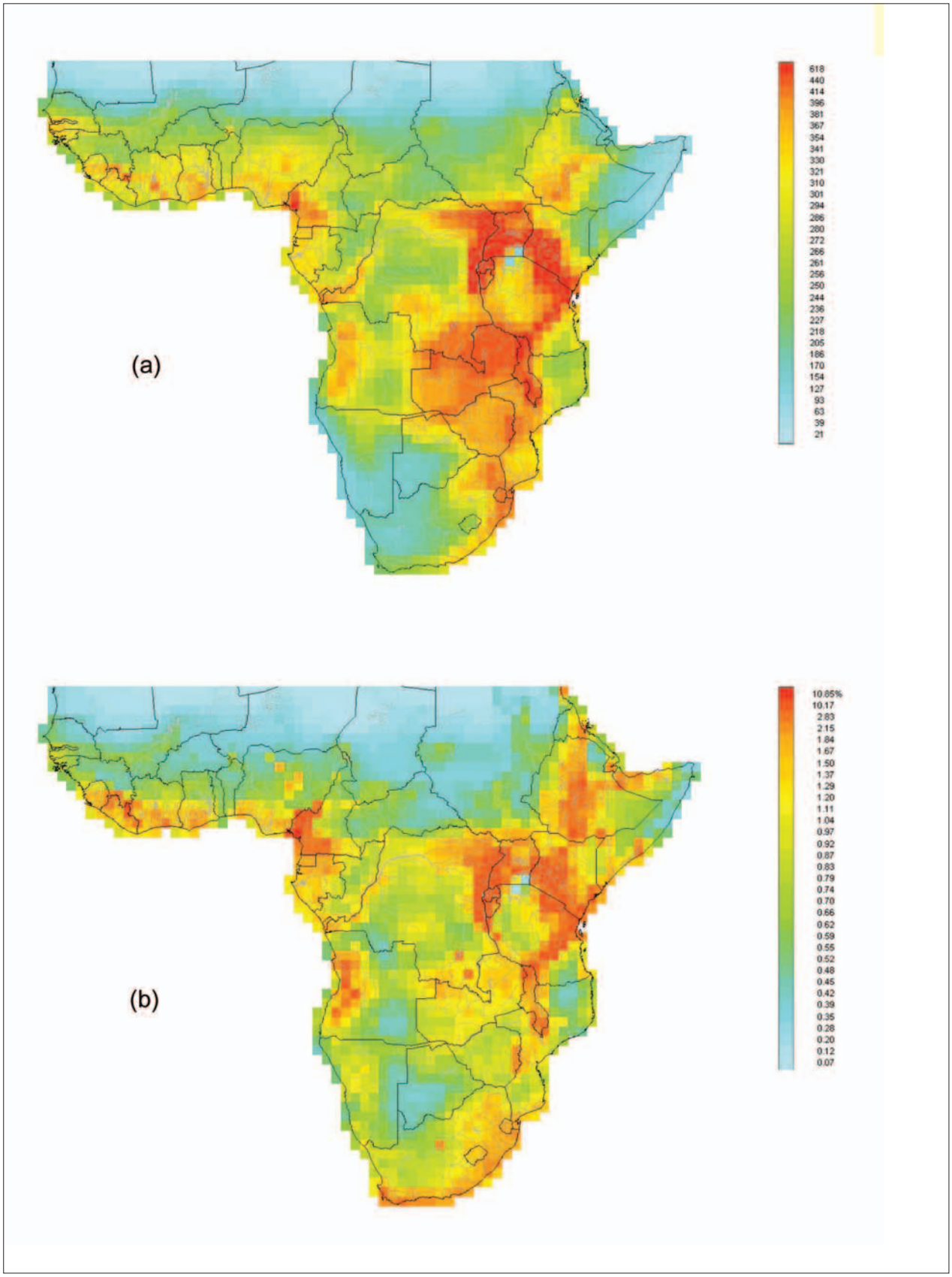
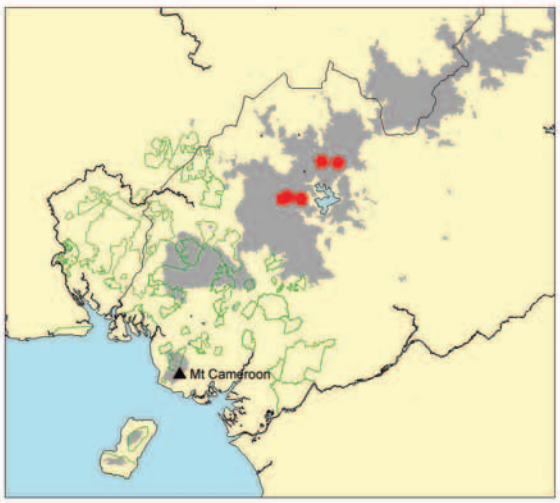


Figure 11. Bird species (a) richness and (b) inverse range size rarity (endemism) in sub-Saharan Africa. Data from the Zoological Museum, University of Copenhagen (ZMUC) database. Maps generated using WORLDMAP (Williams 2001).

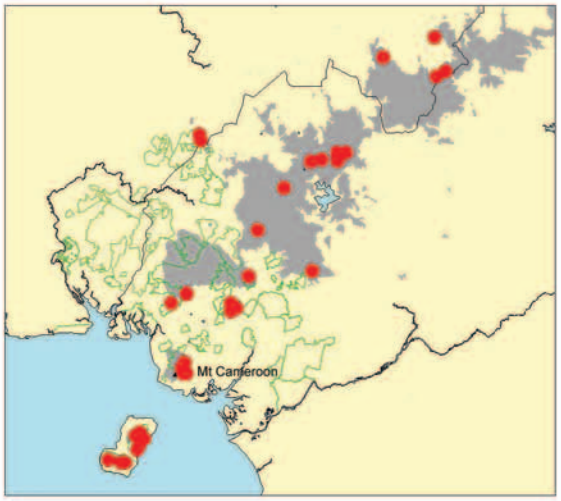
Table 3. Restricted-range bird species of the study region and their conservation status. Taxonomy follows Dowsett and Forbes-Watson (1993).

Family	Scientific Name	Common Name	IUCN Category (IUCN 2002)
Columbidae	*Columba sjostedti*	Cameroon olive pigeon	NT
Estrildidae	*Nesocharis shellyi*	Fernando Po oliveback	NT
Hirundinidae	*Psalidoprocne fuliginosa*	Cameroon mountain roughwing	NT
Malaconotidae	*Laniarius atroflavus*	Yellow breasted boubou	NT
Malaconotidae	*Malaconotus gladiator*	Green breasted bushshrike	VU
Malaconotidae	*Telophorus kupeensis*	Mt. Kupé bushshrike	EN
Musophagidae	*Tauraco bannermani*	Bannerman's turaco	EN
Nectariniidae	*Nectarinia oritis*	Cameroon sunbird	NT
Nectariniidae	*Nectarinia ursulae*	Ursula's mouse colored sunbird	LR
Phasianidae	*Francolinus camerunensis*	Cameroon francolin	EN
Platysteiridae	*Platysteira laticincta*	Banded wattle-eye	EN
Ploceidae	*Ploceus bannermani*	Bannerman's weaver	VU
Pycnonotidae	*Andropadus montanus*	Cameroon greenbul	LR
Pycnonotidae	*Andropadus tephrolaemus*	Gray throated greenbul	NT
Pycnonotidae	*Phyllastrephus poensis*	Cameroon olive greenbul	NT
Pycnonotidae	*Phyllastrephus poliocephalus*	Gray headed greenbul	LR
Sylviidae	*Apalis bamendae*	Bamenda apalis	NT
Sylviidae	*Bradypterus bangwaensis*	Bangwa forest warbler	LR
Sylviidae	*Cisticola discolor*	Brown backed cisticola	NT
Sylviidae	*Phylloscopus herberti*	Black capped woodland warbler	NT
Sylviidae	*Poliolais lopezi*	White tailed warbler	LR/NT
Sylviidae	*Urolais epichlora*	Green longtail	NT
Turdidae	*Cossypha isabellae*	Mountain robin-chat	NT
Timaliidae	*Kupeornis gilberti*	White throated mountain babbler	EN
Zosteropidae	*Speirops brunneus*	Fernando Po speirops [white-eye]	VU
Zosteropidae	*Speirops melanocephalus*	Mt. Cameroon speirops [white-eye]	VU

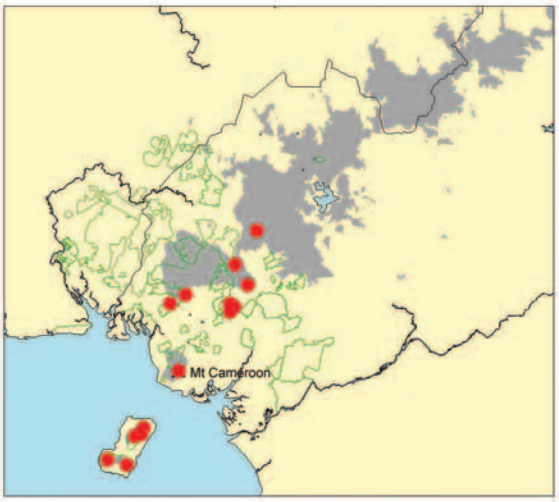
Figure 12. Point locality maps bird species endemic to the study region. Existing and proposed protected areas and reserves shown in green. Land above 1,200 m shown in gray. See text for sources of data. Figure continues on pp. 45–48.



