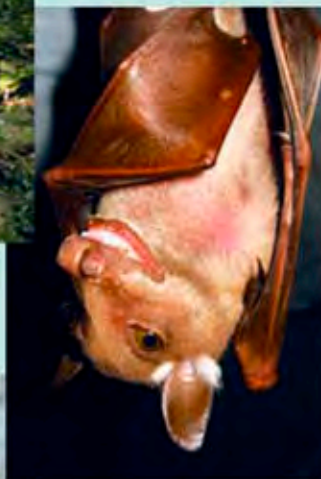
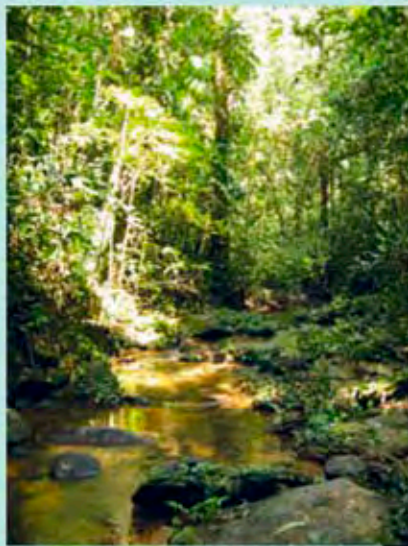


A Rapid Biological Assessment of North Lorma, Gola and Grebo National Forests, Liberia

Peter Hoke, Ron Demey and Alex Peal
(Editors)



RAP Bulletin of Biological Assessment 44

Center for Applied Biodiversity Science
(CABS)

Conservation International

Conservation International – Liberia

Forestry Development Authority (FDA)

Society for the Conservation of Nature
(SCNL)

University of Liberia

United Nations Mission in Liberia

United States Department of State

Rapid Assessment Program

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Organizational Profiles

CENTER FOR APPLIED BIODIVERSITY SCIENCE (CABS)

The Center for Applied Biodiversity Science (CABS), the scientific hub of Conservation International, works to link science and action to guide the conservation of nature worldwide.

Conservation initiatives have garnered significant political support in the last quarter century, as is evident in the international consensus around instruments such as the 1992 Convention on Biological Diversity. Political and economic support alone, however, is not enough to preserve the Earth's dwindling biodiversity. The conservation community can only be effective if it is equipped with clear goals, objectives, and strategies grounded in reliable and verifiable scientific research. There is still much to learn about the Earth's natural diversity, its role in ecosystem function and related services, and the most effective ways to preserve it.

Scientists at CABS work to fill these knowledge gaps. Founded in 1999 with generous support from the Gordon and Betty Moore Foundation, CABS brings together a staff of more than 70 research scientists who are highly respected in their fields and dedicated to saving our biodiversity.

CONSERVATION INTERNATIONAL

Conservation International (CI) is an international, non-profit organization based in Arlington, VA. CI's mission is to conserve the Earth's living natural heritage, our global biodiversity, and to demonstrate that human societies are able to live harmoniously with nature.

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CONSERVATION INTERNATIONAL – LIBERIA

Conservation International–Liberia has been working with the Government of Liberia and civil society organizations since 2002 to achieve its conservation goals. These include: working with the Government of Liberia to create a network of protected areas covering 1.5 million hectares of the remaining forest cover, strengthening and improving protected area and wildlife management; increasing awareness and public participation; enhancing livelihoods by fostering sustainable biodiversity use; and promoting good governance of Liberia's forest resources. CI–Liberia implements its strategy to conserve Liberia's biodiversity by creating partnerships, conducting scientific research, and improving human welfare.

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FORESTRY DEVELOPMENT AUTHORITY (FDA)

A 1976 Act of Legislature created the Forestry Development Authority (FDA) with responsibilities to effectively conserve and sustainably manage the forest resources of Liberia for its entire people. Among the primary objectives of the Authority are: (a) Establish a permanent forest estate made up of reserved areas upon which scientific forestry will be practiced; (b) Conduct essential research in forest conservation and pattern action programs upon the results of such research; (c) Give training in the practice of forestry; offer technical assistance to all those engaged in forestry activities; and spread knowledge of forestry and the acceptance of conservation of natural resources throughout the country;

(d) Conserve recreational and wildlife resources of the country concurrently with the development of forestry programs.

Forestry Development Authority
P.O. Box 10-3010
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LIBERIA

SOCIETY FOR THE CONSERVATION OF NATURE IN LIBERIA (SCNL)

SCNL is a non-governmental, non-profit conservation organization in Liberia. The organization was created in 1986 and has since worked to promote programs that influence the wise use of biological resources in Liberia, Africa and the world. Its mission is to manage and conserve biodiversity; increase public awareness of the importance of sustainable utilization of natural resources; improve livelihoods to alleviate poverty and work toward maintaining the integrity of the natural environment in Liberia.

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UNITED NATIONS MISSION IN LIBERIA (UNMIL)

The United Nations Mission in Liberia (UNMIL) was established by Security Council resolution 1509 (2003) of 19 September 2003 to support the implementation of the ceasefire agreement and the peace process; protect United Nations staff, facilities and civilians; support humanitarian and human rights activities; as well as assist in national security reform, including national police training and formation of a new, restructured military. UNMIL also has a mandate “to assist the transitional government in restoring proper administration of natural resources.” Under such mandate, UNMIL has been supporting Government’s various natural resources management programme/projects, including the provision of assistance in forest resource management and wildlife protection.

UNMIL Headquarters
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UNITED STATES DEPARTMENT OF STATE

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UNIVERSITY OF LIBERIA

The University of Liberia (UL), formerly Liberia College, was created in 1872. A president appointed by the President of the Republic, with oversight by a Board of Trustees, heads the University of Liberia. A Council and a Faculty Senate is responsible for the day-to-day management of the institution.

UL has three graduate schools – Regional Planning, Educational Administration and Supervision and the Ibrahim B. Bagagida School of International Studies. The UL also runs three specialized programs, the Louis Arthur Grimes School of Law, The A. M. Doglioti College of Medicine and the School of Pharmacy.

There are five undergraduate programs at the University of Liberia:

1. The Liberia College (College of Social Science and Humanities)
2. The William V. S. Tubman Teacher College
3. The William R. Tolbert, Jr. College of Agriculture and Forestry
4. The College of Business and Public Administration
5. The T. J. R. Faulkner College of Science and Technology

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Acknowledgments

Conservation International–Liberia and the entire RAP team would like to thank the United States Department of State for funding this expedition. We also thank the Government of Liberia and the Forestry Development Authority (FDA), and in particular the Managing Director, D. Eugene Wilson, for their support and guidance.

We are extremely grateful for the logistical support that was provided by the United Nations Mission in Liberia (UNMIL); without it this expedition would have been impossible. During our meeting with Alan Doss, Special Representative to the Secretary General, it was apparent that he recognized the importance of Liberia's flora and fauna. He is well served by his advisors, Webby Bonali, Senior Advisor/Environment and Hiroko Mosko, Advisor/Environment. Both were instrumental in this project and in coordinating our movement throughout Liberia. Special thanks to Hiroko for her tireless efforts making sure that we made it safely to each of our destinations. At our sites in North Lorma and Grebo National Forests, Lt. Col. Syed Wajid Raza and his men of PAK BAT IV in Voinjama provided us with a safe environment to do our work. In Grebo, the UN staff at Fishtown and the Ethiopian Army assisted us. We are also grateful to the UN helicopter pilots and crew that safely and swiftly transported us to each of our survey sites.

We appreciate the generous hospitality of each of the communities that we stayed in prior to entering the forest. Chief Flomo Zuba of Luyema, Chief Seku Kamara of SLC and Superintendent Christian Chea of Jalipo welcomed us and facilitated the hiring of guides and assistants. We would like to thank the numerous guides, assistants and cooks that helped us during our visits.

The participants would like to thank all of the personnel at Conservation International–Liberia, in particular Tyler Christie, Zannah Sackie, Nat Walker, Amos Andrews, Jerry Brown, and Nyumeh Mensoh for organizing this survey in Liberia.

We thank Professor Blaydon of the University of Liberia for allowing the team use of botanical equipment, Fauna & Flora International–Liberia for the use of a vehicle and the University of Liberia for hosting the closing event where we presented our preliminary results. We would like to

recognize our colleagues in CI–Ghana for assisting with Ara Monadjem's travel through Accra for this survey. We also owe thanks to Mark Denil of CI's Conservation Mapping Program and Jennifer McCullough for her comments on the report.

The small mammal team would like to thank Mawolo Kpewor and Joshua Quawah for assistance in the field. The identification of shrews and murids by Rainer Hutterer (ZFMK) is much appreciated. Fritz Dieterlen (SMNS) and Wulf Gatter, Lenningen, kindly made available bat specimens collected in Liberia by the latter. Suzanne B. McLaren (CM) sent bat specimens on loan and the late Charles O. Handley, Jr. provided access to the mammal collections at the USNM. Jan Decher, University of Vermont, commented on a draft version of the manuscript. Analysis and publication of the data is part of the BIOLOG-program of the German Ministry of Education and Science (BMBF; project W09 BIOTA-West, 01 LC 0411).

Lastly, this was a logistically challenging RAP and we appreciate the patience of the scientists and assistants that participated. Despite difficult conditions at times, everyone kept a good attitude and worked hard to document Liberia's amazing biodiversity.

A RAPID BIOLOGICAL ASSESSMENT OF NORTH LORMA, GOLA AND GREBO NATIONAL FORESTS, LIBERIA

Expedition Dates

13 November – 11 December 2005

Area Description

North Lorma National Forest consists of seasonal moist evergreen and semi-deciduous forest and some open riverine forest habitat. It is situated in northwestern Liberia near the border with Guinea and lies between the Wologizi and the Wonegizi Mountains. Many smaller streams were present within a slightly hilly landscape. Further from the river but at a higher elevation the vegetation quickly changed to lower forest with large scattered trees. This site had the least amount of disturbance with the presence of an old overgrown logging road the only noticeable sign.

Gola National Forest is also seasonal moist evergreen and semi-deciduous forest and is situated between the Gola Strict Nature Reserve in Sierra Leone and Kpelle National Forest in Liberia. The terrain has steep slopes with small, rocky streams and the vegetation was dense in most areas although large lianas were present. Illegal small-scale diamond mining was observed just inside the forest.

Grebo National Forest is a wet evergreen forest situated in the southeast of the country and is contiguous with the Forêt Classée du Cavally in Côte d'Ivoire. It consists of mature secondary forest that is open with isolated huge trees. Aquatic sites within the area were medium sandy streams with a few stones and rocks as well as large ponds. Logging occurred in this area roughly twenty years ago.

Reason for the Expedition

This survey was part of the larger Liberia Forest Initiative (LFI), an initiative supporting efforts to rehabilitate and reform the forest sector in Liberia and harmonize activities associated with these efforts. In addition to collecting data on the sites to strengthen and expand conservation efforts in Liberia, the RAP survey worked to build scientific capacity within the FDA, University of Liberia and local NGOs. Efforts were also made to increase the Liberian public's awareness of their rich flora and fauna.

