GABON BIODIVERSITY PROGRAM

BIODIVERSITY RESEARCH, MONITORING AND TRAINING IN THE GAMBA COMPLEX

THE ASSESSMENTS IN LOANGO NATIONAL PARK

BRIEFING PAPER #6

GABON BIODIVERSITY PROGRAM PUBLICATION # 20

SMITHSONIAN INSTITUTION
MONITORING AND ASSESSMENT OF BIODIVERSITY PROGRAM
CONSERVATION AND RESEARCH CENTER
NATIONAL ZOOLOGICAL PARK

FEBRUARY 2003

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The Assessments in Loango National Park

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Written and produced by Patrick Campbell, Alfonso Alonso, Michelle Lee and Francisco Dallmeier
Smithsonian Institution
Monitoring and Assessment of Biodiversity Program
Conservation and Research Center
National Zoological Park
1100 Jefferson Drive, SW Suite 3123
Washington, DC 20560 USA

February 26, 2003

The Smithsonian Institution would like to thank John E. Brown III for his efforts in establishing and managing the camp at Loango National Park.

Cover photograph: A hippopotamus in the N'dogo Lagoon, Gabon.

Gabon Biodiversity Program

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The Assessments in Loango National Park

Summary
The Smithsonian Institution Monitoring and Assessment of Biodiversity Program of the National Zoological Park has been studying the biodiversity of a remarkable wild area as part of the Gabon Biodiversity Program. This study represents the fourth assessment in the Gamba Complex and the first assessment of the newly created Loango National Park. This program is a successful collaboration of international scientists and their Gabonese counterparts. The team members are working, with support from Shell Foundation, Shell International and Shell Gabon, to better understand and protect the natural heritage of Gabon.

The results from the Loango assessment, have tremendous regional, national and international value. They provide initial baseline data for this area, which is crucial for continued conservation efforts. The findings also serve to increase awareness about conservation of biodiversity in Loango, the Gamba Complex, Gabon and throughout Central Africa.

To date, 27 Smithsonian scientists and associates, 20 Gabonese scientists and eight para-taxonomists have participated in training sessions and research projects. Open houses, lectures and slide presentations in surrounding communities and regular reports from the field have informed scientists, governmental officials, Shell employees, local residents and other stakeholders of our progress and results. Recently, the Shell Foundation launched a new website (www.shellfoundation.org) providing details about the program. The Smithsonian Institution Biodiversity Center at Vembo, established in 2001, proves to be a world-class facility for research and an ideal venue to host a regional scientific reference collection, house an information management system and serve as a training and local education outreach center.

The Loango assessment has produced remarkable results. Botanists established 27 0.1-hectare plots and have collected information on 2019 trees. Herpetologists, using techniques such as pitfalls, recorded 67 species. These include 36 species of reptiles and 31 species of amphibians. Ornithologists, employing mist nets, sightings and vocalizations, recorded 200 bird species. The mammal team, using scent posts, vocalizations and sign (tracks, scat, bones, hair, etc.), recorded 18 species of medium and large-sized mammals and at least 12 species of small mammals.

The arthropod study in Gamba continues as the scientists analyze data from more than 440,000 insects at the Smithsonian Institution Biodiversity Center in Vembo. The team's first manuscript was recently accepted for publication by the Journal of Tropical Ecology. This document will answer questions such as; What is the overall impact of human activities on insect fauna?

1. Introduction

Few places remain in Africa where one can experience truly wild lands teeming with wildlife. For thousands of years, the African rainforests stretched over three million square kilometers (km), filled with elephants, gorillas, hornbills, cobras, bongos, orchids and countless other living things. Sadly, much of these wild lands and the biodiversity dependent upon them were lost to human activities. Humans have and continue to encroach on this forest through logging, agriculture and urbanization and this has reduced the forest area and caused declines in populations of many species resulting in an overall loss of biodiversity. It is imperative that scientists assess the biodiversity of these remaining forests now and formulate measures to effectively conserve this region of extraordinary biodiversity before it is too late.

Protection of Africa's remaining forests is a priority for environmental leaders. They make efforts to locate and study the last remaining wild areas, to discover what biodiversity remains and devise means to protect it. Much of their efforts focus on Gabon, which boasts vast tracts of unspoiled tropical rainforest brimming with biodiversity. In an encouraging, proactive move, in September of 2002, the government of Gabon established a National Park system. The decree states that Gabon will set aside 10% of its land to establish 13 national parks. This legislation represents an important step towards the conservation of Gabon and central Africa's biodiversity. The establishment of a national park system also shows a commitment by the people of Gabon to protect their natural heritage.