Tauraco bannermani (Musophagidae)

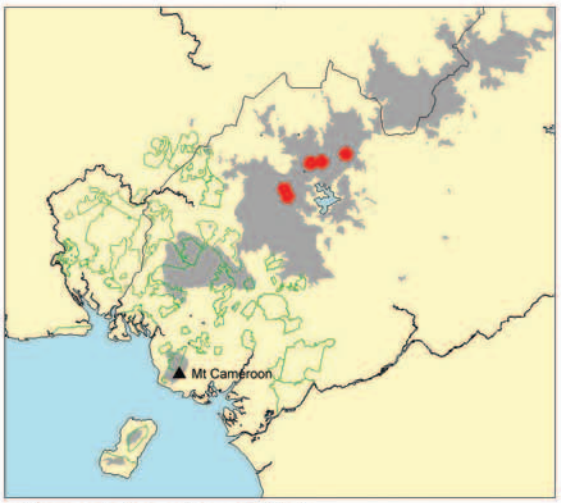


Nectarinia oritis (Nectariniidae)

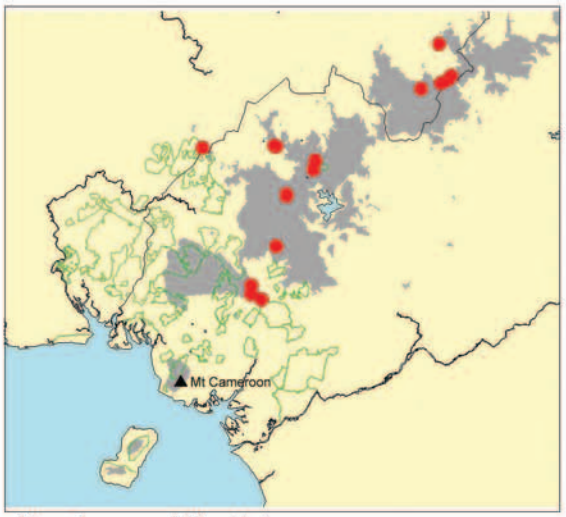


Nectarinia ursulae (Nectariniidae)

Francolinus camerunensis (Phasianidae)

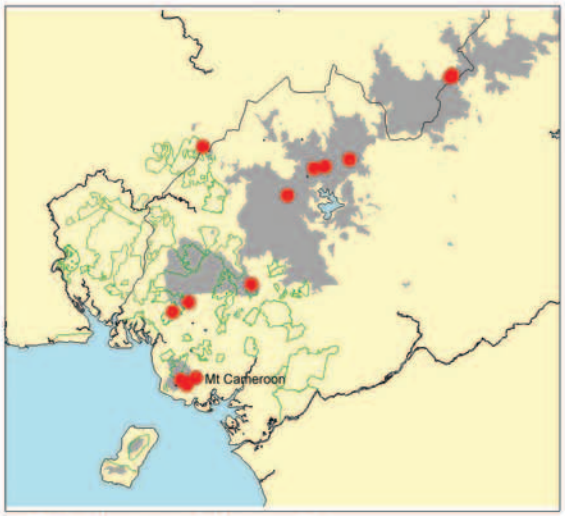


Platysteira laticincta (Platysteiridae)

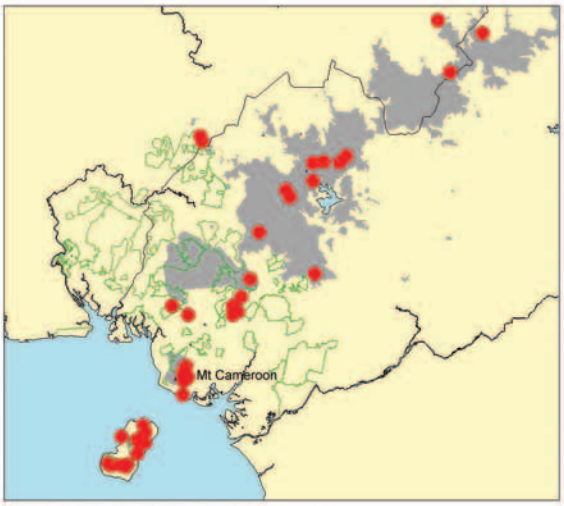


Ploceus bannermani (Ploceidae)

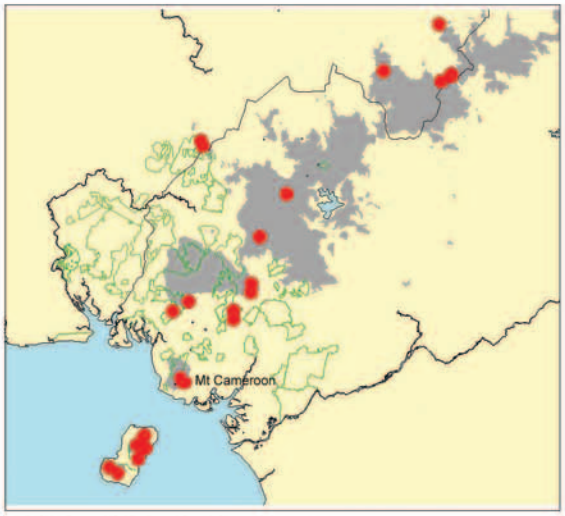
Figure 12 continued.



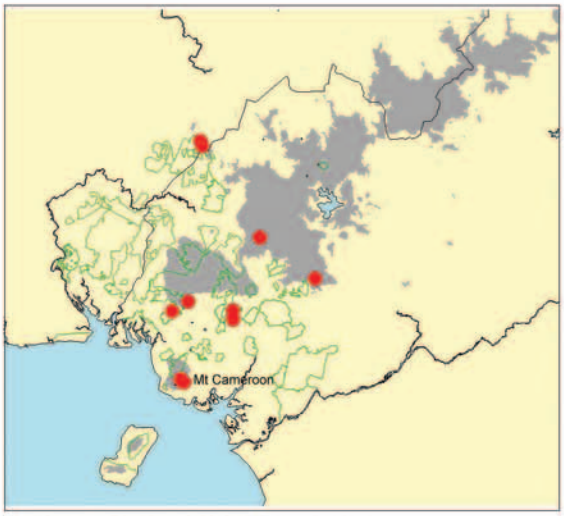
Andropadus montanus (Pycnonotidae)



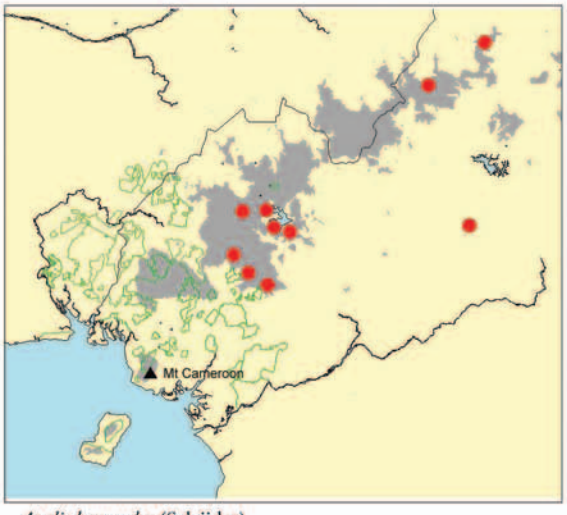
Andropadus tephrolaemus (Pycnonotidae)



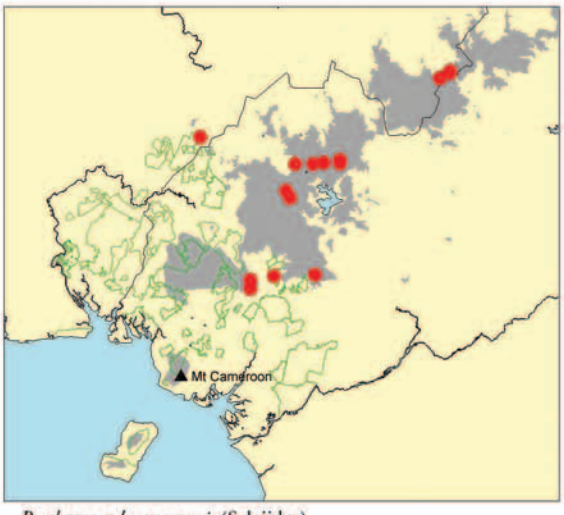
Phyllastrephus poensis (Pycnonotidae)



Phyllastrephus poliocephalus (Pycnonotidae)

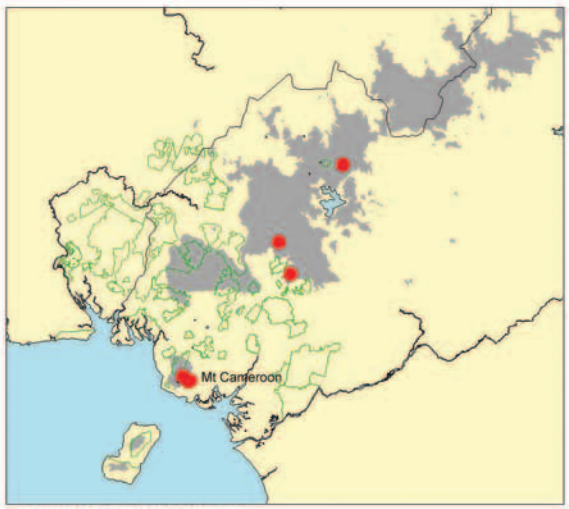


Apalis bamendae (Sylviidae)

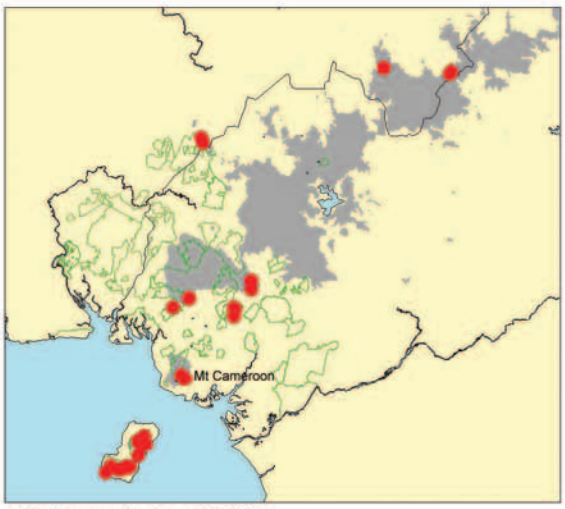


Bradypterus bangwaensis (Sylviidae)

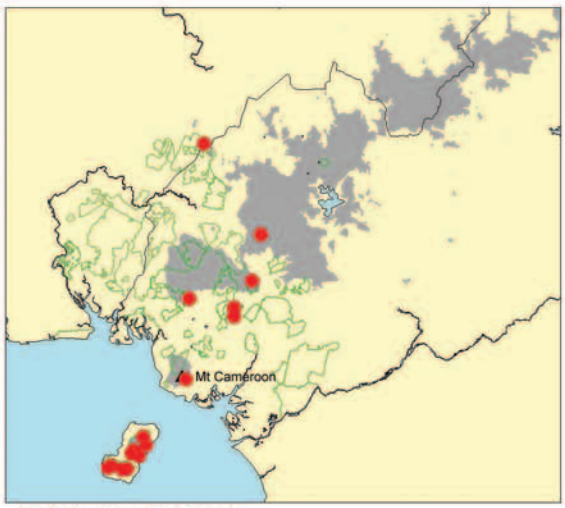
Figure 12 continued.