Major Results

	All RAP sites in this survey	North Lorma	Gola	Grebo
Number of species recorded	969	526	486	520
Species of conservation concern	60	29	27	41
New species discovered	6	—	5	4
New records for Liberia	18	7	7	3
Species endemic to Upper Guinea	147	61	81	70

Number of Species Recorded:

Plants	548 species
Dragonflies & damselflies	93 species
Amphibians	At least 40 species
Reptiles	17 species
Birds	211 species
Bats	22 species
Small terrestrial mammals	9 species
Large mammals	29 species

New Species Discovered:

Plants (3)	
	<i>Drypetes</i> sp. nov.
	<i>Leptoderris</i> sp. nov.
	<i>Rhaphiostylis</i> sp. nov.
Dragonflies and damselflies (1)	
	<i>Eleuthemis</i> sp. nov.
Amphibians (1?)	possibly <i>Phrynobatrachus</i> cf. <i>annulatus</i>
Bats (1?)	possibly <i>Neoromicia</i> aff. <i>grandidieri</i>

New Records for Liberia:

Plants (3)	
	<i>Elytraria ivorensis</i>
	<i>Gardenia nitida</i>
	<i>Zanthoxylum psammophilum</i>
Dragonflies and damselflies (7)	
	<i>Nesciothemis minor</i>
	<i>Palpopleura deceptor</i>
	<i>Palpopleura portia</i>
	<i>Paragomphus nigroviridis</i>
	<i>Tetrathemis polleni</i>
	<i>Tramea limbata</i>
	<i>Trithemis monardi</i>
Amphibians (5)	
	<i>Africalus nigeriensis</i>
	<i>Astylosternus occidentalis</i>
	<i>Bufo superciliaris</i>
	<i>Chiromantis rufescens</i>
	<i>Phrynobatrachus villiersi</i>
Bats (3)	
	<i>Neoromicia</i> aff. <i>grandidieri</i>
	<i>Neoromicia guineensis</i>
	<i>Rhinolophus landeri</i>

Species of Conservation Concern:

Dragonflies and damselflies (2)	
	<i>Sapho fumosa</i> (NT)
	<i>Trithemis africana</i> (NT)
Amphibians (17)	
	<i>Amnirana occidentalis</i> (EN)
	<i>Phrynobatrachus annulatus</i> (EN)
	<i>Phrynobatrachus</i> cf. <i>annulatus</i> (EN)
	<i>Conraua alleni</i> (VU)
	<i>Phrynobatrachus villiersi</i> (VU)
	<i>Africalus nigeriensis</i> (NT)
	<i>Bufo togoensis</i> (NT)
	<i>Hyperolius chlorosteus</i> (NT)
	<i>Leptopelis macrotis</i> (NT)
	<i>Leptopelis occidentalis</i> (NT)
	<i>Petropedetes natator</i> (NT)
	<i>Phrynobatrachus alleni</i> (NT)
	<i>Phrynobatrachus guineensis</i> (NT)
	<i>Phrynobatrachus liberiensis</i> (NT)
	<i>Phrynobatrachus phyllophilus</i> (NT)
	<i>Ptychadena superciliaris</i> (NT)
	<i>Bufo superciliaris</i> (CITES I)
Reptiles (5)	
	<i>Osteolaemus tetraspis</i> (CITES I)
	<i>Kinixys eros</i> (CITES II)
	<i>Kinixys homeana</i> (CITES II)
	<i>Python sebae</i> (CITES II)
	<i>Varanus ornatus</i> (CITES II)
Birds (14)	
	<i>Malimbus ballmanni</i> (EN)
	<i>Agelastes meleagrides</i> (VU)
	<i>Bleda eximius</i> (VU)
	<i>Criniger olivaceus</i> (VU)
	<i>Lobotos lobatus</i> (VU)
	<i>Melaenornis annamarulae</i> (VU)
	<i>Picathartes gymnocephalus</i> (VU)
	<i>Bathmocercus cerviniventris</i> (NT)
	<i>Bycanistes cylindricus</i> (NT)
	<i>Ceratogymna elata</i> (NT)
	<i>Illadopsis rufescens</i> (NT)
	<i>Lamprotornis cupreocauda</i> (NT)
	<i>Malaconotus lagdeni</i> (NT)
	<i>Melignomon eisentrauti</i> (DD)

Bats (5)*Rhinolophus hillorum* (VU)*Hipposideros fuliginosus* (NT)*Scotonycteris zenkeri* (NT)*Hypsugo (crassulus) bellieri* (n.a.)*Neoromicia aff. grandidieri* (n.a.)**Large Mammals (17)***Hexaprotodon liberiensis* (EN)*Cercopithecus diana* (EN)*Pan troglodytes verus* (EN)*Piliocolobus badius* (EN)*Loxodonta africana cyclotis* (VU)*Cephalophus jentinki* (VU)*Syncerus caffer* (LR/cd)*Cephalophus dorsalis* (LR/nt)*Cephalophus maxwelli* (LR/nt)*Cephalophus niger* (LR/nt)*Cephalophus ogilbyi* (LR/nt)*Cephalophus silvicultor* (LR/nt)*Cercocebus atys* (LR/nt)*Colobus polykomos* (LR/nt)*Procolobus verus* (LR/nt)*Tragelaphus euryceros* (LR/nt)*Panthera pardus* (CITES I)

The IUCN Red List categorizes species based on the degree to which they are threatened. Categories, from less threatened to most threatened, include: Data Deficient (DD, not enough is known to make an assessment), Lower Risk (LR) which includes Conservation Dependent (cd), Near Threatened (nt), and Least Concern (lc, listed but not threatened), Vulnerable (VU), Endangered (EN), and Critically Endangered (CR) (IUCN 2006); n.a.: not assessed by IUCN but likely to be threatened.

CITES Appendices I, II and III list species afforded different levels or types of protection from over-exploitation (see <http://www.cites.org/eng/app/index.shtml>).

CONSERVATION RECOMMENDATIONS

North Lorma, Gola and Grebo National Forests all contain a wealth of biodiversity and a significant number of species of conservation concern and each qualifies as an Important Bird Area. Large numbers of the recorded species are restricted to the forests of Upper Guinea. Over 40% of the remaining Upper Guinea forest lies within Liberia and it includes several large tracts of contiguous forest making these among the last refuges for large migrating mammals. For these reasons it is recommended to:

- Raise the status of Grebo National Forest to National Park. Grebo National Forest's close proximity to both Taï National Park in Côte d'Ivoire and Sapo National Park offers an opportunity to create a biological corridor between the two parks.
- Raise the status of North Lorma National Forest to National Park. It is suggested that Wonegizi and Wologizi Mts. also be included in such a park and that the area should be contiguous to the Biosphere Reserve of the Massif du Ziama in Guinea.
- Raise the status of Gola National Forest to National Park and create a transboundary biological corridor with the Gola Forest in Sierra Leone.
- Create a mechanism within which all potential protected areas, especially Grebo, North Lorma and Gola National Forests, can be given blanket protective coverage to allow time for gradual biological, socio-economic and other relevant studies to occur.
- Involve all stakeholders, especially local communities, at an early stage in an open, transparent manner, when establishing forest management plans for these sites.

Executive Summary

INTRODUCTION

Liberia lies entirely within the Upper Guinea forest region that stretches from Guinea to Togo and is part of the Guinean Forests of West Africa Hotspot, making it one of the 34 biologically richest and most endangered terrestrial ecoregions in the world (see map, Myers et al. 2000, Mittermeier et al. 2004). The remaining forests in this region contain exceptionally diverse ecological communities, distinctive flora and fauna, and a mosaic of forest types providing refuge to a number of endemic species (McCullough 2004).

At the Upper Guinean Forest Priority-Setting Workshop in 1999, Gola National Forest and Grebo National Forest were ranked as being ‘exceptionally high’ and North Lorma National Forest as ‘very high’ conservation priority areas (Bakarr et al. 2001). Since more than 40% of forest remaining in this hotspot is located in Liberia (Bakarr et al. 2004), the country is key to protecting what is left of the region’s fragmented forests.

Historically, Liberia’s 9.6 million hectares were completely forested; however, only 36% remains as intact closed forest (2.4 million hectares) or as open forest (1 million hectares) with evidence of recent logging (Bayol and Chevalier 2004). An additional 24% has been altered by agriculture of which nearly 10% is potentially suitable for sustainable forestry. The estimated annual deforestation rates of 1.6% between 1990-2000 and 1.8% between 2000–2005 are higher than that of the total Upper Guinea forest region (1.4% and 1.6%) (FAO 2005).

A large portion of Liberia’s forest lies in two large blocks: the evergreen lowland forest in the southeast and the semi-deciduous montane forests in the northwest. Overall, little is known about the country’s flora and fauna since few studies have been conducted here.

Liberia currently has two protected areas: Sapo National Park (created in 1983) located in the lowland rainforests of southeastern Liberia and East Nimba Nature Reserve (created in 2003) located in the highest elevations of northeastern Liberia. Prior to the civil war (1989-2003), Sapo National Park was well managed and destined to be the model for all of Liberia’s future parks. However, the long war eroded infrastructure and restricted management. Since the end of the war, a concerted effort has been put forth to re-establish conservation, restore the current protected areas and promote sustainable forest management (Waitkuwait and Suter 2001, 2002; Whiteman 2004). In 2002, Conservation International (CI) signed a Memorandum of Understanding (MoU) with the Government of Liberia which proposed seven conservation areas to form the basis of a Liberian protected area network (Conservation International 2002). This would increase the area under protection from 0.2% to 10.6% (Bayol and Chevalier 2004). As Liberia emerges from 14 years of civil war, there will be tremendous pressure on the natural resources to develop the economy (ITTO 2006). A balance between the needs of Liberians and those of their region’s imperiled flora and fauna will need to be achieved.

RAP EXPEDITION OVERVIEW AND OBJECTIVES

Conservation International’s Rapid Assessment Program (RAP) was created in 1990 to rapidly provide biological information needed to catalyze conservation action and improve biodiversity

protection. From November 19 to December 11, 2005, RAP collaborated with CI's Liberia field office and West Africa Program to carry out a biodiversity survey of three sites in Liberia: 1) North Lorma National Forest in the northwest, 2) Gola National Forest in the northwest, and 3) Grebo National Forest in the southeast. These areas still contain large blocks of contiguous low to medium elevation forest and it was deemed important to survey the biodiversity of these areas in order to make recommendations regarding their protection and management.

The RAP survey was part of the larger Liberia Forest Initiative (LFI) which supports efforts to rehabilitate and reform the forest sector in Liberia and harmonize activities associated with these efforts (Whiteman 2004). In addition to collecting data on the sites to strengthen and expand conservation efforts in Liberia, the RAP team worked to build scientific capacity within Liberia's Forestry Development Authority (FDA), the University of Liberia, and local NGOs. Efforts were also made to increase the general public's awareness of their rich flora and fauna.

A RAP team of 21 international and host-country biologists and forestry managers surveyed plants, dragonflies and damselflies, amphibians and reptiles, birds and mammals. International scientists from Belgium, Germany, the Netherlands, Sierra Leone and Swaziland and Liberians from the FDA, the University of Liberia and the Society for the Conservation of Nature in Liberia (SCNL) participated in the study.

RESULTS BY SITE

Coordinates were taken with a Garmin eTrex Venture GPS, map datum WGS 84. See Table 1 for a summary of the number of species recorded at each site.

North Lorma National Forest (19–24 November 2005)

Site 1: 08° 01' 53.6" N 09° 44' 08.6" W

In 1959 the Government of Liberia created the 71,226 hectare North Lorma National Forest (UNEP-WCMC 2006a). It consists of seasonal moist evergreen and semi-deciduous forest. It is situated in northwestern Lofa County near the border with Guinea and constitutes an important forest corridor between the Wologizi and the Wonegizi Mountains. These two mountain ranges, which include Liberia's highest peak, Mt. Wutewe (1424 m), form the most important montane region in Liberia apart from Mt. Nimba. Annual precipitation at North Lorma is approximately 2500 mm and the annual mean temperature is 24.9°C (Chapter 5). Threats to the area include agriculture and hunting (Sambolah 2005).