Palm trees are a major component of the coastal forests of Loango National Park. This is one feature that sets Loango apart from other forests in the Gamba Complex.

Conservation of Gabon's biodiversity still faces considerable challenges. The development and extraction of natural resources are on the increase and despite new protection measures, biodiversity in Gabon remains threatened by resource extraction to meet human demands for food, fuel and shelter. These issues and concerns are relevant in Gabon's Gamba Complex where oil companies have been extracting rich oil reserves for more than 40 years. The Gamba Complex covers more than 11,000 square km of tropical rainforest bordering the Atlantic Ocean and extending up to 100 km inland. To protect this wild land, Gabon has established two new national parks in the Complex, Loango and Moukalaba-Doudou National Parks, the remainder of the Complex will remain under lesser degrees of environmental protection.

With support from Shell Foundation and Shell Gabon, the Smithsonian Institution Monitoring and Assessment of Biodiversity Program (MAB) and Shell International are currently collaborating on the Gabon Biodiversity Program. Studies are underway to assess the biodiversity within Loango and Moukalaba-Doudou National Parks and other regions in the Complex. These studies generate great value by providing information that will assist governmental, industrial and environmental leaders in making informed decisions about the conservation of Loango National Park and the Gamba Complex.

In 2000, MAB and the partners initiated the Gabon Biodiversity Program. An initial stakeholder workshop held in Gamba, established the needs and objectives of the Program. Participants, including a national and international team of scientific experts, proposed the following objectives (see Briefing Paper #2):

- Increase knowledge of biodiversity within Gabon through biodiversity research, assessment and monitoring.
- Promote links among stakeholders in Gabon, researchers, conservation scientists and resource developers.
- Increase in-country capacity for continued biodiversity work through technical training in established protocols.
- Disseminate the scientific information generated from the biodiversity assessments to a wide range of audiences.
- Advance the model of conservation and sustainable development through successful partnerships among local stakeholders, scientists and industry.

Following the workshop, scientists conducted the first biodiversity assessment in the Gamba region (see Briefing Paper #3). Soon after, the teams conducted assessments in Rabi (Briefing Paper #4) and Toucan (Briefing Paper #5).

In September 2002, MAB lead a team of scientists into Loango National Park. Their aim was to document the biodiversity in the park, highlight conservation concerns and develop effective conservation actions. These efforts were prompted by environmental, industrial and governmental leaders' desires to better understand and care for the wealth of plants and animals in the park.

During the Loango assessment, 21 experts, including MAB staff and an international team of scientists from the Smithsonian Institution and affiliated organizations, conducted studies and

specialized field-based training with 14 Gabonese technicians, students and collaborating scientists. This furthers our objective to increase in-country capacity by creating valuable leaders who will continue to study and promote the conservation of biodiversity in this and all of Gabon's national parks.

2. Study Area

Loango National Park is of international conservation importance. The World Wildlife Fund includes the region in its Global 200 Endangered Spaces register, IUCN considers the region as a critical site for conservation, the Ramsar Convention, an international treaty signed by 124 nations, includes Loango in its List of Wetlands of International Importance, it has recently been proposed as a World Heritage Site and the Smithsonian Institution regards Loango as a region of vast scientific and conservation value.

Loango National Park covers over 1500 km^2. The 100 km of uninhabited coastline is among the longest and most pristine in Africa. Elephants, buffalo, hippopotamus, and sea turtles frequent the beaches while whales are common along the coast. Inland, one encounters sand dunes, littoral forest, mangrove forest, coastal scrub forest, freshwater swamp, lowland seasonally flooded forest, upland non-flooded forest, open grassland and extensive lagoons and lakes. Contained further inland are extensive tracts of upland forest occasionally dissected by lowland, seasonally flooded forest along rivers and larger streams. The entire area may represent a transition zone between the Guineo-Congolian tropical forest zones (White 1983) and the savanna ecosystems of the south, thus providing important habitat for migratory species.

An aerial view of Loango National Park showing the mosaic of habitat types including ocean, beach, savanna, freshwater lagoon and coastal forests.