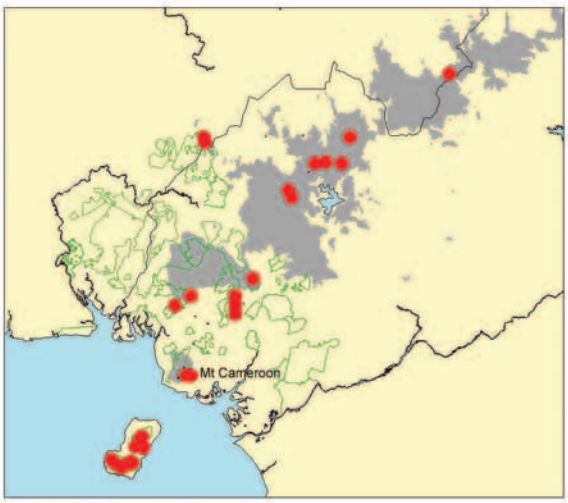
Cisticola discolor (Sylviidae)



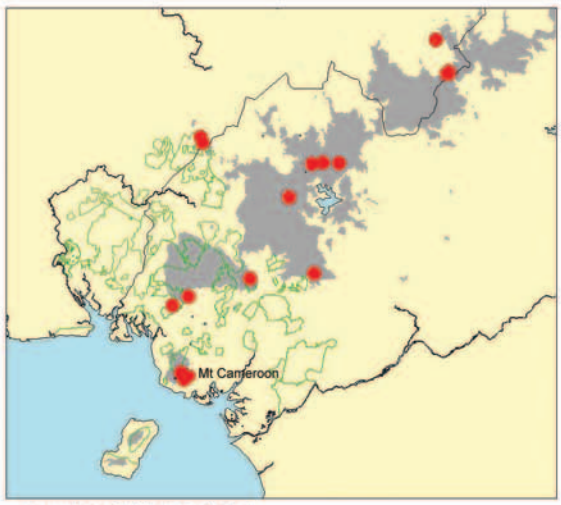
Phylloscopus herberti (Sylviidae)



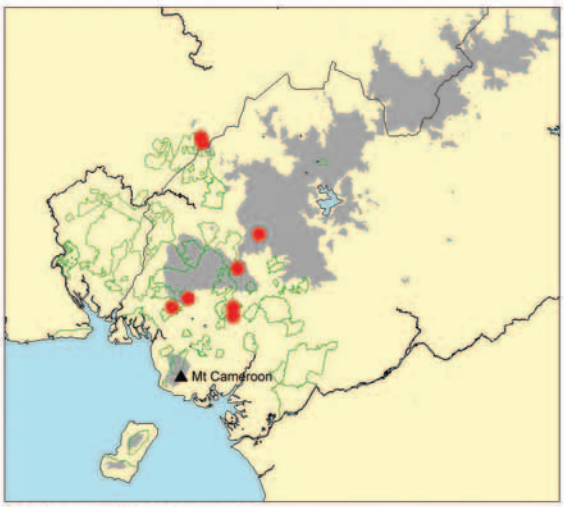
Poliolais lopezi (Sylviidae)



Urolais epichlora (Sylviidae)



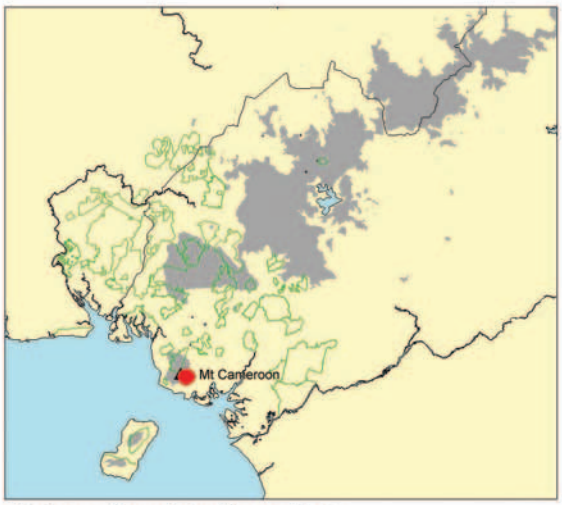
Cossypha isabellae (Turdidae)



Kupeornis gilberti (Timaliidae)

Figure 12 continued.

Speirops brunneus (Zosteropidae)



Speirops melanocephalus (Zosteropidae)

Figure 12 continued.

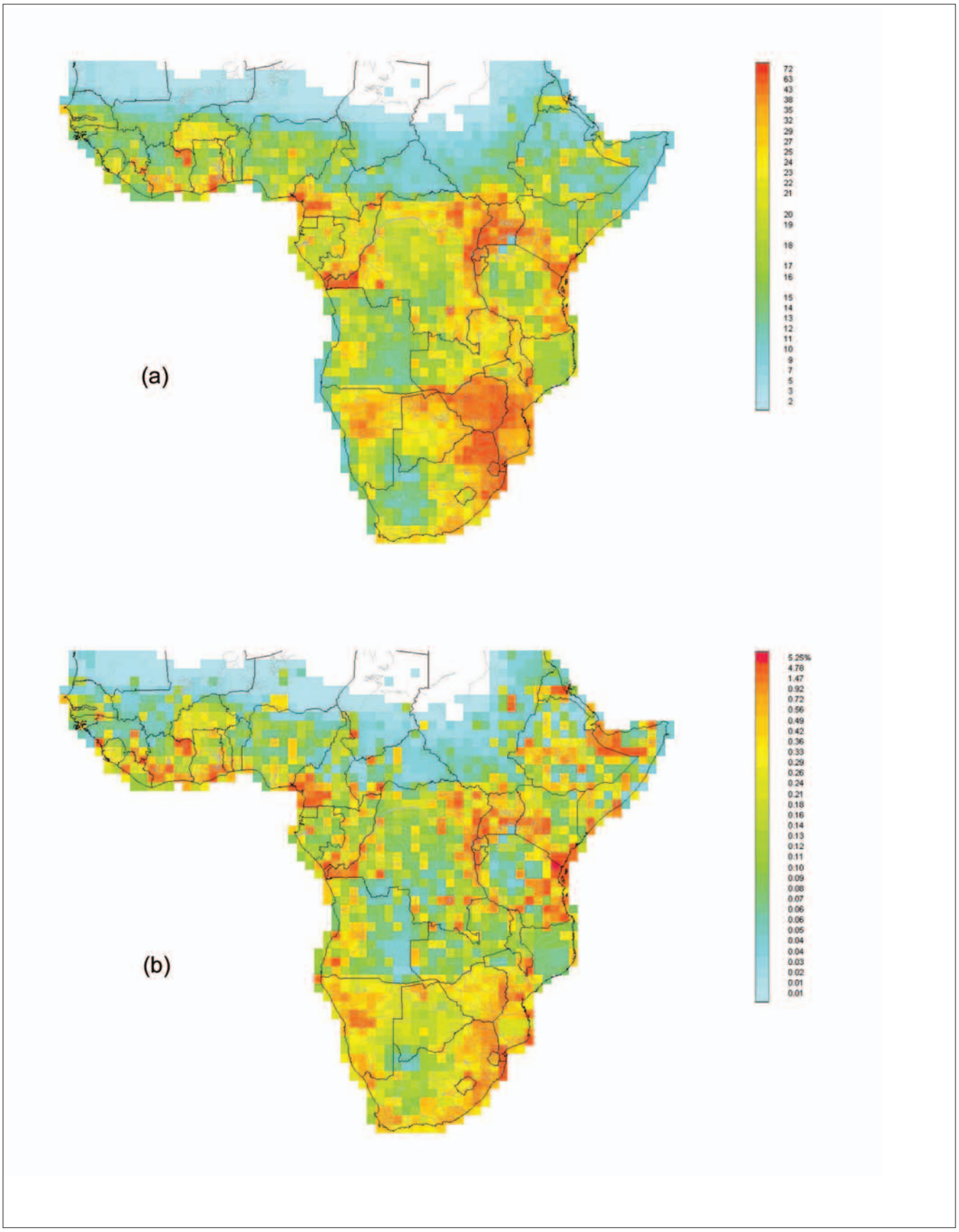


Figure 13. Snake species (a) richness and (b) inverse range size rarity (endemism) in sub-Saharan Africa. Data from the Zoological Museum, University of Copenhagen (ZMUC) database. Maps generated using WORLDMAP (Williams 2001).