The camp at Site 1 was situated next to the Lawa River in an open riverine forest habitat. Many smaller streams were present within a slightly hilly landscape. Further from the river, at a higher elevation, the vegetation quickly changed to lower forest with large scattered trees. This site had the least amount of disturbance with the presence of an old

overgrown logging road the only noticeable sign of previous human activity.

Significant findings:

- This was the richest site for plants with 266 plant species collected, of which 39 (15%) are endemic to Upper Guinea. One species, *Gardenia nitida*, is a new country record for Liberia. Many different vegetation types were found in close proximity to each other. Next to the Lawa River, species-rich wet forest quickly changed into dry forest and even into completely herbaceous vegetation uphill, whereas in lower areas it gradually changed into swamp forest. Although a logging road was discovered near the camp, logging did not appear to occur in the area.
- Species numbers of dragonflies and damselflies (Odonata) were relatively low due to the unfavorable season. However, the 58 species found are all representative of the Upper Guinean rainforest fauna. *Tetrathemis polleii* marked a new country record for Liberia.
- The recorded herpetofauna consisted of 18 amphibian species and six reptile species. One amphibian species is categorized as Endangered, one as Vulnerable and four as Near Threatened (IUCN 2006, Table 2). Most of these species were very abundant. One amphibian species and two reptile species are listed under CITES. Three amphibian species were new records for the country.
- At this site, 143 species of birds were recorded. Of these, eight are of global conservation concern with two species listed as Vulnerable, five as Near Threatened and one as Data Deficient (IUCN 2006, Table 2). Seven of the 15 restricted-range species (i.e. landbird species which have a global breeding range of less than 50,000 km²) that make up the Upper Guinea forests Endemic Bird Area (the area from Sierra Leone and southeast Guinea to southwest Ghana that encompasses the overlapping breeding ranges of restricted-range species, Stattersfield et al. 1998) were found during the study. The reserve holds an important proportion of the Upper Guinea endemics and qualifies as an Important Bird Area (IBA, see Birdlife International 2006 for more on IBAs).
- Seven species of bats were found that are restricted to good forest habitat including *Hipposideros fuliginosus*, categorized by IUCN as Near Threatened. A large cave system sheltering over a thousand *Rousettus aegyptiacus* was also found near this site.
- Of the 21 large mammal species recorded, 11 (52%) appear on the IUCN Red List (Table 2). Primates were seen daily and eight species were observed, including the nests of West African Chimpanzees. This was also the only site where African Buffalo was seen.

Gola National Forest (28 November – 4 December 2005)

Site 2: 07° 27' 09.9" N 010° 41' 33.2" W

SLC Village: 07° 26' 56.3" N 010° 39' 05.0" W

Gola National Forest was established in 1960 and covers 202,000 hectares (UNEP-WCMC 2006a). It is a seasonal moist evergreen and semi-deciduous forest and is situated in Gborpolu County between the Gola Strict Nature Reserve in Sierra Leone and Kpelle National Forest in Liberia. Annual precipitation at Gola is approximately 2700 mm and the annual mean temperature is 25.4°C (Chapter 5). Threats to the area include logging, hunting and diamond mining (Sambolah 2005).

Two camps were established. The main camp, Site 2, was located within mainly primary forest. The landscape had steep slopes with small, rocky streams. The vegetation was dense in most areas and some huge lianas were present. After it was found that the terrain and closed canopy was hindering sampling efforts for some taxonomic groups, a second camp was established in a clearing at the SLC village. The clearing was once the site of a Spanish Liberia Company (SLC) sawmill, which is now completely destroyed. Illegal small-scale diamond mining was observed just inside the forest.

Significant findings:

- In total, 200 plant species were identified, of which 53 (27%) are endemic to Upper Guinea, including three species endemic to Liberia (*Cephaelis micheliae*, *Trichoscypha linderi* and *Sericanthe adamii*). A large liana, *Zanthoxylum psammophilum*, not previously recorded west of eastern Côte d'Ivoire, constitutes a new record for Liberia. A *Rhaphiostylis* species likely to be new to science was also discovered. Three saprophytic plant species without chlorophyll were found next to each other at one location. These are not commonly seen and even more rarely in such close proximity.
- Seventy species of Odonata were collected, of which five are Upper Guinean endemics. Two, *Sapho fumosa* and *Trithemis Africana*, are of conservation concern and have a preliminary assessment of Near Threatened. Four species are new country records for Liberia (*Paragomphus nigroviridis*, *Phyllogomphus moundi*, *Palpopleura deceptor* and *Trithemis monardi*).
- Thirty amphibians and nine reptiles were recorded, including one Endangered, two Vulnerable and six Near Threatened amphibian species. Two reptile species are listed under CITES (Table 2). Two of the amphibian species constituted new country records for Liberia. The diversity of amphibians and reptiles was higher at this site than at the other two, but included more non-forest species, possibly because of the clearing of forest for diamond mining.
- In total, 145 bird species were found including six Upper Guinea Forest endemics. The Gola Malimbe *Malimbe ballmanni*, categorized as Endangered, was seen on most

days. One Vulnerable and four Near Threatened bird species were also noted (Table 2). This site qualifies as an Important Bird Area (IBA).

- A Vulnerable species of bat, *Rhinolophus hillorum*, with a restricted distribution and known from only a few specimens was found. Two additional species that were recorded, *Hypsugo (crassulus) bellieri* and *Neoromicia aff. grandidieri*, are restricted to West Africa, with the latter being a new record for Liberia, and possibly representing a species new to science. In total, 13 bat species and five terrestrial small mammals were noted, including the rarely reported Western Palm Squirrel *Epixerus ebii*.
- Of the 14 species of large mammals recorded, one is listed as Vulnerable and four as Lower Risk/Near Threatened (Table 2).

Grebo National Forest (7 – 11 December 2005)

Site 3: 05° 24' 10.4" N 007° 43' 56.2" W

Jalipo Village: 05° 22' 10.5" N 007° 46' 14.5" W

Grebo National Forest was created in 1960 and covers 260,326 hectares (UNEP-WCMC 2006a). It is a wet evergreen forest situated in the southeast of the country in River Gee County. It is contiguous with the Forêt Classée du Cavally and very close to Taï National Park, both in Côte d'Ivoire, but forest habitat is broken by a narrow strip of dense human settlement and farming on the Ivorian side next to the latter. Annual precipitation at Grebo is approximately 2500 mm and the annual mean temperature is 25.7°C (Chapter 5). Threats to the area include logging and hunting.

Two camps were again established to increase the sampling efforts for some taxonomic groups. The main camp, Site 3, was located in the forest along an old logging road, with a secondary camp at the forest edge in Jalipo Village. Site 3 was a former logging area left untouched for some twenty years and consisting of mainly open, mature secondary forest with isolated huge trees. Some medium-sized sandy streams with a few rocks occurred, as well as large ponds.

Significant findings:

- In total, 220 plant species were recorded, of which 37 (17%) are endemic to Upper Guinea, including a new country record for Liberia (*Elytraria ivorensis*). Two species, a *Drypetes* and a *Leptoderris* are likely to be new to science. The abundant presence of *Psychotria kwewonii* was interesting as it is a recently discovered species occurring in eastern Liberia and southwestern Côte d'Ivoire.
- Of the 63 Odonates collected two are Upper Guinean endemics. *Nesciothemis minor* is a new country record for Liberia.
- The herpetofauna diversity at this site was high, with 30 species of amphibians and six species of reptiles being identified. These consisted mainly of true forest species, with two Vulnerable, ten Near Threatened and possibly

one Endangered species (Table 2). Two reptile species are listed under CITES.

- Ten of the 156 bird species recorded are of global conservation concern, with five Vulnerable and five Near Threatened species (Table 2). Nine bird species are Upper Guinea endemics. Additionally, a number of rare and poorly known species were observed including Spot-breasted Ibis *Bostrychia rara*, Congo Serpent Eagle *Urotriorchis spectabilis* and Blue-headed Bee-eater *Merops muelleri*. The site also qualifies as an Important Bird Area (IBA).
- All of the 12 bat species captured in Grebo prefer forested habitat, including *Scotonycteris zenkeri*, a Near Threatened species. *Neoromicia guineensis* is a new country record for Liberia. Five other small mammal species were noted including the scaly-tailed swirrel, *Anomalurus cf. pusillus*, which is the third record for West Africa.
- All but one of the 29 large mammal species recorded on the RAP survey were seen in Grebo. Primates were regularly noted including Olive Colobus (*Procolobus verus*) and West African Chimpanzee (*Pan troglodytes verus*). The Red River Hog (*Potamochoerus porcus*) was the only mammal recorded only from this site. Of the 28 large mammal species recorded 14 (50%) are of conservation concern (Table 2). Tracks of Leopard *Panthera pardus* (CITES Appendix I) were observed and large numbers of primates were seen and heard daily.

RESULTS BY TAXON

Plants

We recorded 548 plant species (Table 1) of which 101 (18%) are endemic to the Upper Guinea forest area (Upper Guinea sensu White 1983). The sites in North Lorma and Gola are considered to be healthy mature forest and showed only lim-

ited disturbance by human activity that does not, at present, constitute a threat to the vegetation. Grebo was logged about 20 years ago and is now in the process of regeneration and recovering well. We found three plant species endemic to Liberia, *Cephaelis micheliae*, *Sericanthe adamii* and *Trichoscypha linderi*, and three plant species that were recorded for the first time in the country, *Elytraria ivorensis*, *Gardenia nitida* and *Zanthoxylum psammophilum*. We also found three plant species likely to be new to science, *Drypetes* sp., *Leptoderris* sp. and *Rhaphiostylis* sp.

Dragonflies and damselflies

We recorded 93 species of dragonflies and damselflies (Table 1). Seven species were recorded in Liberia for the first time. Numbers of species and individuals seemed low, probably because the survey was at the end of the wet season, rather than towards the start. The results nonetheless indicate a healthy watershed in each forest, with limited pollution and streambed erosion. If forest cover and natural stream morphology are retained, the present dragonfly faunas are expected to persist. The most interesting species assemblage was recorded in Gola, including two species of conservation concern (Table 2).

Amphibians and Reptiles

We recorded at least 40 amphibian and 17 reptile species (Table 1). Fifteen amphibians are on the IUCN Red List: two are classified as Endangered, two as Vulnerable, and 11 as Near Threatened (Table 2). We found five species that had not been recorded in Liberia before. For several species records represent large range extensions. Five of the reptile species recorded and one amphibian species are listed under CITES (Table 2). All three forests have a high conservation value as their herpetofauna mainly consists of forest specialists which are endemic to the Upper Guinea forest block.

Table 1. Number of species documented during the RAP survey in the North Lorma, Gola and Grebo National Forests, Liberia.

	All RAP sites in this survey	North Lorma	Gola	Grebo
Plants	548	266	200	220
Dragonflies and damselflies	93	58	70	63
Amphibians	40	18	30	30
Reptiles	17	6	9	6
Birds	211	143	145	156
Bats	22	7	13	12
Small Mammals	9	7	5	5
Large Mammals	29	21	14	28
Total	969	526	486	520

Birds

We recorded 211 bird species: 143 at North Lorma, 145 at Gola, and 156 at Grebo (Table 1). Of these, 14 are of conservation concern (eight in North Lorma, six in Gola and 10 in Grebo), amongst which one is classified as Endangered (Gola Malimbe *Malimbus ballmanni*), six as Vulnerable, six as Near Threatened and one as Data Deficient (Table 2). Twelve of the 15 species restricted to the Upper Guinea forests Endemic Bird Area and 136 (or 74%) of the 184 Guinea-Congo forests biome species recorded in Liberia were found during the study. Range extensions or new localities were noted for several species. All three sites qualify as Important Bird Areas (IBA).