Over the past 40 years, oil development and selective logging occurred in select locations of the Gamba Complex, mostly in the Rabi-N'dogo region. Loango and Moukalaba-Doudou National Parks surround this zone of activity and serve as a contrast to areas of higher human encroachment and impact.

3. Biological Groups

3.1. Forest Vegetation Diversity, Composition and Structure

3.1.1. Introduction

The first step in a biodiversity assessment is often to characterize vegetation in a region. Vegetation represents the first level of energy and nutrient input into a natural system. Plants convert sunlight into energy, a process that allows plants to grow and produce leaves, fruits and flowers. The leaves, fruits, flowers and other plant parts become food for animals. Plants and the forest itself also provide shelter for animals. As examples, monkeys climb trees to escape predators and birds build nests in the holes of trees to hide their young.

The distribution and abundance of plant species depends upon environmental factors such as soil type or moisture. Thus, plant species often occur in definable arrangements called vegetation types. Depending on their needs, animals also tend to occur in predictable arrangements that are related to vegetation types. Knowledge of the diversity and distribution of vegetation types across the landscape allows us not only to understand the diversity of plant species, but also to understand the distribution and abundance of animal species.

The vegetation team at work. Left: Thomas Nzabi presses specimens as vouchers. Above: Dr. Duncan Thomas measures the diameter at breast height (dbh) of one of the trees in the vegetation plots.

Vegetation assessments in this region are the first of their kind. These assessments are crucial to prevent loss of species and to increase understanding of how these forests function and the effects of human encroachment on them.

The Loango vegetation team consisted of Patrick Campbell and Pedro Rivera, Smithsonian Institution; Henri Bourobou Bourobou (Smithsonian Research Associate) and Thomas Nzabi, the National Herbarium in Libreville, Gabon; and Duncan Thomas, Oregon State University (Appendix 1). The team conducted a 23-day assessment (23 September to 15 October, 2002) at Loango. Objectives included: (1) describe the diversity, structure and composition of vegetation in selected vegetation types, (2) determine the important tree species in each vegetation type, and (3) compare the structure and composition of the flora among vegetation types.

3.1.2. Methods

The team established 27 rectangular biodiversity plots randomly stratified in five forest types to quantitatively assess forest vegetation (Table 1). Each plot measured 50 meters (m) by 20 m (or 0.1 hectare). Within each plot, the team collected data on all trees at least 5 centimeters (cm) in diameter at breast height (dbh). Data included identification of each tree species, dbh and height.

3.1.3. Results and Discussion

The 27 plots sampled in Loango produced data on 2019 trees. This data set from Loango, combined with the 40 plots previously established in Rabi/Toucan (Briefing Paper #5), is one of the largest yet collected on vegetation in the Gamba Complex. Currently, the team is entering, cleaning and analyzing this massive data set.

A diverse forest mosaic characterizes Loango National Park. The vegetation team established plots in five distinctive forest types (Table 1). Species diversity in Loango is lower than in Rabi/Toucan (Table 1); but the higher diversity of vegetation types will likely portray a region of amazing plant diversity. The plant vouchers are currently being evaluated and soon data analyses will begin. When all species are eventually identified, the team will be able to examine spatial aspects of vegetation in Loango and Rabi/Toucan to gain insight about dominant species.

Trees of the lowland, seasonally flooded forests are often characterized by long stilt like roots that allow the trees to breath when the forest is flooded. Lianas are also a common feature of these forests. Both are visible in the photograph.

Table 1 – Comparison of mean number of species and mean number of individuals recorded in Loango National Park and Rabi/Toucan. NE = Vegetation type does not occur at the site and was therefore not evaluated.

	Number of plots sampled		Mean number of species per plot		Mean number of individuals per plot	
Forest Type	Loango	Rabi/Toucan	Loango	Rabi/Toucan	Loango	Rabi/Toucan
Upland Non-flooded Forest	8	23	17.5*	43.3*	92.9	112.1
Lowland Seasonally Flooded Forest	6	4	13.3*	41.3*	91.7	106.8
Permanently Flooded Forest	NE	8	NE	30.1	NE	105.4
Coastal Forest	6	NE	6.2	NE	59.7	NE
Savanna Gallery Forest	4	NE	13.3	NE	69.5	NE
Mangrove Swamp	3	NE	1.7	NE	30.0	NE

* Mean values are greater at Rabi/Toucan based on Student's t-test, $p < 0.01$.