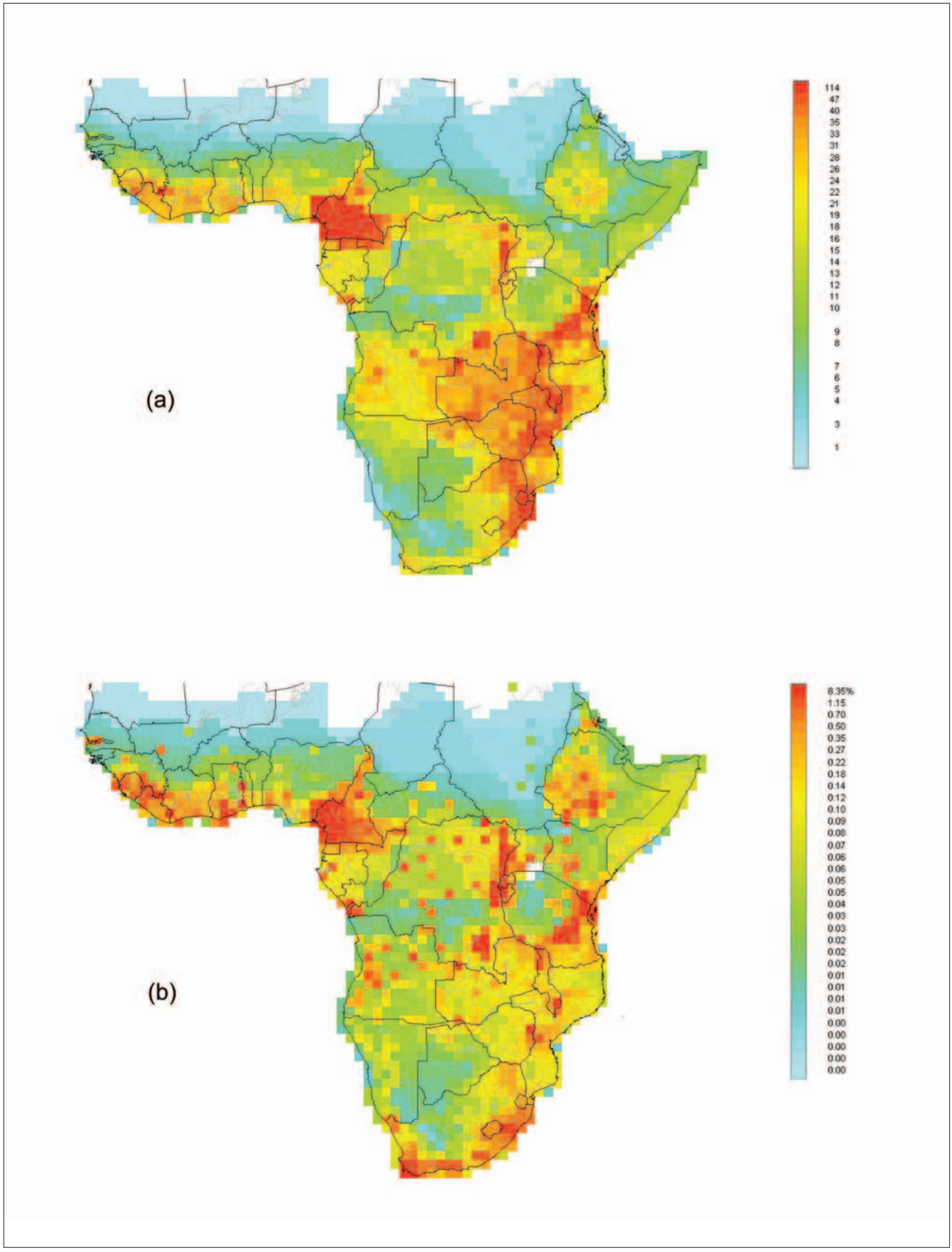


Figure 14. Amphibian species (a) richness and (b) inverse range size rarity (endemism) in sub-Saharan Africa. Data from the Zoological Museum, University of Copenhagen (ZMUC) database. Maps generated using WORLDMAP (Williams 2001).

Table 4. Anuran amphibian species either completely or mostly restricted to the Nigeria-Cameroon border region, based on ZMUC/WORLDMAP data and our own research (list may be partial). Species known to occur in a few sites outside the region are indicated with an asterisk.

Family	Species
Arthroleptidae	**Cardioglossa elegans*
	C. melanogaster
	C. nigromaculata
	C. oreas
	C. pulchra
	C. schioetzei
	C. trifasciata
	C. venusta
	Astylosternus diadematus
	A. fallax
	A. laurenti
	A. montanus
	A. nganhanus
	A. perreti
	A. ranoides
	A. rheophilus
	A. schioetzi
	Leptodactylon axillaris
	L. bicolor
	L. boulengeri
	L. erythrogaster
	L .mertensi
	L. ornatus
	L. perreti
	L. polyacanthus
Bufonidae	*B. villiersi*
	Didynamipus sjostedti
	Werneria bambutensis
	**W. mertensi*
	**W. preussi*
	W. tandyi
	Wolterstorffina mirei
	**W. parvipalmata*
Hyperolidae	*Afrixalus lacteus*
	A. schneideri
	Arlequinus krebsi
	Hyperolius adametzi
	H. bopeleti
	H. koelheri
	H. riggenbachi
Pipidae	*Xenopus amieti*
	X. longipes
Ranidae	*Conraua robusta*
	Petropedetes cameronensis
	**P. parkeri*
	P. perreti
	Phrynobatrachus cricogaster
	P. manengoubensis
	**P. steindachneri*
	P. werneri
	Hylarana asperrima

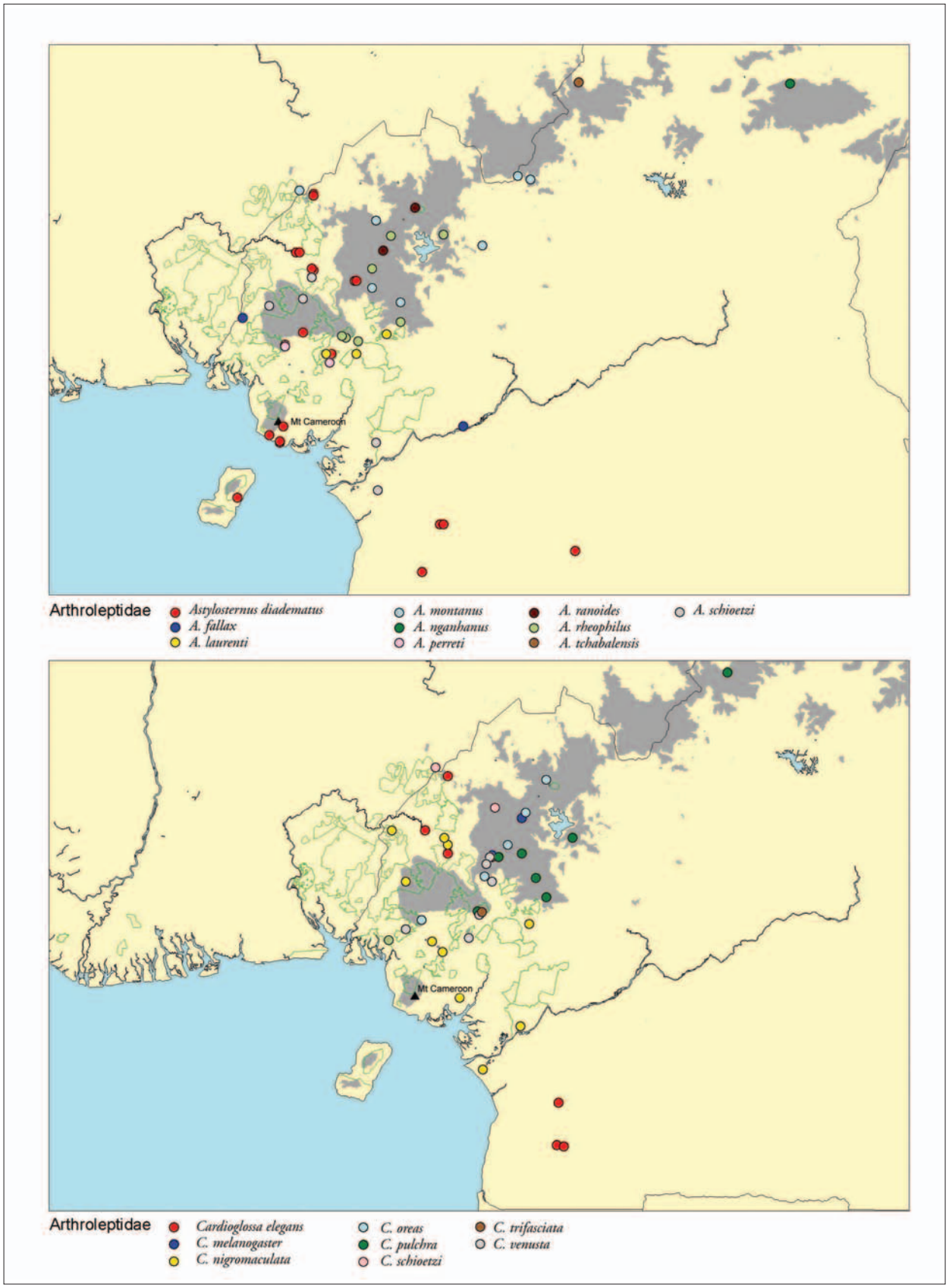
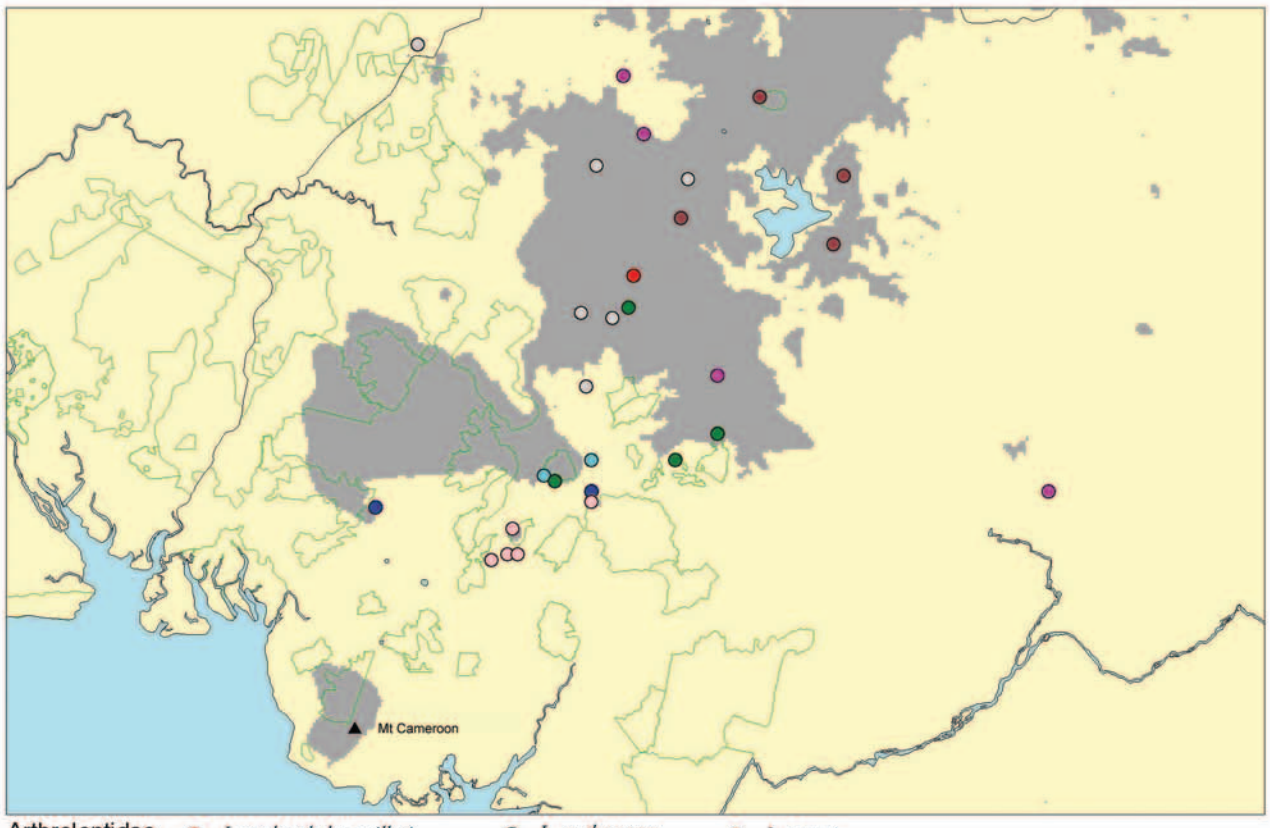