Bats and terrestrial small mammals

A total of 182 bats of 22 species were captured (Table 1), representing 37% of the bat species known to occur in Liberia. Species richness was highest at Gola and Grebo, possibly because secondary forest and forest edge was sampled there. North Lorma, where only forest interior was surveyed, had both the lowest capture success and the lowest species richness. Three IUCN Red List species were recorded (Table 2). Bat assemblages in each of the surveyed areas were characterized by forest-dependent species. Not a single species typical of savanna habitats was recorded, indicating high habitat integrity of the National Forests. Three bat species are reported for the first time from Liberia (*Rhinolophus landeri*, *Neoromicia guineensis* and *Neoromicia* aff. *grandidieri*), raising the bat species total for the country to 59. Two species of shrews, one murid rodent, five squirrels and one anomalure (scaly-tailed squirrel) were also recorded, including the rarely reported Western Palm Squirrel *Epixerus ebii* and the Lesser Anomalure *Anomalurus* cf. *pusillus*.

Large mammals

We recorded 29 mammal species including nine primates: 21 in North Lorma, 14 in Gola and 28 in Grebo National Forest (Table 1). Four are listed by the IUCN Red List as Endangered, one as Vulnerable, one as Lower Risk/Conservation Dependent, and nine as Lower Risk/Near Threatened (Table 2). The CITES-listed Leopard *Panthera pardus* was also recorded.

CONSERVATION RECOMMENDATIONS

North Lorma, Gola and Grebo National Forests all contain a wealth of biodiversity and a significant number of species of conservation concern (Table 2). Among the fragmented forests of the Upper Guinea hotspot, Liberia has a great potential for conserving large tracts of contiguous forest that house this flora and fauna. In total, 60 species of conservation concern, as categorized by the IUCN Red List and CITES, were recorded in these forests, a considerably large number. Efforts should be taken to monitor and protect all these species.

Species listed on the IUCN Red List are categorized based on the degree to which they are globally threatened. The data

used in the evaluations is objective, based in science and peer reviewed. Categories, from less threatened to most threatened, include: Data Deficient (DD, not enough is known to make an assessment), Least Concern (LC, listed but not threatened), Near Threatened (NT), Vulnerable (VU), Endangered (EN) and Critically Endangered (CR) (IUCN 2006). For species that have not been evaluated since 2001 some categories are slightly different with the category Lower Risk (LR) including Least Concern (lc), Near Threatened (nt) and Conservation Dependent (cd) (IUCN 2006). Species listed by CITES are categorized by how international trade in these species would affect their survival. The Convention provides various levels of trade restrictions based on the Appendix the species is listed under. Appendices from the least restrictive trade to the most restrictive trade include: Appendix III (species not threatened with global extinction), Appendix II (not threatened with extinction but could be if trade is not strictly controlled) and Appendix I (most endangered species, threatened with extinction).

Conservation Priorities

- Raise the status of Grebo National Forest to National Park. Despite human disturbance, 40 animal species of conservation concern were recorded here, the highest number of all three sites visited (Table 2). Many of the bird and amphibian species recorded here have restricted ranges. With nine primate species occurring, primate species diversity at least equals that of nearby Sapo National Park (Waitkuwait 2001). Grebo's close proximity to both Tai National Park in Côte d'Ivoire and Sapo National Park offers an opportunity to create a biological corridor between the two parks. This biological corridor could not only safeguard biodiversity but would also preserve the extensive forest cover that is essential to perpetuate the moist air carried by the southwest monsoon further inland.
- Raise the status of North Lorma National Forest to National Park. In total, RAP scientists found 30 amphibian, reptile, bird and mammal species of conservation concern (Table 2). The variety of habitats and the limited amount of disturbance from human activity make this an area that should be closely monitored so that these habitats remain intact. It is suggested that Wonegizi and Wologizi Mts. also be included within the park and that the area should be contiguous to the Biosphere Reserve of the Massif du Ziama in Guinea. This would constitute one of the most significant protected areas of submontane rainforest in West Africa (for a detailed discussion of the importance of the Massif du Ziama, see Fahr et al. 2006). This mountainous region contains suitable habitat for several cave-roosting bats, many of which have small distribution ranges and are globally threatened.
- Raise the status of Gola National Forest to National Park. At this site RAP scientists recorded 27 animal

species of conservation concern (Table 2). Of the three sites surveyed, Gola National Forest contained the highest number of threatened species for bats (three) and odonates (two) and was second highest for amphibians (nine). This site had the highest number (80) of recorded species that are endemic to the Upper Guinea forests. A transboundary biological corridor with the Gola Forest in Sierra Leone could be created allowing migratory animals, such as Forest Elephant, to move between the two countries. Biological surveys should also be conducted at nearby Kpelle National Forest to examine the feasibility of extending the corridor.

- All three sites surveyed qualify as Important Bird Areas (IBAs), which further indicates their importance for biodiversity conservation. IBAs are globally recognized sites for conservation, small enough to be conserved in their entirety and often already part of a protected-area network (BirdLife International 2006). IBAs are designated based on one (or more) of three criteria: 1) Holding significant numbers of one or more globally threatened bird species, 2) Being one of a set of sites

that together hold a suite of restricted-range bird species or biome-restricted bird species, and 3) Having exceptionally large numbers of migratory or congregatory bird species (BirdLife International 2006).

General Conservation Recommendations

- Create a mechanism within which all potential protected areas, especially Grebo, North Lorma and Gola National Forests, can be given blanket protective coverage to allow time for gradual biological, socio-economic and other relevant studies to occur. The economic pressures on the natural resources of Liberia are immense and were seen in Gola National Forest where small-scale diamond mining and large scale prospecting are occurring. Many of the species that were recorded during this survey depend on healthy intact forests and if these areas are degraded prior to obtaining protection their survival here could be impacted.
- Involve all stakeholders, especially local communities, at an early stage in an open, transparent manner when establishing forest management plans for these sites.

Table 2. Animal species of conservation concern recorded during the RAP survey (IUCN 2006, UNEP-WCMC 2006).

Taxon	Species Name	Common Name	Conservation Status*	RAP Survey Site		
				North Lorma	Gola	Grebo
Amphibian	<i>Ammirana occidentalis</i>	Ivory Coast Frog	EN		x	
Amphibian	<i>Phrynobatrachus annulatus</i>		EN	x		
Amphibian	<i>Phrynobatrachus</i> cf. <i>annulatus</i>		EN	x		
Bird	<i>Malimbus ballmanni</i>	Gola Malimbe	EN		x	
Large Mammal	<i>Hexaprotodon liberiensis</i>	Pygmy Hippopotamus	EN			x
Primate	<i>Cercopithecus diana</i>	Diana Monkey	EN	x		x
Primate	<i>Pan troglodytes verus</i>	West African Chimpanzee	EN	x		x
Primate	<i>Piliocolobus badius</i>	Western Red Colobus	EN	x		x
Amphibian	<i>Conraua alleni</i>	Allen's Slippery Frog	VU		x	x
Amphibian	<i>Phrynobatrachus villiersi</i>		VU	x	x	x
Bird	<i>Agelastes meleagrides</i>	White-breasted Guineafowl	VU			x
Bird	<i>Bleda eximius</i>	Green-tailed Bristlebill	VU			x
Bird	<i>Criniger olivaceus</i>	Yellow-bearded Greenbul	VU	x	x	x
Bird	<i>Lobotos lobatus</i>	Western Wattled Cuckoo-shrike	VU			x
Bird	<i>Melaenornis annamarulae</i>	Nimba Flycatcher	VU			x
Bird	<i>Picathartes gymnocephalus</i>	Yellow-headed Picathartes	VU	x		
Bat	<i>Rhinolophus hillorum</i>	Upland Horseshoe Bat	VU		x	
Large Mammal	<i>Loxodonta africana cyclotis</i>	Forest Elephant	VU	x	x	x
Large Mammal	<i>Cephalophus jentinki</i>	Jentink's Duiker	VU			x
Large Mammal	<i>Syncerus caffer</i>	African Buffalo	LR/cd	x		
Damselfly	<i>Sapho fumosa</i>		NT		x	
Dragonfly	<i>Trithemis africana</i>		NT		x	
Amphibian	<i>Africalus nigeriensis</i>	Nigeria Banana Frog, Banana Tree Frog	NT		x	x

Table 2. (continued)

Taxon	Species Name	Common Name	Conservation Status*	RAP Survey Site		
				North Lorma	Gola	Grebo
Amphibian	<i>Bufo togoensis</i>		NT	x		x
Amphibian	<i>Hyperolius chlorosteus</i>		NT		x	x
Amphibian	<i>Leptopelis macrotis</i>	Big-eared Forest Frog	NT			x
Amphibian	<i>Leptopelis occidentalis</i>	Tai Forest Tree Frog	NT			x
Amphibian	<i>Petropedetes natator</i>		NT		x	
Amphibian	<i>Phrynobatrachus alleni</i>		NT	x	x	x
Amphibian	<i>Phrynobatrachus guineensis</i>		NT			x
Amphibian	<i>Phrynobatrachus liberiensis</i>		NT	x	x	x
Amphibian	<i>Phrynobatrachus phyllophilus</i>		NT	x	x	x
Amphibian	<i>Ptychadena superciliaris</i>		NT			x
Bird	<i>Bathmocercus cerviniventris</i>	Black-headed Rufous Warbler	NT	x		
Bird	<i>Bycanistes cylindricus</i>	Brown-cheeked Hornbill	NT	x	x	x
Bird	<i>Ceratogymna elata</i>	Yellow-casqued Hornbill	NT	x	x	x
Bird	<i>Illadopsis rufescens</i>	Rufous-winged Illadopsis	NT	x	x	x
Bird	<i>Lamprotornis cupreocauda</i>	Copper-tailed Glossy Starling	NT	x	x	x
Bird	<i>Malaconotus lagdeni</i>	Lagden's Bush-shrike	NT			x
Bat	<i>Hipposideros fuliginosus</i>	Sooty Leaf-nosed Bat	NT	x		
Bat	<i>Scotonycteris zenkeri</i>	Zenker's Fruit Bat	NT			x
Large Mammal	<i>Cephalophus dorsalis</i>	Bay Duiker	LR/nt	x	x	x
Large Mammal	<i>Cephalophus maxwelli</i>	Maxwell's Duiker	LR/nt	x	x	x
Large Mammal	<i>Cephalophus niger</i>	Black Duiker	LR/nt	x	x	x
Large Mammal	<i>Cephalophus ogilbyi</i>	Ogilby's Duiker	LR/nt	x		x
Large Mammal	<i>Cephalophus silvicultor</i>	Yellow-backed Duiker	LR/nt			x
Large Mammal	<i>Tragelaphus euryceros</i>	Bongo	LR/nt			x
Primate	<i>Cercocebus atys</i>	Sooty Mangabey	LR/nt	x	x	x
Primate	<i>Colobus polykomos</i>	Western Pied Colobus	LR/nt	x		x
Primate	<i>Procolobus verus</i>	Olive Colobus	LR/nt			x
Bird	<i>Melignomon eisentrauti</i>	Yellow-footed Honeyguide	DD	x		
Bat	<i>Hypsugo (crassulus) bellieri</i>	Bellier's Pipistrelle	n.a.		x	
Bat	<i>Neoromicia aff. grandidieri</i>	Grandidier's Pipistrelle	n.a.		x	
Amphibian	<i>Bufo superciliaris</i>	African Giant Toad, Congo Toad	CITES I	x		
Reptile	<i>Osteolaemus tetraspis</i>	African Dwarf Crocodile	CITES I		x	x
Large Mammal	<i>Panthera pardus</i>	Leopard	CITES I			x
Reptile	<i>Kinixys eros</i>	Forest Hingeback Tortoise	CITES II			x
Reptile	<i>Kinixys homeana</i>	Home's Hingeback Tortoise	CITES II	x		
Reptile	<i>Python sebae</i>	African Rock Python	CITES II	x		
Reptile	<i>Varanus ornatus</i>	Ornate Monitor	CITES II		x	

* The IUCN Red List categorizes species based on the degree to which they are threatened. Categories, from less threatened to most threatened, include: Data Deficient (DD, not enough is known to make an assessment), Lower Risk (LR) which includes Conservation Dependent (cd), Near Threatened (nt), and Least Concern (lc, listed but not threatened), Vulnerable (VU), Endangered (EN), and Critically Endangered (CR) (IUCN 2006); n.a.: not assessed by IUCN but likely to be threatened.