3.2. Amphibian and Reptile Diversity

3.2.1. Introduction

Loango National Park is renowned for its abundance of large mammals like elephants, hippopotamuses and buffalo, but its herpetofauna, with the exception of sea turtles which have received special attention by marine biologists, has never been subject of a recent or specific study. The park is composed of a coastal vegetation mosaic on white sand, including forest, scrub and grassland. This gives rise to a peculiar environment that has never been herpetologically studied in Gabon.

The Loango herpetology team consisted of Olivier S.G. Pauwels, Institut Royal des Sciences Naturelles de Belgique and Smithsonian Research Associate; Marius Burger, University of Cape Town, South Africa and Smithsonian Research Collaborator; William Branch, Port Elizabeth Museum, South Africa and Smithsonian Research Associate; Elie Tobi and Jean-Eric Makaya, Smithsonian Institution Biodiversity Center, Gabon; Emerie Mikolo, Direction de la Faune et de la Chasse, Gabon; and Phillipe Robin, Project Loango, Gabon (Appendix 1). The team conducted a 7 week assessment (24 September to 11 November, 2002). The main objectives were to: (1) determine the herpetological diversity of Loango, and (2) to train Gabonese scientists and students and thus establish in-country herpetological expertise.

3.2.2. Methods

The team established the base camp in a grassland a few hundred meters from the beach. Sampling activities were led mainly from the camp area to 7 km inland. The team collected data on reptiles, amphibians and voucher specimens by utilizing three methods: funnel and pitfall traps, and active search. The team sampled as many vegetation types and biotopes as possible. The team installed nine pitfall trap lines, seven funnel trap lines and three combined lines, all bordered by drift fences. In the pitfall lines, 11 20-liter buckets were buried eight m from each other, giving a total line length of 80 m. Funnel trap lines consisted of six funnels, three regularly arranged on each side of the fence, and were 15 m long. The team conducted day and night active searches at every trap site. Voucher specimens were injected with formaline (5%) then preserved in 70% ethanol, and will be housed in several scientific institutions.

3.2.3. Results and Discussion

The team recorded 36 species of reptile (three crocodilians, eight chelonians, 14 lacertilians and 11 ophidians) distributed among 15 families and 29 genera. All three African crocodile species are represented in the park. The two species of softshell turtles known to occur in Gabon, live in the lagoons and mangroves of the park. These turtles are heavily hunted elsewhere in Gabon and have been extirpated from many localities. The team recorded nests on the beaches of the park of three species of marine turtles, including, the leatherback turtle (*Dermochelys coriacea*) the biggest turtle in the world. The team also obtained novel data on the diet and ecology of snake species by examining stomach contents.

The team recorded 31 species of amphibians representing seven families and 16 genera. The data include the first record in Gabon of the rare burrowing frog, *Hemisus perreti*. The data also suggest two of the documented frog species represent new taxa. This will be eventually confirmed by thorough laboratory studies.

*A Nile crocodile, (*Crocodylus niloticus*), one of three species of crocodile recorded in Loango National Park.*

Pitfall and funnel traps recorded eight and six reptile species respectively. These include two extremely rare reptiles, the giant red skink, *Lygosoma fernandi,* (in both trap types) and the little known blind snake, *Typhlops angolensis,* (in pitfall trap only). Active searching found neither species. Many specimens of *H. perreti* were recorded in the pitfall traps, while none were found by active search. Many clawed frogs, *Xenopus* spp., were recorded in the pitfall traps but just a few specimens were recorded by active searching. The team found that trapping and active searching methods served as excellent complements to each other.

Loango's reptile fauna is remarkable because of its high representation of endangered and protected species, notably all three African crocodile species, and its unusual combination of forest, grassland, and marine species. Due to the overall similarity between the grassland at Loango and the savanna at La Lopé National Park in central Gabon, and the presence of several savanna dwelling taxa at Loango, we can expect a number of additional savanna and ubiquitous species in Loango that were recorded at La Lopé. In total, the team expects a total list of about 50 reptile species for the park. Frogs are probably also more numerous. Each new record will continue to increase the already very high conservation value of the park.