Figure 15. Point locality maps for anuran amphibian species endemic to the study region. Existing and proposed protected areas and reserves shown in green. Land above 1,200 m shown in gray. See text for sources of data. Figure continues on pp. 53–56.



Xenopus amieti (Pipidae)

X. longipes (Pipidae)

Figure 15 continued.

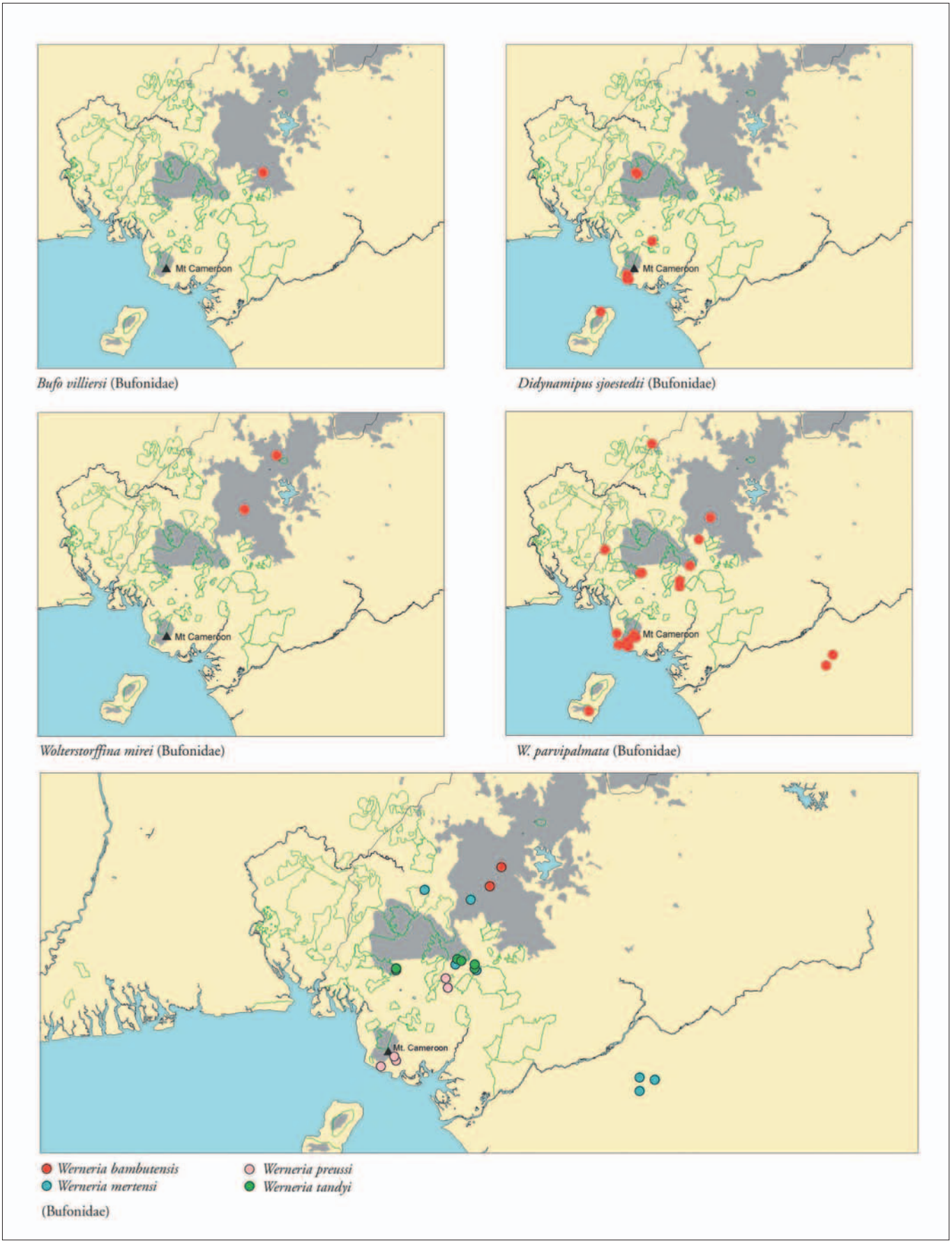
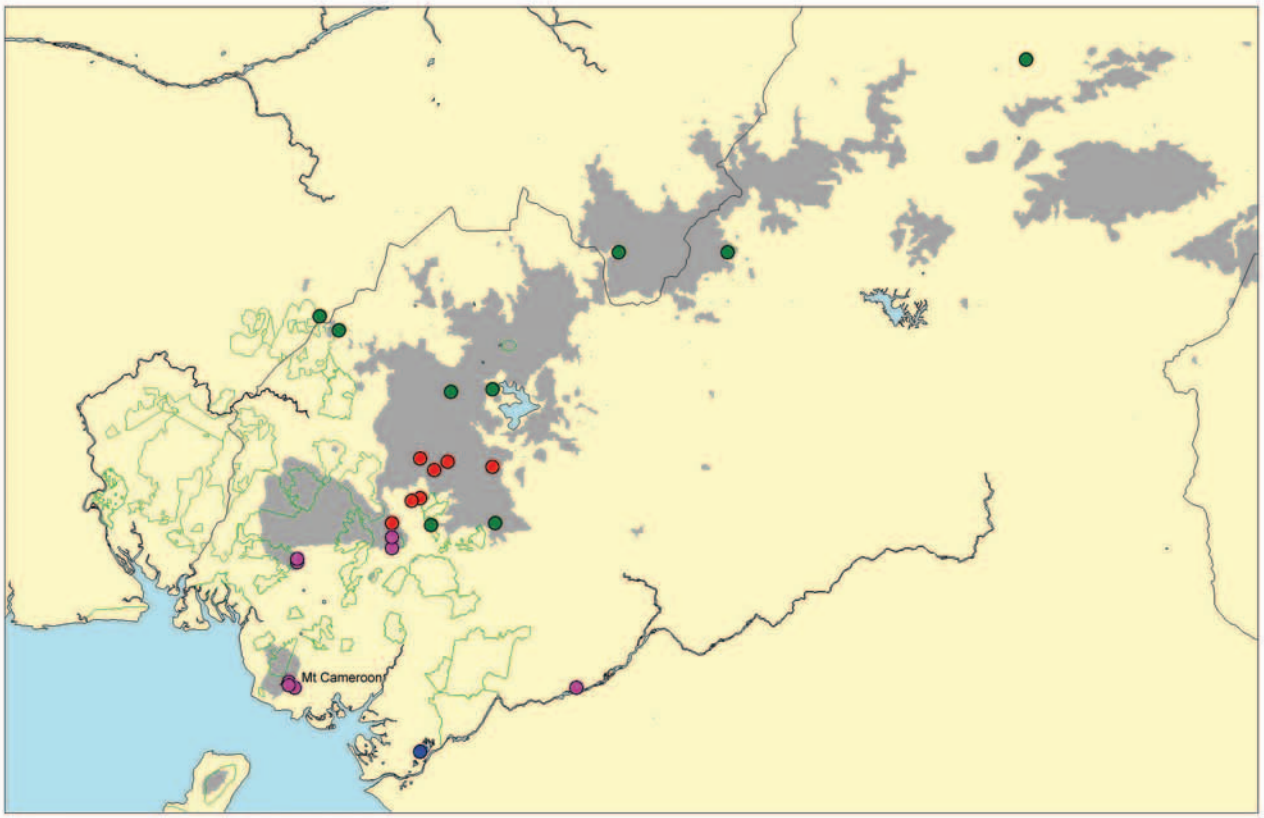
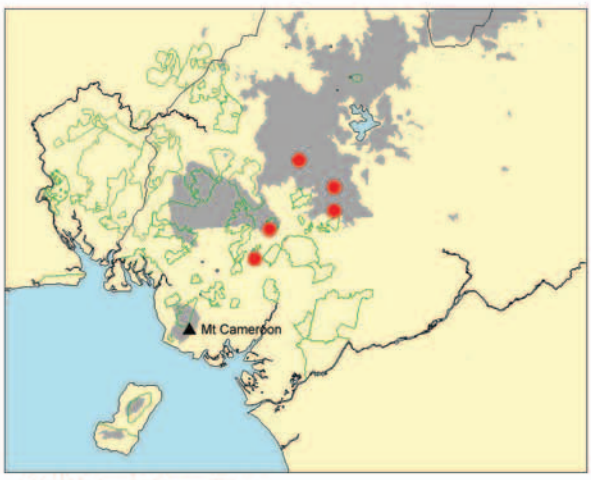


Figure 15 continued.