*CITES Appendices I, II and III list species afforded different levels or types of protection from over-exploitation (see <http://www.cites.org/eng/app/index.shtml>).

- Carry out additional survey work on all taxa at different times of the year for a more comprehensive inventory that would include **population estimates and distribution patterns**.
- Continue educating local communities that depend on the forest, as well as the general public, on the importance of maintaining healthy, biologically diverse forests and watersheds.
- Enforce existing laws on hunting. Although hunting in national forests is prohibited in Liberia, evidence was found of active poaching in all three forests. Enforcement and education could lead to a diminished bushmeat trade.
- Monitor species of conservation concern. This could be done in collaboration with the government (FDA), NGOs and Liberian universities.

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Chapter 2

Rapid survey of dragonflies and damselflies (Odonata) of North Lorma, Gola and Grebo National Forests, Liberia

Klaas-Douwe B. Dijkstra

SUMMARY

During a rapid survey of the North Lorma, Gola and Grebo National Forests, 93 species of dragonflies and damselflies were found. Seven species were recorded in Liberia for the first time. Numbers of species and individuals seemed low, probably because the survey was at the end of the wet season, rather than towards the start. The results nonetheless indicate a healthy watershed in each forest, with limited pollution and streambed erosion. If forest cover and natural stream morphology are retained, the present dragonfly faunas are expected to persist. The most interesting species assemblage was recorded in Gola National Forest, including two species of conservation concern. Gola National Forest is a major diamond mining area, and the possible beneficial and detrimental impacts of these activities are discussed. Harboring typical examples of a rich Upper Guinea fauna, each forest, and especially Gola National Forest, deserves to be conserved.

INTRODUCTION

Odonata (dragonflies and damselflies) are receiving increasing attention from scientists and the general public. These graceful, colorful creatures are the quintessence of freshwater health. Due to their attractive appearance, dragonflies and damselflies can function as guardians of the watershed. They can be flagships for conservation, not only of water-rich habitats such as wetlands and rainforests, but also of habitats where water is scarce and, therefore, especially vital to the survival of life. Their sensitivity to structural habitat quality (e.g. forest cover, water limpidity) and amphibious habits make Odonata well suited for evaluating environmental change in the long term (biogeography, climatology) and in the short term (conservation biology), both above and below the water surface (Corbet 1999).

Odonata larvae are excellent indicators of the structure and quality of aquatic habitats (e.g. water, vegetation, substrate), while adult Odonata are highly sensitive to the structure of their terrestrial habitats (e.g. degree of shading). As a consequence, Odonata respond strongly to habitat changes, such as those related to deforestation and erosion. Ubiquitous species prevail in disturbed or temporary waters, while habitats like pristine streams and swamp forests harbor a wealth of more vulnerable and local species. Different ecological requirements are linked to different dispersal capacities. Species with narrow niches disperse poorly, while pioneers of temporal habitats (often created by disturbance) are excellent colonizers. For this reason, Odonata have a potential use in the evaluation of habitat connectivity (Clausnitzer 2003, Dijkstra and Lempert 2003).

Odonata possess characteristics distinct from those of relatively well-studied taxonomic groups like plants, birds, mammals and butterflies. Therefore, their study supplements knowledge obtained from these better-known groups. There are also practical advantages to Odonata as environmental monitors. Aquatic habitats, the focal point of their life histories, are easy to locate, and their diurnal activity and high densities make Odonata easy to study. The number

of dragonfly species occurring in Africa is manageable, their taxonomy is fairly well resolved, and identification relatively straightforward. Considering the ever-changing nature of the African environment, be it under human, geological or climatic influence, the study of African Odonata constitutes an exciting challenge, as knowledge of their distribution, ecology and phylogeny helps us understand the past and future of a rapidly changing continent.

This was only the second African RAP survey that included Odonata. The first, at Lokutu in Democratic Republic of Congo (Butynski and McCullough *in press*), proved that it is possible to obtain a fair picture of the local diversity within a short period of time. This picture showed a rich and apparently largely natural Odonata fauna, which probably represents high overall aquatic biodiversity. This result contrasted sharply with the impoverished and imperiled fauna and flora found for the other taxonomic groups studied on that RAP survey. Because of their ‘information-rich’ potential, Odonata might be placed more at the forefront of RAP surveys and conservation policy. Particularly in forest and freshwater ecosystems, an emphasis on odonate research seems beneficial as a baseline for biodiversity and watershed conservation. Sampling these charismatic insects can demonstrate whether present and future conservation actions are protecting freshwater biodiversity. Moreover, the interpretation of survey results has recently been facilitated by the inclusion of Odonata in IUCN’s assessment of freshwater biodiversity in western Africa, which summarizes the distribution, habitat, threats and taxonomy of all species (Dijkstra, unpubl.).

The Odonata of the Upper Guinea forest have been fairly well studied. Landmark papers appeared on Sierra Leone (Carfi and D’Andrea 1994), Ghana (O’Neill and Paulson 2001), the Guinean side of Mt Nimba (Legrand 2003) and Taï Forest in Côte d’Ivoire (Legrand and Couturier 1985). The fauna of Liberia is principally known due to Lempert (1988), who surveyed the country (mostly the eastern half) during a total of six months. His thesis is still the most in-depth study of any tropical dragonfly community and includes countless unique observations of reproductive behavior. Lempert recorded between 140 and 150 species, including numerous unnamed species, especially in the Gomphidae. A number of these have probably been described since by Legrand (1992, 2003) and require re-examination. Judging from data from neighboring countries, the true number of species occurring in Liberia should be approximately 200 (Dijkstra and Clausnitzer 2006); about one-fifth of these do not occur east of Nigeria. Lempert’s data were analyzed in combination with this author’s data from Ghana (Dijkstra and Lempert 2003). This analysis describes the composition of odonate assemblages in running waters in the Upper Guinea rainforest. As running forest waters harbor the larger part of the region’s odonate diversity, particularly of range-restricted species, this baseline is an important tool in the interpretation of the data from the present survey.

Despite Lempert’s (1988) efforts, large parts of Liberia remain unexplored, in particular the center (e.g. Grand Bassa and River Cess Counties), the southeast (River Gee, Grand Kru, Maryland) and the northwest (Gbarpolu, Lofa). Central Liberia is probably of lesser interest because it is enclosed in Lempert’s survey area and relatively deforested. The southeast is interesting because rainfall is spread most evenly over the year and the region is probably nearest to the center of the Upper Guinea rainforest refugium. The northwest has the most diverse terrain, with marked relief and the strongest savannah influences in a country consisting largely of rainforest. It is also the region with the most marked seasons, with distinct wet (May–Oct) and dry (Nov–Apr) seasons. The three national forests (North Lorma, Gola and Grebo) covered by the present survey lie in three previously unstudied counties (Lofa, Gbarpolu and River Gee respectively).

METHODS

North Lorma National Forest was surveyed from 19 to 25 November, Gola National Forest from 27 November to 3 December, and Grebo National Forest from 5 to 11 December 2005. Adult and larval Odonata were observed and caught with a handnet during daylight at freshwater habitats, and details of their ecology and behavior were noted. Identifications were made using Clausnitzer and Dijkstra (in prep.) and additional literature; taxonomy follows Dijkstra and Clausnitzer (in prep.). Relevant name changes from that checklist and other unpublished revisions by the author are provided in the footnotes. Collected specimens will be deposited in the collection of the National Museum of Natural History (Leiden, The Netherlands).

RESULTS

A total of 93 species of Odonata were found, representing 59% of the estimated 158 species known from the country (Appendix 2). Of these, 60% are forest species found only within the Guineo-Congolian realm, with the remaining 40% being widespread non-forest species. Only 31% of the forest species are of more restricted occurrence (i.e. not occurring throughout the realm). Seven species were recorded for the first time in Liberia: *Paragomphus nigroviridis*, *Phyllogomphus moundi*, *Nesciothemis minor*, *Palpopleura deceptor*, *Tetrathemis polleni*, *Tramea limbata* and *Trithemis monardi*.

DISCUSSION

Because no research of Odonata had been undertaken prior to this study in the regions visited, any result from these areas greatly supplements the knowledge of the Upper Guinea fauna in general and the Liberian fauna in particular.

Although the total of 93 species seems high, it compares poorly with the result of the RAP in D.R. Congo, where 86 species were found at a single site during half the number of field days. Moreover, in D.R. Congo 72% were forest species found only within the Guineo-Congolian realm (versus 60% in Liberia), with 53% of these being of more restricted occurrence (versus 31% in Liberia). Of the seven species that were recorded for the first time in Liberia, *Paragomphus nigroviridis* is a widespread forest species, while the remaining additions are widespread non-forest species.

The absence of certain expected species, as well as the generally low individual numbers observed, may be explained by seasonality. High and fluctuating water levels are a possible reason why activity of adult dragonflies is low during the transition from wet to dry season. Conditions are then not only challenging for adult dragonflies (e.g. submerged or variably available oviposition substrates; dangerous conditions for emergence), but also for the researcher, whose access to research sites is limited by high water. Moreover, many species may still be in the larval stage at the close of the wet season, because heightened reproductive activity can be expected at the start of the rains when habitat availability increases. Insect numbers generally seemed low during the RAP survey, especially where concentrations would be expected. For instance, very few nocturnal insects were drawn to light, and fruit on the forest floor attracted low numbers of frugivorous butterflies. Insect captures with Malaise traps were also low. The period from February to May is probably the best for recording Odonata.