*Above left: Smithsonian herpetologists Olivier Pauwels and Marius Burger study a nesting leatherback turtle (*Dermochelys coriacea*) on the beach at Loango. The herpetology team also recorded many spectacular frogs (above right) and snakes (below) in Loango National Park.*

3.3. Bird Diversity

3.3.1. Introduction

Birds are important consumers and dispersers in a tropical forest. They fill many roles, including primary consumers (frugivores and granivores), secondary and tertiary consumers (insectivores and carnivores). Since birds span many trophic levels, they may impact populations of many other species. As frugivores, they are among the most important seed dispersal agents and may be important pollinators. As insectivores, they may control insect populations, including folivores that attack forest trees and other plants. Birds are also important prey items for other

vertebrate carnivores. Their various roles also make them vital to the structure and function of ecosystems.

*A cattle egret (*Bubulcus ibis*) perches on the roots of a mangrove tree (*Manilkara lacera*).*

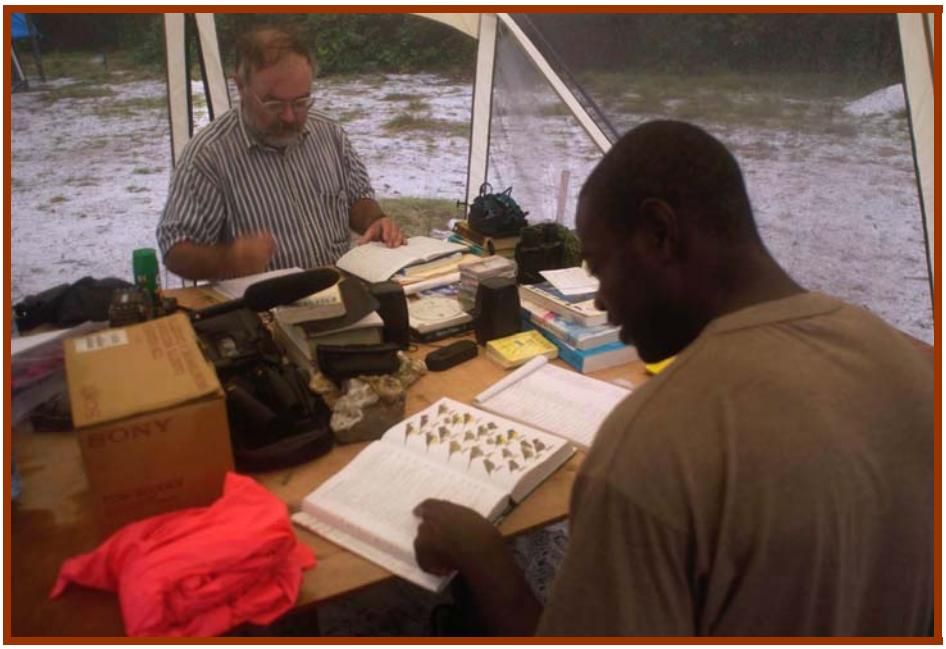
Tropical bird communities are often diverse, but may be drastically modified through alteration of their habitat. Many species are restricted to a narrow niche and are unable to survive if their habitat is altered or degraded. Because of their important ecological roles, disappearances of certain species may affect the ecological health of the rest of the biological community in an area.

The bird team consisted of George Angehr and Brian Schmidt, Smithsonian Institution; Francis Njie, Bird Life International; Gauthier Moussavou, Smithsonian Institution Biodiversity Center; and Martin Ombenotori, Brigade de Sette Cama, Gabon (Appendix 1). The team conducted a 52-day assessment (23 September to 13 November, 2002) at Loango. This period coincided with the early part of the long rainy season. The objective of the study was to assess the bird community in the Loango National Park.

3.3.2. Methods

The team sampled birds using mist nets and opportunistic observations. Mist nets are large, finely meshed nets normally placed in the understory (less than three m high) of the forest. Mist nets constrain birds moving through the forest understory.

The team established arrays of mist nets at nine sites representing three habitat types: primary forest, coastal scrub/mangrove, and savanna-forest edge. In standardized samples at these sites, 20 to 25 nets were used for a minimum of 400 net hours (usually two and one-half days). In addition to these standard samples, the team netted opportunistically at other sites and recorded birds by active searching.



Smithsonian ornithologist George Angehr and assistant, Martin Erere Ombenotori of the Brigade de Sette Cama discuss the day's sightings at the Loango base camp.