Afrixalus lacteus (Hyperolidae)

A. schneideri (Hyperolidae)

Figure 15 continued.

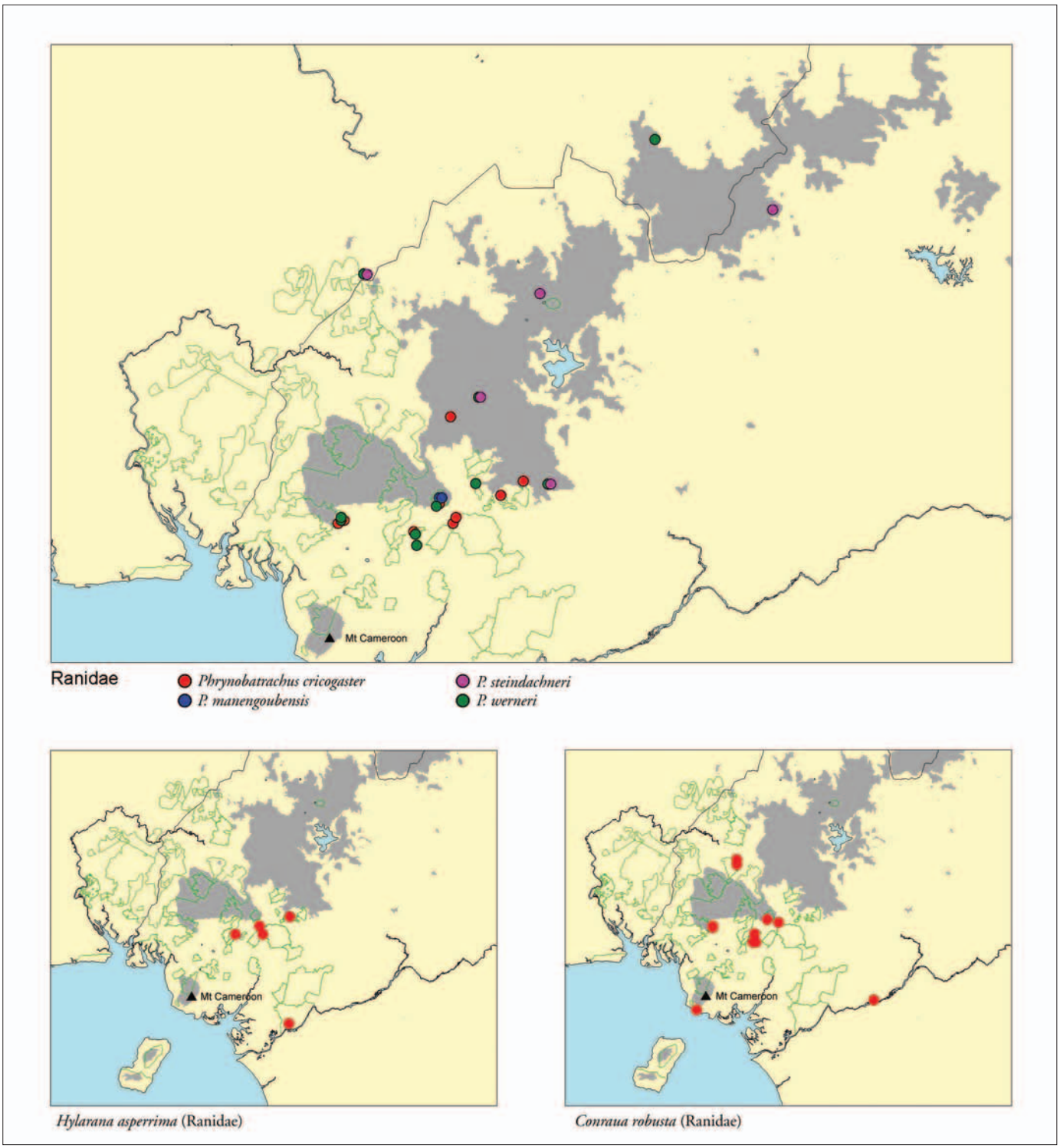


Figure 15 continued.

Table 5. Butterflies of the Korup and Cross River National Parks (Okwangwo and Oban), not including the Rumpi Hills (from Larsen 1997c).

	Korup	Oban Hills	Okwangwo*
Larsen expeditions 1995/97	400	650	600
Ever recorded from area	477	775**	620
Estimated total for area	990	1,000	950

*Including about 60 submontane species from the Obudu Plateau.
**Museum studies would probably add another 25–50 confirmed species.
NOTE: The joint total known from CRNP (Oban and Okwangwo) is 920, with an estimated total of 1,100.

Table 6. Butterfly species and subspecies endemic to the Cameroon-Nigeria highlands including the Obudu Plateau (from Larsen 1997b).

Taxon	Known distribution
Endemic species	
Liptena boei	Mt. Tabenken only
Liptena priscilla	Obudu only
Capys bamendanus	Bamenda, but perhaps widespread
Uranothauma frederikkae	Obudu, many mountains
Bicyclus anisops	Obudu, many mountains
Charaxes obudoensis	Obudu, many mountains
Charaxes tectonis	Obudu, many mountains
Charaxes musakensis	Mt. Cameroon only
Euriphene bernaudi	Obudu and Rumpi Hills
Pseudathyma legeri	Obudu only
Pseudacraea annakae	Obudu, Mambilla, and Mbam
Gorgyra sp.	Obudu only
Ceratrichia sp.	Obudu only
Chondrolepis nero	Obudu, many mountains
Endemic subspecies	
Papilio rex schultzei	Obudu/Atlantika
Papilio charopus charopus	Many mountains
Papilio zoroastres zoroastres	Not in Nigeria
Colias electo manengoubensis	Many mountains
Colotis elgonensis glauningi	Many mountains
Belenois zochalia connexiva	Many mountains
Mylothris jacksoni knutsoni	Many mountains
Mylothris yulei bansoana	Many mountains
Iolaus bansana bansana	Not in Nigeria
Eicochrysops ?unigemmata sangba	Obudu/Sangba
Abisara neavei latifasciata	Many mountains
Tirumala formosa morgeni	Many mountains
Amauris echeria occidentalis	Many mountains
Aphysanota scapulifascia occidentalis	Mambilla/Cameroon
Bicyclus saussurei camerunia	Mambilla/Cameroon
Ypthima albida occidentalis	Many mountains
Neptis occidentalium batesi	Not yet in Nigeria
Neptis ochracea milbraedi	Many mountains
Antanartia dimorphica mortoni	Many mountains
Acraea wigginsi occidentalium	Not yet in Nigeria
Acraea obliqua obliqua	Many mountains

Table 7. Species of large trees restricted to the Nigeria-Cameroon border region, or with their range centered within this region, and mapped in this project. List compiled from Cable and Cheek (1998) and our own research.

Family	Species
Anacardiaceae	*Sorindeia mildbraedii*
	S. nitidula
	Trichoscypha abut
	T. mannii
	T. preussii
Annonaceae	*Uvariastrum zenkeri*
	Uvariodendron connivens
	U. fuscum
Apocynaceae	*Tabernaemontana contorta*
Caricaceae	*Cylicomorpha solmsii*
Ericaceae	*Aguaria salicifolia*
Euphorbiaceae	*Drypetes preussii*
	D. staudtii
	Hamilcoa zenkeri
	Macaranga occidentalis
Flacourtiaceae	*Oncoba lophocarpa*
	O. ovalis
Guttiferae	*Garcinia conrauna*
	G. densivenia
	G. staudtii
Huaceae	*Afrostyrax kamerunensis*
Leguminosae, Caesalpinioideae	*Anthonotha leptorrhachis*
	Brachystegia cynometroides
	Crudia bibundina
	Daniellia oblonga
	Loesenera talbotii
	Microberlinia bisulcata
Leguminosae, Mimosoideae	*Calpocalyx winkleri*
Leguminoseae, Papilionoideae	*Andira inermis* (subsp. *inermis)*
	Baphia leptostemma (var. *gracilipes*)
Loganiaceae	*Strychnos elaeocarpa*
	S. gnetifolia
Moraceae	*Ficus chlamydocarpa* (subsp. *chlamydocarpa*)
Myricaceae	*Myrica arborea*
Podocarpaceae	*Podocarpus mannii*
Rubiaceae	*Aidia rhacodosepala*
	Cuviera wernhamii
	Ixora foliosa
	Pausinystalia talbotii
	S. gnetifolia
	Pavetta hookeriana
	Psydrax dunlapii
Rutaceae	*Oricia trifoliata*
	S. gnetifolia
Sapindaceae	*Allophylus bullatus*
	Lychnodiscus grandifolius
Sterculiaceae	*Leptonychia pallida*
	Mansonia altissima (var**.** *kamerunica*)
	Scaphopetalum cf. *zenkeri*
Vochysiaceae	*Korupodendron songweanum*