Of the species found, 17 are rainforest species that do not enter the Congo Basin (mostly ranging east to Nigeria, Cameroon or Gabon); six of these are Upper Guinea endemics (not occurring east of Togo). Of these, *Prodasineura villiersi*, *Phyllomacromia sophia*, *Eleuthemis* sp. n. and *Zygonyx chrysobaphes* are widespread in the Upper Guinea realm. The first was found at all three sites, the second and third in Gola National Forest only, and the fourth in Grebo National Forest. Unlike the Odonata of northern, eastern and southern Africa, those of central and western Africa were not assessed for the global Red List of 2006, as data were fragmented and relatively limited (Dijkstra and Vick 2004). However, the author has recently collated these data and made a regional and preliminary global assessment (Appendix 2). Six Liberian species have globally been assigned the category Near Threatened or higher: *Sapho fumosa* (Near Threatened = NT), *Mesocnemis tisi* (Endangered = EN), *Agriocnemis angustirami* (Vulnerable = VU), *Phyllomacromia funicularioides* (NT), *Neodythemis campioni* (NT) and *Tritthemis africana* (NT). Three additional species occur in adjacent Sierra Leone: *Elatoneura dorsalis* (VU), *Pseudagrion mas-cagnii* (Critically Endangered = CR) and *Orthetrum sagitta* (NT). Of these nine, only two in the lowest category were found during the survey, both in Gola National Forest:

1. *T. africana* is only known from deeply shaded rainforest streams in Sierra Leone, Liberia and Côte d'Ivoire; Liberia must be the species' stronghold.
2. *S. fumosa* is known from a few sites in Senegal and Guinea-Bissau near the border with Guinea, through Sierra Leone to Mt Nimba, where the only previous Liberian record was obtained by Lempert (1988). The species is closely related to *S. ciliata*, *S. bicolor* and *Umma cincta*. All four species were found on the same stream system at Gola National Forest, although they are ecologically segregated. *S. ciliata*, *S. bicolor* and *U. cincta* favor sandy streams, occurring on the sunniest, shadiest and intermediate sections respectively. *S. fumosa* was found only where streams were rather shaded and dominated by rocks, a preference that explains why the species is confined to the more hilly parts of Upper Guinea.

Three additional species found at Gola National Forest are more widespread in western Africa, ranging east to Cameroon, but have been recorded only locally: *Phyllogomphus moundsi*, *Tetrathemis godiardi* and *Tritthemis basitincta*. These results indicate that from an odonatological perspective Gola National Forest was the most interesting site. Of the 17 western African species mentioned above, only seven were found at North Lorma National Forest, compared to 14 in Gola National Forest and 12 in Grebo National Forest.

Although deforestation and subsequent alteration of waterbodies (e.g. erosion, siltation) seem to be the only potential threats to Odonata in North Lorma and Grebo National Forests, diamond mining may be detrimental also in Gola National Forest. Small-scale activities that do not open up the canopy appear beneficial. Stagnant waterbodies are comparatively scarce in rainforest, and partly overgrown pits filled with leaf-litter create new habitat. *Tetrathemis godiardi* is the most obvious beneficiary; both territorial and emerging individuals were found at abandoned pits under closed canopy. Open pits are colonised by many species that would otherwise find no or almost no habitat in the area, but these are all well-dispersing species that dominate savannah faunas throughout Africa. The drainage of the mines leads to increased turbidity, and probably siltation of streams, the former reducing visibility for larvae, the latter changing the substrate. Reduced motion and increased insulation of water in open pits also affects the flow, oxygen and temperature regimes of drainage streams. One such stream in Gola National Forest, which was rocky and therefore suitable for *S. fumosa*, held very low numbers of that species in comparison to a pristine stream, but observations are too limited to draw conclusions.

CONSERVATION RECOMMENDATIONS

Odonates were the only invertebrate group included in the RAP. Unlike some other taxonomic groups studied, they are not actively exploited by man and are strongly tied to water. They therefore serve to assess the more indirect anthropogenic disturbance—the gradual alteration of the environment. As expected, all three studied forests harbor odonate assemblages that are representative of the Upper Guinea rainforest fauna. The forest stream assemblages found match those described by Dijkstra and Lempert (2003), suggesting healthy watersheds, with limited degrees of pollution and streambed erosion. As long as forest cover and natural stream morphology are retained, the existing dragonfly fauna is expected to persist. Considering the threats to the Upper Guinea rainforest, it is recommended that the three forests and the watersheds they protect be conserved. This recommendation especially concerns Gola National Forest, which had the most interesting dragonfly fauna, including two species of conservation concern (*Sapho fumosa*, *Tritthemis africana*). The additional threat of diamond mining may jeopardize the aquatic biodiversity in Gola National Forest. Minimizing the outflow of mining water into the stream systems may reduce the possible negative effect of those activities.

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Appendix 2

Checklist of Odonata recorded from Liberia and neighboring areas.

Klaas-Douwe B. Dijkstra

RL: Unpublished global or western African (between brackets) Red List assessment made by the author (assessed May, evaluated August 2006).

Biology (preferences are inferred from observations during the fieldwork, augmented with previous experience):

B: biogeography of the species. **A:** all over tropical Africa including savannahs, **G:** confined to Guineo-Congolian forest, **N:** associated with northern African savannah (Senegal to Ethiopia), **U:** confined to Upper Guinean forest (Sierra Leone to Togo), **W:** confined to western Africa forest (Senegal to Cameroon).

L: preferred landscape. **F:** forest, **O:** open habitats.

W: preferred water type. **R:** running; **S:** standing.

Liberian records (type locality lies in Liberia if species marked with asterisk):

NL, Go, Gr: North Lorma, Gola and Grebo National Forests.

A: adult voucher obtained; **L:** larval voucher obtained; **S:** adults caught for identification or seen only; records obtained nearby but outside the national forest are given between brackets.

Li: country records after Lempert (1988) and current survey. **1:** species found in current survey (! indicates new national record), **2:** found by Lempert, **3:** found by Lempert, but identification requires confirmation, **4:** literature record listed by Lempert; **5:** not listed by Lempert, but by Pinhey (1984). Species with old or dubious records (probable misidentifications) that are removed from the list until confirmed are: *Sapho orichalcea* McLachlan, 1869; *Umma puella* (Sjöstedt, 1917); *Ceriagrion ignitum* Campion, 1914; *Trithemis nuptialis* Karsch, 1894.

Neighboring areas (type locality lies in stated area if species marked with asterisk):

SL: Sierra Leone records after Carfi and D'Andrea (1994) and Marconi and Terzani (2006). **1:** authors' material; **2:** authors' material, identification requires confirmation; **3:** Aguesse (1968) records; **4:** other literature records. Omitted are: *Stenocnemis pachystigma* (Selys, 1886); *Elatoneura pruinosa* (Selys, 1886); *Agriocnemis forcipata* Le Roi, 1915; *Pseudagrion nubicum* Selys, 1876; *Anaciaeschna triangulifera* McLachlan, 1896; *Anax speratus* Hagen, 1867; *Diastomma* sp. Gambles, 1987; *Phyllogomphus aethiops* Selys, 1854; *Phyllomacromia monoceros* (Förster, 1906); *Orthetrum caffrum* (Burmeister, 1839); *Orthetrum machadoi* Longfield, 1955; *Porpax asperipes* Karsch, 1896; *Trithemis dorsalis* (Rambur, 1842).

MN: Mt Nimba (Guinean side) records after Legrand (2003). **1:** author's material; **2:** author's material, identification requires confirmation; **3:** uncertain records, mostly personal communication P. Aguesse. Omitted are: *Lestes tridens* McLachlan, 1895; *Phyllomacromia aequatorialis* Martin, 1907; *Trithemis furva* Karsch, 1899.

Si: Simandou (Guinea) records after Legrand and Girard (1992). **1:** identification reliable; **2:** identification requires confirmation.

TF: Tai Forest (Côte d'Ivoire) records after Legrand and Couturier (1985): **1.**

Taxa	Notes	RL	Biology			Liberian records				Neighboring areas			
			B	L	W	NL	Go	Gr	Li	SL	MN	Si	TF
Calopterygidae													
<i>Phaon camerunensis</i> Sjöstedt, 1900	1.		G	F	R	A		A	1	2	1	1	1
<i>Phaon iridipennis</i> (Burmeister, 1839)			A	O	R	A	A		1	1	1	1	1
<i>Sapho bicolor</i> Selys, 1853			G	F	R	A	A	S	1	1	1	1	1
<i>Sapho ciliata</i> (Fabricius, 1781)			W	F	R	A	A	A	1	1	1	1	1
<i>Sapho fumosa</i> Longfield, 1932	2.	NT	U	F	R		A		1	3*	1		
<i>Umma cincta</i> (Hagen in Selys, 1853)			G	F	R	A	A	S	1		1	1	1
Chlorocyphidae													
<i>Chlorocypha curta</i> (Hagen in Selys, 1853)			G	O	R				2	1	1	1	
<i>Chlorocypha dispar</i> (Palisot de Beauvois, 1807)			G	F	R	A	A	A	1	1	1	1	1
<i>Chlorocypha luminosa</i> (Karsch, 1893)	3.		U	F	R				2		1		
<i>Chlorocypha pyriformosa</i> Fraser, 1947	4.		G	F	R	A		S	1	1			1
<i>Chlorocypha radix</i> Longfield, 1959	5.		W	F	R	A	S	A	1	1	1	1	1
<i>Chlorocypha rubida</i> (Hagen in Selys, 1853)			W	F	R				2	1	3		1
<i>Chlorocypha selysi</i> (Karsch, 1899)			G	F	R	A	A	A	1	1	1	1	1
Lestidae													
<i>Lestes dissimulans</i> Fraser, 1955			A	O	S						1		1
Platycnemididae													
<i>Mesocnemis singularis</i> Karsch, 1891			A	O	R	S	S	A	1	1	1		1
<i>Mesocnemis tisi</i> Lempert, 1992	6.	EN	U	F	R				2*				
<i>Platycnemis guttifera</i> Fraser, 1950			W	F	R	A		A	1				1
<i>Platycnemis sikassoensis</i> (Martin, 1912)			G	O	R				2	1	1	1	1
Protoneuridae													
<i>Chlorocnemis elongata</i> Hagen in Selys, 1863			W	F	R	A	S	A	1	1	1	1	
<i>Chlorocnemis flavipennis</i> Selys, 1863	7.		W	F	R		A	A	1	1	1	1	
<i>Chlorocnemis subnodalis</i> (Selys, 1886)	8.		W	F	R	A	A	A	1	1	1		1
<i>Elattonneura balli</i> Kimmins, 1938			W	F	R	A	A	A	1	1*	1	1	1
<i>Elattonneura dorsalis</i> Kimmins, 1938		VU	U	F	R					1*			
<i>Elattonneura girardi</i> Legrand, 1980	9.		W	F	R				2	1	1		1
<i>Elattonneura nigra</i> Kimmins, 1938			G	O	R					1	1		
<i>Prodasineura villiersi</i> Fraser, 1948			U	F	R	A	A	A	1		1		1
Coenagrionidae													
<i>Aciagrion africanum</i> Martin, 1908			G	O	S				2		1		
<i>Aciagrion gracile</i> (Sjöstedt, 1909)			A	O	S						1		1
<i>Africallagma subtile</i> (Ris, 1921)	10.		A	O	S					1	1	1	
<i>Agriocnemis angustirami</i> Pinhey, 1974		VU	U	?	S				2*	1			
<i>Agriocnemis exilis</i> Selys, 1872			A	O	S				2	1			
<i>Agriocnemis maclachlani</i> Selys, 1877			G	F	S			A	1	3	1		1
<i>Agriocnemis victoria</i> Fraser, 1928	11.		G	O	S				2	1	3		
<i>Agriocnemis zerafica</i> Le Roi, 1915			A	O	S				2				
<i>Argiagrion leoninum</i> Selys, 1876	12.	DD	U	?	?					4*			
<i>Ceriagrion bakeri</i> Fraser, 1941			G	O	S			A	1	1	2		1