3.3.3. Results and Discussion

The team recorded a total of 200 bird species throughout Loango. The team captured 364 individuals (not counting recaptures), representing 50 species, in a total of 1,405 net-hours. Capture rates were lowest in primary forest (17.6 captures/100 net-hours) and highest in coastal scrub (37.6 captures/100 net-hours), with savannah-forest transition being intermediate (27.0 captures/100 net-hours). This result conforms to the general pattern of edge habitats having higher capture rates than undisturbed primary forest.

3.4. Mammal Diversity

3.4.1. Introduction

Mammals are important components of tropical ecosystems. Herbivorous mammals such as elephants (*Loxodonta africana*) and buffalo (*Syncerus caffer*) can have immense effects on the structure and composition of vegetation, plant productivity and nutrient cycling. Carnivorous mammals such as leopards (*Panthera pardus*) and jackals (*Canis adustas*) are the top predators of this ecosystem and may regulate populations of many species. Small mammals directly affect the distribution of plant species in tropical forests through seed dispersion and pollination. Bats, for example, are important agents in re-seeding disturbed areas. Terrestrial small mammals are also the main food source for many small- and medium-sized carnivores. As the abundances of small and terrestrial mammals change, so may those of their predators. Mammals also are valued by humans for food, trade, clothing and cultural reasons.

Mammals, especially large- and medium-sized mammals, are often better known than other taxonomic groups and contribute to conservation programs for scientific reasons and for their ability to generate public awareness and support. As examples, elephants may be regarded as keystone species because they can affect ecosystems in ways that greatly affect other species. Gorillas (*Gorilla gorilla*) and chimpanzees (*Pan troglodytes*), which are of special conservation concern because of declines related to human activities, are frequently used as flagship species to assist in generating awareness and funding for research and conservation. Many small mammals are sensitive to structural changes in the forest brought about by development activities such as

clearings for roads and oil wells and waterflow obstruction due to construction. It is expected that changes in small mammal populations will have pronounced effects on the composition of forests in the Gamba Complex.

*A hippopotamus (*Hippopotamus amphibious*) challenges a nearby rival in one of Loango's many wetlands.*

Participating team members included William McShea and Carrie O'Brian, Smithsonian Institution; Major Boddicker, Rocky Mountain Wildlife Services and Smithsonian Institution research associate; Sally Lahm, Institut de Recherche en Ecologie Tropicale, Gabon and Smithsonian Research Associate; Sylvain Guimondou, Direction de la Faune et de la Chasse, Gabon; Jean Pierre Tezi and Jean Luc Makaya (Appendix 1). Small mammals were sampled at Loango between 23 October and 11 November, 2002; medium and large mammals were sampled between 3 October and 31 October, 2003. The objective at Loango was to determine existing species of small, medium and large mammals.

3.4.2. Medium and Large Mammal Methods

The researchers established transects on the beach and inland in savanna and mixed primary and secondary forest habitats. Researchers used the transects to conduct standard mammal assessment methods including direct observation, identification of vocalizations, scent-post surveys, identification of sign (tracks, scats, bones, hair, etc.) and camera traps. The team also walked the transects at night searching for animals with flashlights.

*Two elephants (*Loxodonta africana*) bathe in a mangrove swamp in Loango.*

3.4.3. Small Mammal Methods

The team sampled small non-volant mammals using a combination of pitfall arrays and mammal sampling lines. Six sites were assessed, three with pitfalls. Habitats sampled included savanna, coastal forest, swamp/flooded forest, and upland/non-flooded forest. The small mammal crew worked with the herpetology crew to establish and monitor the pitfalls (see reptile and amphibian section for a description of pitfall lines). Sherman live-traps and Museum Specials were used at all sites, baited with either a mixture of rolled oats and peanut butter or cassava.

The team transported sampled specimens to the laboratory for identification and voucher specimen preparation. They recorded detailed measurements and information for each specimen. Each animal was then tentatively identified and tagged with a unique code number. Voucher specimens will serve as the first baseline reference voucher collection for the area.

An adult male 'silverback' gorilla (Gorilla gorilla) curiously watches the mammal team watch him. Although endangered in many parts of central Africa, gorilla populations thrive in Loango.