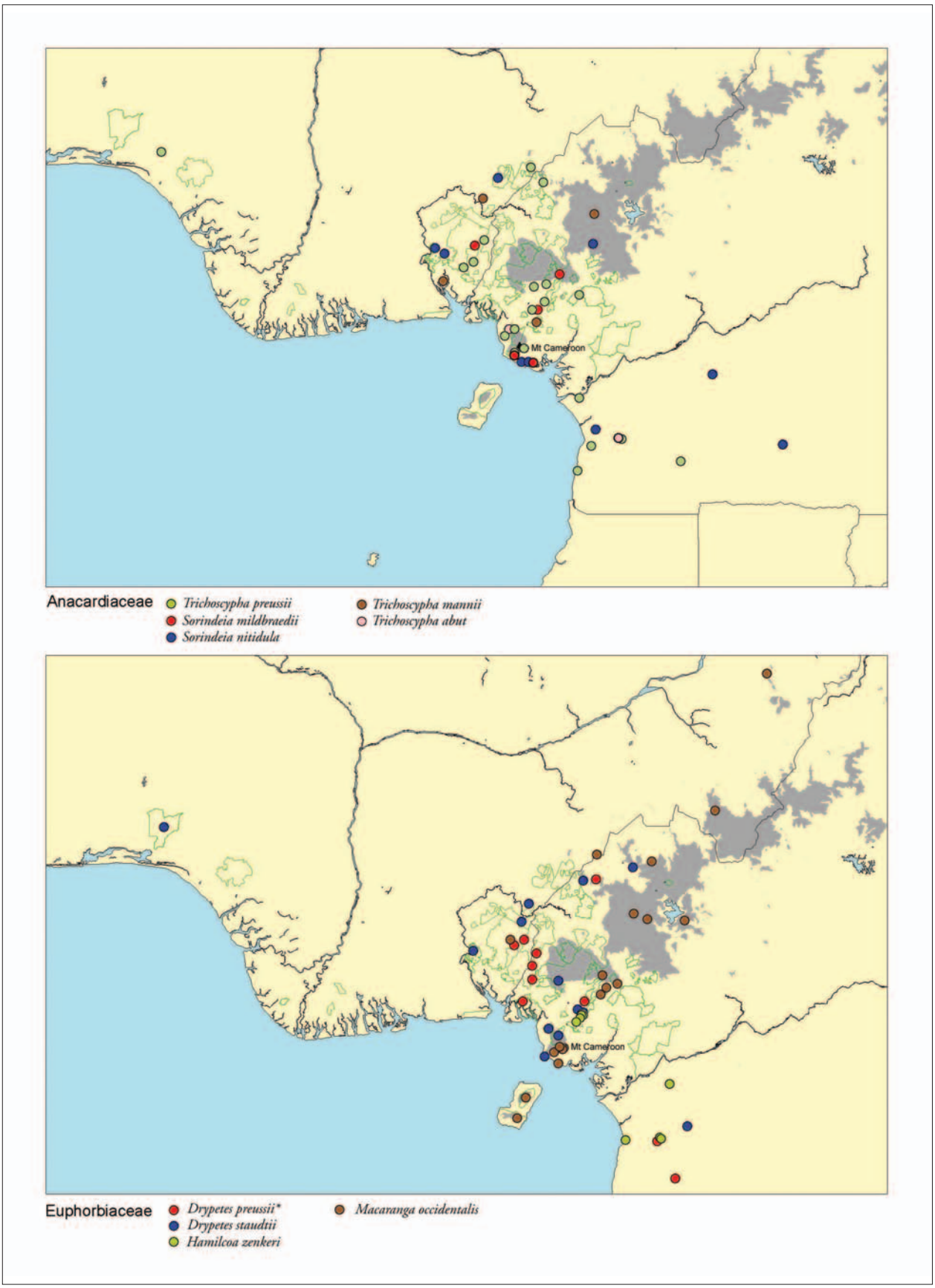
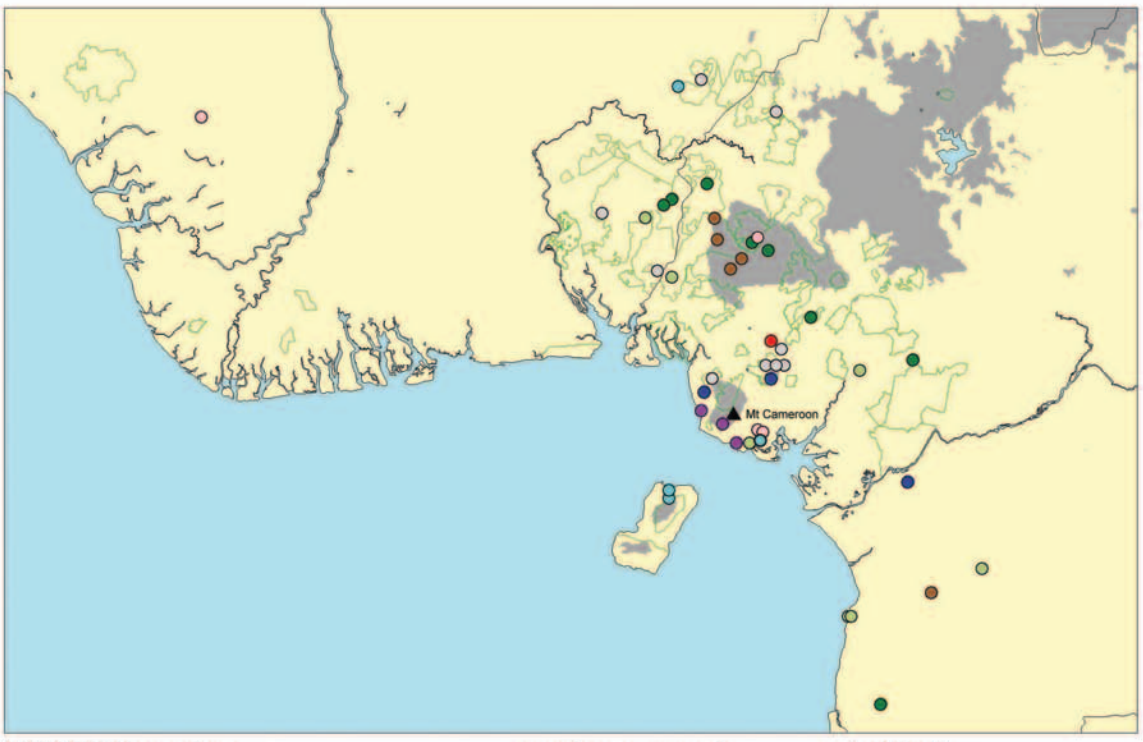


Figure 16. Point locality maps for tree species endemic in the study region. Taxa marked with an asterisk have unverified localities outside the map area. Existing and proposed protected areas and reserves shown in green. Land above 1,200 m shown in gray. See text for sources of data. Figure continues on pp. 60–63.



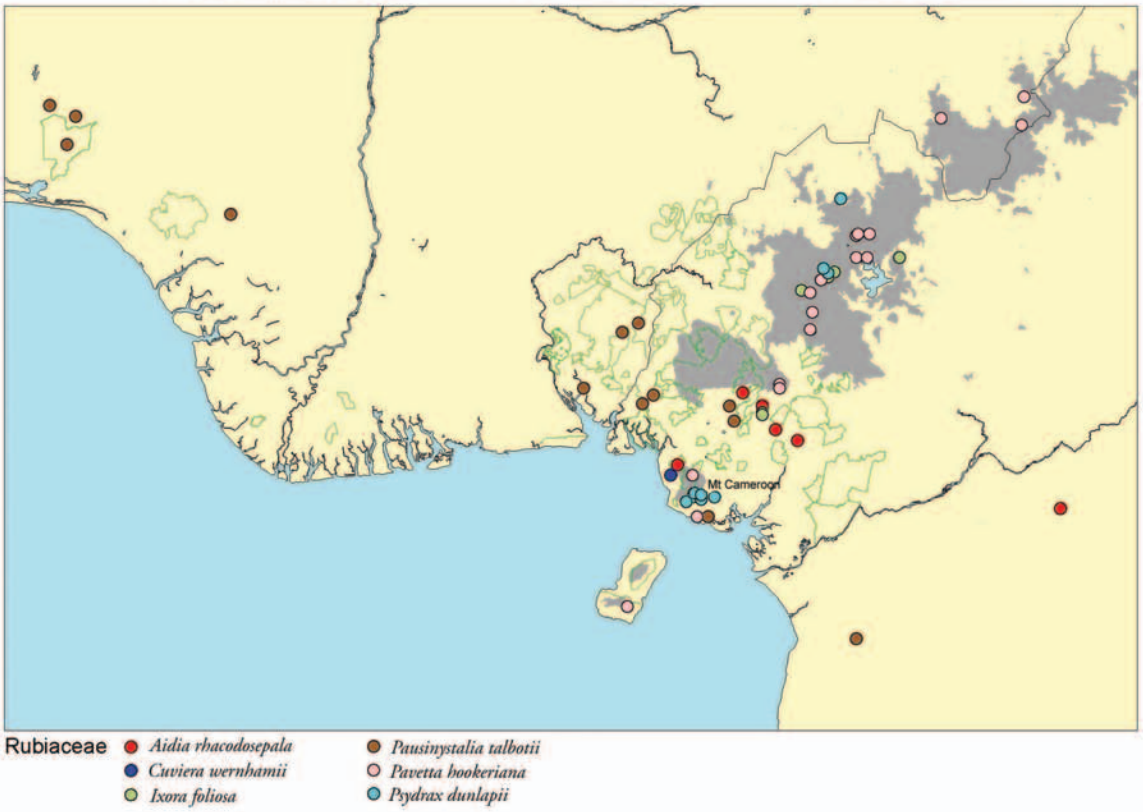


Figure 16 continued.