continued

Taxa	Notes	RL	Biology			Liberian records				Neighboring areas			
			B	L	W	NL	Go	Gr	Li	SL	MN	Si	TF
<i>Ceriagrion corallinum</i> Champion, 1914			G	O	S		A		1	1*			
<i>Ceriagrion glabrum</i> (Burmeister, 1839)			A	O	S	S	S		1	1	1	1	1
<i>Ceriagrion rubellocerinum</i> Fraser, 1947			G	F	S	A		A	1	1	1		1
<i>Ceriagrion suave</i> Ris, 1921	13.		A	O	S				3	1	2		
<i>Ceriagrion tricrenaticeps</i> Legrand, 1984		(DD)	G	?	S				2				
<i>Ceriagrion wbellani</i> Longfield, 1952			A	O	S				2	3	1		
<i>Ischnura senegalensis</i> (Rambur, 1842)			A	O	S				2	1			
<i>Pseudagrion aguessei</i> Pinhey, 1964			N	O	R					3*			
<i>Pseudagrion camerunense</i> (Karsch, 1899)	14.		W	O	R				2	1			
<i>Pseudagrion epiphonematicum</i> Karsch, 1891			G	F	R	A	A	A	1	3	1	1	
<i>Pseudagrion gigas</i> Ris, 1936			N	?	R					3	1		
<i>Pseudagrion glaucescens</i> Selys, 1876			A	O	S				2	1	3		
<i>Pseudagrion glaucoideum</i> Schmidt in Ris, 1936			G	F	S	S			1				
<i>Pseudagrion glaucum</i> (Sjöstedt, 1900)	15.		G	O	S				2				
<i>Pseudagrion hamoni</i> Fraser, 1955			A	O	S					1		2	
<i>Pseudagrion hemicolon</i> Karsch, 1899	16.		G	F	R	A	A	A	1	1		1	1
<i>Pseudagrion kersteni</i> Gerstäcker, 1869			A	O	R					1			
<i>Pseudagrion mascagnii</i> Terzani & Marconi, 2004		CR	U	?	?					1*			
<i>Pseudagrion melanicterum</i> Selys, 1876			G	O	R	A	A	A	1	1	1	1	1
<i>Pseudagrion sjoestedti</i> Förster, 1906			A	O	R		A	S	1	1			1
<i>Pseudagrion sublacteum</i> (Karsch, 1893)			A	O	S				2	1		2	1
“ <i>Pseudagrion</i> ” <i>cyathiforme</i> Pinhey, 1973	17.		W	F	R				2	1			
“ <i>Pseudagrion</i> ” <i>malagasoides</i> Pinhey, 1973	18.		W	F	R				2				
Aeshnidae													
<i>Anax chloromelas</i> Ris, 1911			A	O	S					4			
<i>Anax imperator</i> Leach, 1815			A	O	S	S			1			1	
<i>Anax tristis</i> Hagen, 1867			A	O	S				2		3		
<i>Gynacantha africana</i> (Palisot de Beauvois, 1807)			G	F	S								1
<i>Gynacantha bullata</i> Karsch, 1891			G	F	S	S		A	1	1	1	1	1
<i>Gynacantha cylindrata</i> Karsch, 1891			G	F	S				2	1	3		1
<i>Gynacantha manderica</i> Grünberg, 1902			A	O	S					1	3		
<i>Gynacantha nigeriensis</i> (Gambles, 1956)	19.		G	F	S					1			
<i>Gynacantha sextans</i> McLachlan, 1896			G	F	S						1		1
<i>Gynacantha</i> sp. indet.	20.		?	?	?				3				
<i>Gynacantha vesiculata</i> Karsch, 1891			G	F	S				2	1	3		
<i>Heliaeschna fuliginosa</i> Karsch, 1893	21.		G	F	S		A	A	1	1			1
<i>Heliaeschna</i> cf. <i>cynthiae</i> Fraser, 1939	22.		?	?	?				3				
Gomphidae													
<i>Diastomma gamblesi</i> Legrand, 1992	23.		U	F	R				2		1*		
<i>Gomphidia bredoi</i> (Schouteden, 1934)	24.		N	O	R								1
<i>Gomphidia gamblesi</i> Gauthier, 1987			W	F	R			S	1		1		
<i>Ictinogomphus ferox</i> (Rambur, 1842)			A	O	R					1	3		
<i>Ictinogomphus fraseri</i> Kimmins, 1958			W	F	R					1*			

continued

Taxa	Notes	RL	Biology			Liberian records				Neighboring areas				
			B	L	W	NL	Go	Gr	Li	SL	MN	Si	TF	
<i>Lestinogomphus africanus</i> (Fraser, 1926)		DD	?	F	R						4*			
<i>Lestinogomphus matilei</i> Legrand & Lachaise, 2001	25.		U	F	R					2				
<i>Lestinogomphus</i> n. sp. 1	26.		U	F	R					3				
<i>Lestinogomphus</i> n. sp. 2	27.		U	F	R					3				
<i>Lestinogomphus</i> sp. indet.			?	F	R	S		L		1				
<i>Microgomphus jannyae</i> Legrand, 1992			U	F	R							1*		
<i>Microgomphus</i> sp. indet.	28.		?	F	R	A				1				
<i>Onychogomphus xerophilus</i> Fraser, 1956	29.	(DD)	U	F	R						2	2		
<i>Paragomphus genei</i> (Selys, 1841)			A	O	S					2	1			
<i>Paragomphus kiautai</i> Legrand, 1992		DD	U	F	R							1*		
<i>Paragomphus mariannae</i> Legrand, 1992	30.	DD	U	F	R					2		1*		
<i>Paragomphus nigroviridis</i> Cammaerts, 1968			G	F	R		A			1!				
<i>Paragomphus serrulatus</i> (Baumann, 1898)	31.		N	F	R					2	1			
<i>Paragomphus tournieri</i> Legrand, 1992	32.	DD	U	F	R					2		1*		
<i>Paragomphus</i> n. sp. cf. <i>elpidius</i> Ris, 1921	33.		U	F	R					2				
<i>Paragomphus</i> sp. indet.			?	F	R	L	L			1				
<i>Phyllogomphus bartolozzii</i> Marconi, Terzani & Carletti, 2001	34.	DD	U	F	R							1*		
<i>Phyllogomphus helena</i> Lacroix, 1921		DD	U	F	R							4*		
<i>Phyllogomphus moundi</i> Fraser, 1960			W	F	R		A	S		1!		1		
<i>Phyllogomphus</i> n. sp.	35.		U	F	R					2				
<i>Tragomphus christinae</i> Legrand, 1992	36.	DD	U	F	R					2		1*		
<i>Tragomphus</i> sp. indet.			?	F	R		L			1				
Corduliidae														
<i>Idomacromia lieftincki</i> Legrand, 1984			G	F	R					2		1		
<i>Idomacromia provavita</i> Karsch, 1896			G	F	R							1		1
<i>Neophya rutherfordi</i> Selys, 1881			G	F	R					2	1	1		
<i>Phyllomacromia aeneothorax</i> (Nunney, 1895)		(DD)	G	F	R					2	4	1	1	
<i>Phyllomacromia contumax</i> Selys, 1879	37.		A	O	R					2				
<i>Phyllomacromia funicularioides</i> (Legrand, 1983)		NT	U	F	R					2		1*		
<i>Phyllomacromia hervei</i> (Legrand, 1980)			G	F	R	A		A		1				
<i>Phyllomacromia kimminsi</i> (Fraser, 1954)			A	F	R							1*		
<i>Phyllomacromia lamottei</i> (Legrand, 1993)	38.	DD	U	F	R					2		1*		
<i>Phyllomacromia melania</i> (Selys, 1871)	39.		G	F	R	A	A			1	4	1		
<i>Phyllomacromia occidentalis</i> (Fraser, 1954)		(DD)	U	F	R					2				
<i>Phyllomacromia sophia</i> (Selys, 1871)			U	F	R		A			1	4	1		1
Libellulidae														
<i>Acisoma panorpoides</i> Rambur, 1842			A	O	S	S	S	(S)		1	1	1		1
<i>Acisoma trifidum</i> Kirby, 1889			G	O	S	S	S	(S)		1	1	1		
<i>Aethiothemis bella</i> (Fisher, 1939)	40.	(DD)	G	F	?						3			
<i>Aethiothemis solitaria</i> Martin, 1908			A	O	S						2			
<i>Aethriamanta rezia</i> Kirby, 1889			A	O	S	S	S	S		1		1		
<i>Atoneura luxata</i> Dijkstra, 2006	41.	(VU)	G	F	R						1	1		

continued

Taxa	Notes	RL	Biology			Liberian records				Neighboring areas			
			B	L	W	NL	Go	Gr	Li	SL	MN	Si	TF
<i>Brachythemis lacustris</i> (Kirby, 1889)			A	O	S				2				
<i>Bradynopyga strachani</i> (Kirby, 1900)			N	O	S		A		1	1	3		
<i>Chalcostephia flavifrons</i> Kirby, 1889			A	O	S	S	S	S	1	1	1		
<i>Crocothemis divisa</i> Baumann, 1898	42.		A	O	S				5	1	1		
<i>Crocothemis erythraea</i> (Brullé, 1832)			A	O	S	S	S	(S)	1	1	3		
<i>Crocothemis sanguinolenta</i> (Burmeister, 1839)			A	O	R		(S)		1	1	1	1	
<i>Cyanothemis simpsoni</i> Ris, 1915			G	F	R	A	S	S	1	4*	1		1
<i>Diplacodes deminuta</i> Liefinck, 1969	43.	(DD)	A	O	S				2				
<i>Diplacodes lefebvreii</i> (Rambur, 1842)			A	O	S		A	(S)	1	1	1		
<i>Diplacodes luminans</i> (Karsch, 1893)	44.		A	O	S				2	1	3		
<i>Eleuthemis buettikoferi</i> Ris, 1910			G	F	R			S	1*	2	2		
<i>Eleuthemis</i> n. sp.			U	F	R		A		1				
<i>Hadrothemis camarensis</i> (Kirby, 1889)	45.		G	F	S	S	A	A	1	1	1		1
<i>Hadrothemis coacta</i> (Karsch, 1891)			G	F	S			A	1		3		1
<i>Hadrothemis defecta</i> (Karsch, 1891)			G	F	S	S	A	S	1	1	1		
<i>Hadrothemis infesta</i> (Karsch, 1891)			G	F	S	A	A	S	1	4	1		1
<i>Hadrothemis versuta</i> (Karsch, 1891)			G	F	S	S	A		1		1		
<i>Hemistigma albipunctum</i> (Rambur, 1842)			A	O	S		A		1	1	3		
<i>Lokia incongruens</i> (Karsch, 1893)	46.		W	F	R				2				
<i>Malgassophlebia bispina</i> Fraser, 1958			G	F	R				2		1		
<i>Micromacromia camerunica</i> Karsch, 1890	47.		G	F	R	A			1	4			
<i>Micromacromia zygotera</i> (Ris, 1909)	48.		G	F	R			A	1	1	1		1
<i>Neodythemis campioni</i> Ris, 1915	49.	NT	U	F	R				2	4*	2		
<i>Neodythemis klingi</i> (Karsch, 1890)	50.		G	F	R		A	A	1	1	1		1
<i>Nesciothemis minor</i> Gambles, 1966			N	O	R			(A)	1!	1	1		
<i>Nesciothemis nigeriensis</i> Gambles, 1966			N	O	S					3			
<i>Nesciothemis pujoli</i> Pinhey, 1971	51.		N	O	S				4	1	2		
<i>Notiothemis robertsi</i> Fraser, 1944			G	F	S		S		1		1		
<i>Olpogastra lugubris</i> Karsch, 1895			A	O	R		A	S	1	3	1	1	
<i>Orthetrum abbotti</i> Calvert, 1892			A	O	S	A	A		1	1	1		
<i>Orthetrum africanum</i> (Selys, 1887)			G	F	R				2	4	1		
<i>Orthetrum angustiventre</i> (Rambur, 1842)			A	O	S				2	1			
<i>Orthetrum austeni</i> (Kirby, 1900)			G	O	S	S	S	S	1	1*	1		1
<i>Orthetrum brachiale</i> (Palisot de Beauvois, 1817)			A	O	S		A		1	1	3		1
<i>Orthetrum chrysostigma</i> (Burmeister, 1839)			A	O	S				2	1	3		
<i>Orthetrum guineense</i> Ris, 1910			A	O	R				4	1	1		
<i>Orthetrum hintzi</i> Schmidt, 1951			A	O	S		A	S	1	1	1		1
<i>Orthetrum icteromelas</i> Ris, 1910	52.		A	O	S				2	4			
<i>Orthetrum julia</i> Kirby, 1900			A	O	R	A	A	S	1	1*	1	1	1
<i>Orthetrum latihami</i> Pinhey, 1966	53.		N	O	?					1	1		
<i>Orthetrum microstigma</i> Ris, 1911			G	O	S	A	A	S	1	1	1	1	1
<i>Orthetrum monardi</i> Schmidt, 1951			A	O	S					1			
<i>Orthetrum sagitta</i> Ris, 1915		NT	U	?	?					2*			

continued

Taxa	Notes	RL	Biology			Liberian records				Neighboring areas			
			B	L	W	NL	Go	Gr	Li	SL	MN	Si	TF
<i>Orthetrum stemmale</i> (Burmeister, 1839)			A	O	S	A	A		1		3	1	1
<i>Oxythemis phoenicosceles</i> Ris, 1910			G	F	S				2				
<i>Palpopleura deceptor</i> (Calvert, 1899)			A	O	S		A		1!	4			
<i>Palpopleura jucunda</i> (Rambur, 1842)			A	O	S					1			
<i>Palpopleura lucia</i> (Drury, 1773)			A	O	S	S	S	S	1	1	1	1	1
<i>Palpopleura portia</i> (Drury, 1773)	54.		A	O	S	S	A	S	1	1	1	1	1
<i>Pantala flavescens</i> (Fabricius, 1798)			A	O	S	S	S	(S)	1	1	1		
<i>Parazyxomma flavicans</i> (Martin, 1908)			G	O	S	S			1				
<i>Porpax bipunctus</i> Pinhey, 1966		(VU)	G	F	?				2				1
<i>Rhyothemis fenestrina</i> (Rambur, 1842)			A	O	S	S	A	(S)	1	4			
<i>Rhyothemis notata</i> (Fabricius, 1781)			G	O	S			(A)	1	4	1		
<i>Rhyothemis semihyalina</i> (Desjardins, 1832)			A	O	S				2	1			
<i>Sympetrum navasi</i> Lacroix, 1921			A	O	S				2	3			
<i>Tetrathemis camerunensis</i> (Sjöstedt, 1900)	55.		G	F	S	A	A	S	1		3	1	1
<i>Tetrathemis godiardi</i> Lacroix, 1921			W	F	S		A	A	1		1		
<i>Tetrathemis polleni</i> (Selys, 1869)			A	O	S	S			1!				
<i>Thermochoria equivocata</i> Kirby, 1889			G	F	S				2	1	1		1
<i>Tholymis tillarga</i> (Fabricius, 1798)			A	O	S		A	A	1	1	1		1
<i>Tramea basilaris</i> (Palisot de Beauvois, 1817)			A	O	S	S	S	(S)	1	1			
<i>Tramea limbata</i> (Desjardins, 1832)			A	O	S	S	A	(S)	1!	1			
<i>Trithemis aconita</i> Liefstinck, 1969	56.		A	O	R	A	A	A	1	1	1	1	1
<i>Trithemis africana</i> (Brauer, 1867)		NT	U	F	R		A		1	1*			
<i>Trithemis annulata</i> (Palisot de Beauvois, 1807)			A	O	S				2	1	3		
<i>Trithemis arteriosa</i> (Burmeister, 1839)			A	O	S	A	A	S	1	1	1		1
<i>Trithemis basitincta</i> Ris, 1912			W	F	R		A		1				
<i>Trithemis bredoi</i> Fraser, 1953			N	O	S					1			
<i>Trithemis dichroa</i> Karsch, 1893			G	O	R				2	1	1		
<i>Trithemis dejouxi</i> Pinhey, 1978	57.		N	O	R				3				
<i>Trithemis grouti</i> Pinhey, 1961	58.		G	O	R	A	A	S	1	1	1	1	1
<i>Trithemis hecate</i> Ris, 1912	59.		A	O	?				3	1			
<i>Trithemis kalula</i> Kirby, 1900			N	O	?					1*	1		
<i>Trithemis kirbyi</i> Selys, 1891			A	O	S				2		3		
<i>Trithemis monardi</i> Ris, 1931	60.		A	O	S		A		1!	1			
<i>Trithemis pruinata</i> Karsch, 1899			G	F	R						1		
<i>Trithemis stictica</i> (Burmeister, 1839)			A	O	R				2	1			
<i>Urothemis assignata</i> (Selys, 1872)			A	O	S	S			1		1		
<i>Urothemis edwardsii</i> (Selys, 1849)			A	O	S				2	1			
<i>Zygonyx chrysobaphes</i> Ris, 1915			U	F	R			S	1	4*	1		
<i>Zygonyx flavicosta</i> (Sjöstedt, 1900)	61.		G	F	R	L	A		1	1	1		
<i>Zygonyx geminunca</i> Legrand, 1997	62.		U	F	R				3		1*		
<i>Zygonyx torridus</i> (Kirby, 1889)			A	O	R				2	1*	1		
<i>Zyxomma atlanticum</i> Selys, 1889			A	O	S		S	S	1				

Notes:

1. Includes Lempert's (1988) "*Phaon* cf. *fraseri* Pinhey, 1961";
2. The author's study of type specimens of *Sapho fumosa* and *Umma infumosa* Fraser, 1951 in the Natural History Museum in London suggest the two are synonymous;
3. Formerly known as *C. sharpae* Pinhey, 1972;
4. Formerly known as *C. mutans* Legrand & Couturier, 1986, misidentified as *C. neptunus* (Sjöstedt, 1899) by Carfi & D'Andrea (1994);
5. Formerly listed as *C. glauca radix* or just *C. glauca* (Selys, 1879);
6. "*Mesocnemis* sp. nov." in Lempert (1988);
7. *C. rossii* Pinhey, 1969, treated as a good species by Legrand (2003) is considered a synonym of *C. flavipennis* by the author;
8. Formerly placed in *Ismecocnemis*;
9. Misidentified as *E. acuta* Kimmins, 1938 by Carfi & D'Andrea (1994);
10. Formerly placed in *Enallagma*;
11. Misidentified as *A. forcipata* Le Roi, 1915 by Carfi & D'Andrea (1994);
12. Single female holotype from Sierra Leone is unlike any known African species and may pertain to a mislabelling.
13. Includes *C. moorei* Longfield, 1952;
14. Formerly known as *P. angelicum* Fraser, 1947;
15. Formerly known as *P. basicornu* Schmidt in Ris, 1936;
16. Formerly known as *P. flavipes* Sjöstedt, 1899 or *P. f. leonense* Pinhey, 1964;
17. Described as *Aciagrion walteri* by Carfi & D'Andrea (1994);
18. This and the previous species probably belong to an unnamed genus;
19. Formerly known as *G. sevastopuloi* (Pinhey, 1961), identification by Carfi & D'Andrea (1994) confirmed;
20. Lempert's (1988) "*Gynacantha* sp." female could not be assigned to a known species;
21. Misidentified as "*Gynacantha* cf. *usambarica* Sjöstedt, 1909" by Carfi & D'Andrea (1994);
22. Female published by Lempert (1988) as *H. fuliginosa*;
23. "*Diastatomma* sp. nov." in Lempert (1988);
24. Formerly known as *G. madi* Pinhey, 1961;
25. "*Lestinogomphus* sp. 2" in Lempert (1988);
26. "*Lestinogomphus* sp. 1" in Lempert (1988);
27. "*Lestinogomphus* sp. 3" in Lempert (1988);
28. Includes Lempert's (1988) "*Microgomphus* sp." females;
29. Records of *O. quirrkii* Pinhey, 1964 and *O. supinus* Hagen in Selys, 1854 listed under this name, the only one for this type of *Onychogomphus* from West Africa;
30. "*Paragomphus* sp. nov. 3" in Lempert (1988);
31. Formerly known as *P. bredoi* (Schouteden, 1934) includes records by that name and "*Paragomphus* sp. nov. 2" by Lempert (1988) and misidentified as *P. cognatus* (Rambur, 1842) by Carfi & D'Andrea (1994);
32. "*Paragomphus* sp. nov. 4" in Lempert (1988);
33. "*Paragomphus* sp. nov. 1" in Lempert (1988);
34. May be the same as *P. moundi* and *P. helenae*;
35. Lempert's (1988) "*Phyllogomphus* sp." male is unlike known species;
36. Identified as *T. tenaculatus* (Fraser, 1926) by Lempert (1988);
37. Formerly known as *P. bifasciata* Martin, 1912;
38. Lempert's (1988) "*Macromia* sp. nov." is this species;
39. Formerly known as *P. funicularia* (Martin, 1907);
40. Formerly known as *Sleuthemis displacoides* Fraser, 1951 and *Monardithemis leonensis* Aguesse, 1968;
41. Formerly mistaken for *A. biordinata* Karsch, 1899;
42. Misidentified as *C. saxicolor* Ris, 1921 by Carfi & D'Andrea (1994), old Liberian record of that species also included here;
43. Three specimens published by Lempert (1988) as *D. lefebvreii*;
44. Formerly placed in *Philonomon*;
45. Misidentified (partly) as *Lokia incongruens* by Carfi & D'Andrea (1994);
46. Several records accidentally excluded by Lempert (1988);
47. Some records may require reexamination following confusion with *M. zygoptera*;
48. Formerly placed in *Eothemis*;
49. Formerly placed in *Allorrhizucha*, probably misidentified as *Neodythemis scalarum* Pinhey, 1964 by Legrand (2003);
50. Formerly placed in *Allorrhizucha*;
51. All western African specimens of *N. farinosa* (Förster, 1898) examined by author pertained to *N. pujoli*;
52. Single Liberian female among material not noted previously by Lempert (1988);
53. Identification by Carfi & D'Andrea (1994) confirmed;
54. *P. lucia* and *P. portia* were not separated by Lempert (1988), but both present in material;
55. Includes *T. bifida* Fraser, 1941;
56. Misidentified as *T. bifida* Pinhey, 1970 and *T. basitincta* by Carfi & D'Andrea (1994);
57. "*T. donaldsoni* (Calvert, 1899)" in Lempert (1988);
58. Formerly known as *T. ara* Pinhey, 1961, misidentified as *T. nuptialis* Karsch, 1894 by Carfi & D'Andrea (1994);
59. Identification by Marconi & Terzani (2006) confirmed, Lempert's (1988) "*T. cf. hecate*" is probably also correct;
60. Includes *T. imitata* Pinhey, 1961;
61. Includes *Z. fallax* (Schouteden, 1934);
62. Lempert's (1988) "*Zygonyx* sp." may be this species, but the specimen is lost.