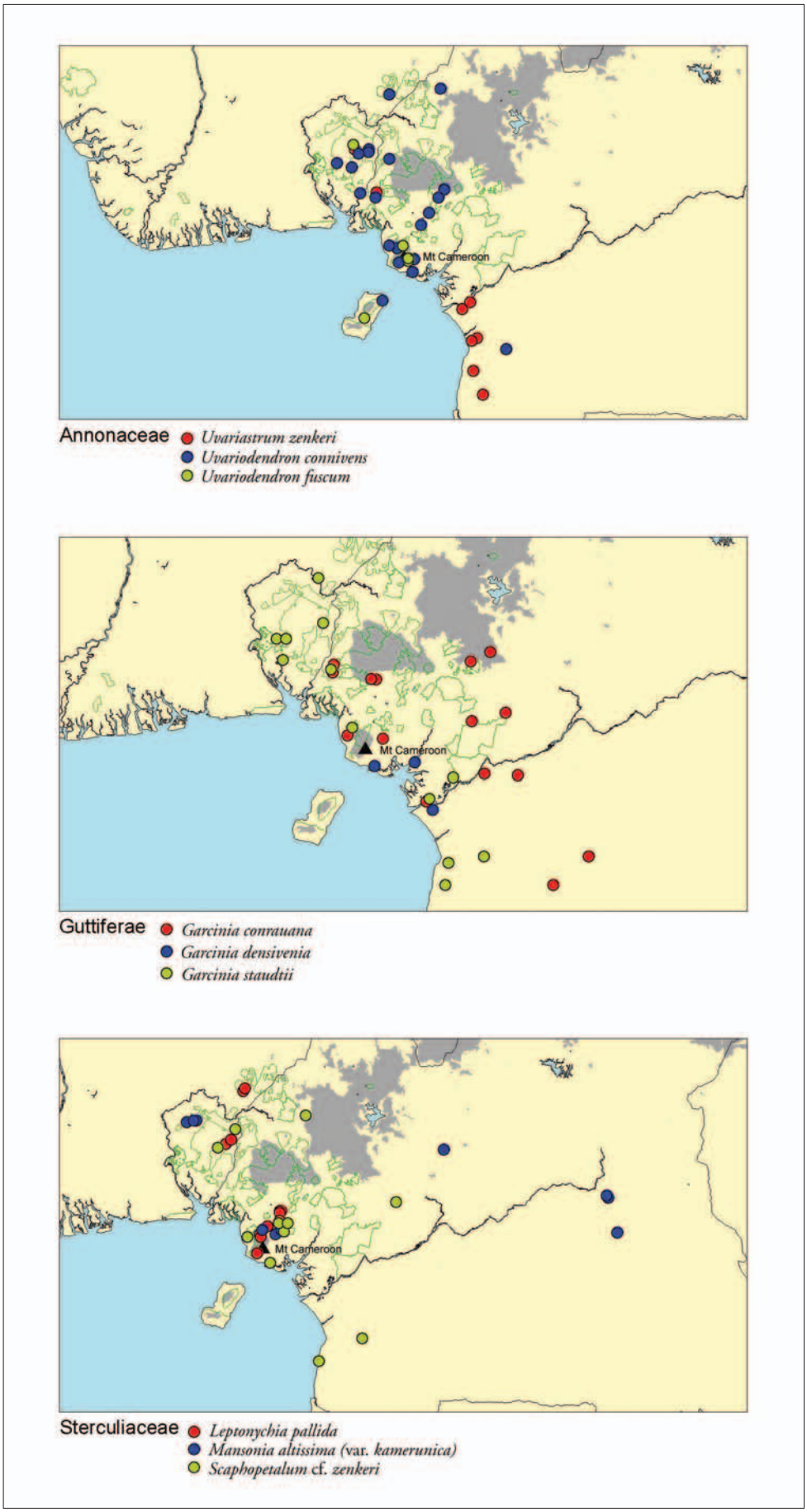
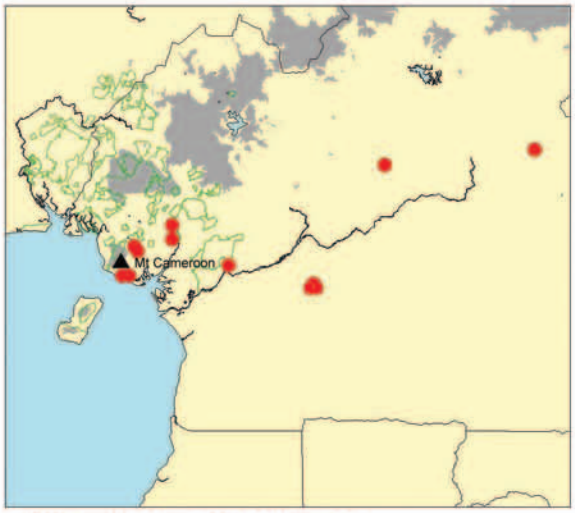
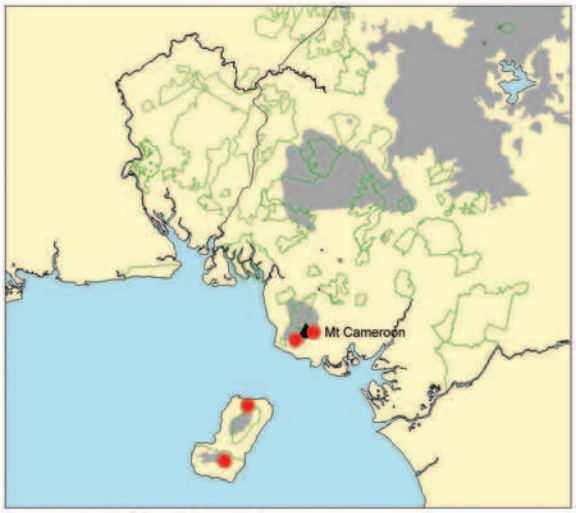


Figure 16 continued.



Tabernaemontana contorta (Apocynaceae)

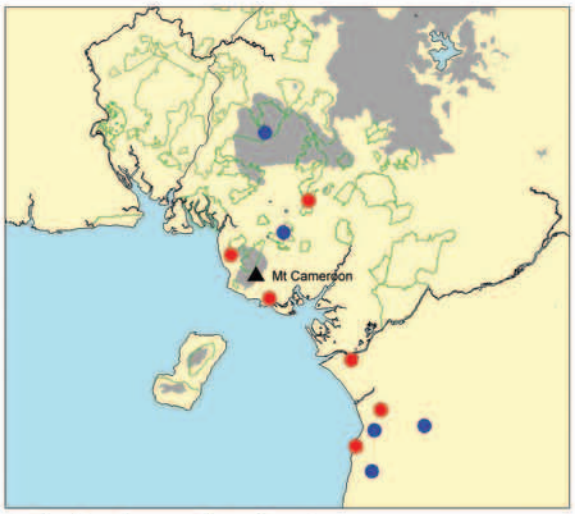
*Cylicomorpha solmsii** (Caricaceae)



Aguaria salicifolia (Ericaceae)

Oncoba lophocarpa (Flacourtiaceae)
Oncoba ovalis

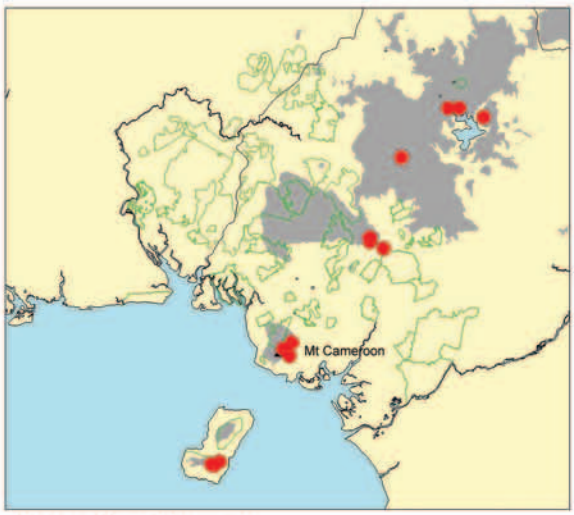
Afrostyrax kamerunensis (Huaceae)



Strychnos elaeocarpa (Loganiaceae)
Strychnos gnetifolia

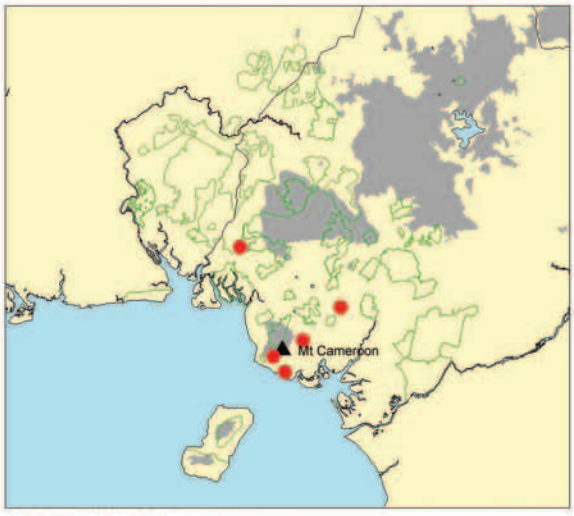
Figure 16 continued.

Ficus chlamydocarpa (Moraceae)

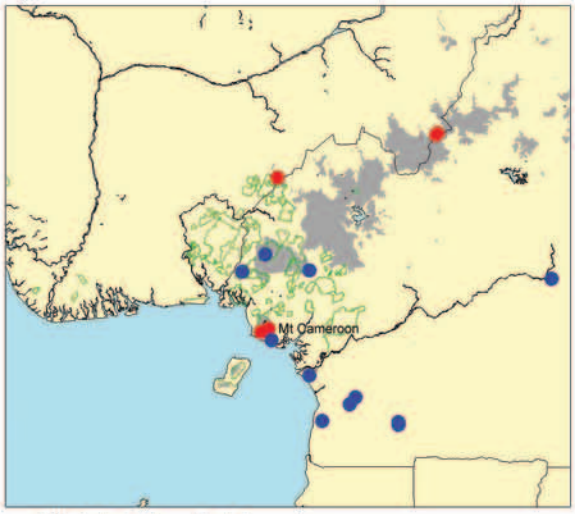


Myrica arborea (Myricaceae)

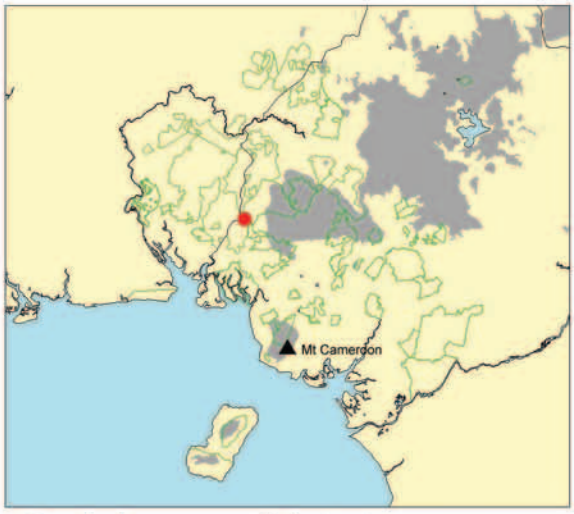
Podocarpus mannii (Podocarpaceae)



Oricia trifoliata (Rutaceae)



Allophylus bullatus (Sapindaceae)
Lychnodiscus grandifolius



Korupodendron songweanum (Vochysiaceae)

Figure 16 continued.

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