3.4.4. Medium and Large Mammal Results and Discussion

The team verified the presence of 18 species of medium- and large-sized mammals in the area at the time of the assessments. Elephants, forest buffalo, red river hogs (*Potamochoerus porcus*), red-capped mangabeys (*Cercocebus torquatus*), blue duiker (*Cephalophus monticola*), lowland gorillas and chimpanzees were the most abundant species observed. Sitatunga (*Tragelaphus spekii*), Ogilby's duiker (*Cephalophus ogilbyi*), yellow-backed duiker (*Cephalophus silvicultor*), water chevrotain (*Hyemoschus aquaticus*), grey-cheeked mangabeys (*Lophocebus albigena*), mustached guenon (*Cercopithecus cephus*), marsh

mongoose (*Atilax paludinosus*), black-legged mongoose (*Bdeogale nigripes*), African civet (*Civettictis civetta*), servaline genet (*Genetta servalina*), and leopards were observed or showed their presence with frequent tracks and signs.

Preliminary observations indicate that the large mammal populations in Loango are in good health with expected age classes being observed from infants to older animals. In some places, buffalo and elephant grazing on the savanna and beach grasses was heavy and grazing may be having an impact on the diversity of plant species in those habitats. In addition, preliminary analyses by the vegetation, small mammal and herpetology teams suggested that abundant large mammal populations may be impacting plant, small mammal, reptile, and amphibian populations.

3.4.5. Small Terrestrial Mammal Results and Discussion

The team examined 161 animals representing 12 species during 3,501 trap nights of effort.

When comparing Loango to Rabi, Rabi had a similar number of captures (192 animals) but about twice the number of species (26 species) with slightly more effort (4,059 trap nights). The difference in species richness may be attributed to the contrasting habitat between the two locations. The team found few small mammals in the savanna between the coastal scrub and swamp forest patches, with only two animals captured. The team's success in the coastal scrub was similar, with only five animals captured. The majority of the small mammals were captured in swamp and upland forest. The swamp and upland forest sites had lower tree species diversity in comparison to Rabi, which may also help explain the lower small mammal diversity.

One of seven species of rodents recorded in Loango. Smithsonian mammalogists at the Smithsonian National Museum of Natural History are currently working with reference collections to identify the small mammal specimens from Loango. This individual was photographed in the Smithsonian photographic studio.

In Loango the team examined 30 shrews of five species; of these, 14 individuals were of one species. The ratio of rodents to shrews was 3:1 in Loango, 1:1 in Rabi and 2:1 in Toucan. The team recorded 131 rodents of seven species, of these 72 individuals (55%) were of one species. Interestingly, this common species was present in very low numbers in the Rabi/Toucan study. At a pitfall site approximately seven km inland from camp in Loango, the rodent captures were evenly divided among four species. The small mammal community at this inland site began to resemble that of Rabi and suggested the potential of a dynamic mammal community between the coast and more inland areas.

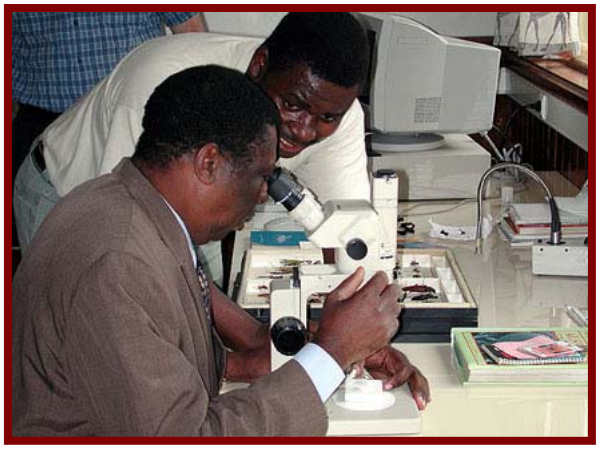
After the Loango assessment, a study was conducted in Gamba to compare the small mammal community in an area of similar habitat but with a human presence. Three pitfall sites were established in fairly homogenous secondary forest. Although the data are still being analyzed, preliminary results show the rodent community at Gamba is dominated by a different rodent species than in Loango. Only one individual of this species was captured in Loango. Clearly, additional work is needed to better understand the small mammal community in the coastal region. Our preliminary results show that species abundance and richness varies greatly among sites within the Loango-Gamba area and also between Loango and Rabi.

4. Arthropods Study at the Smithsonian Institution Biodiversity Center

4.1. Introduction

Insects dominate the living world, comprising 75% of all animal species known to date. Such diversity offers many opportunities for research, not just in discovering new species, but also in addressing environmental questions. Insects, being short-lived and having specific environmental requirements, tend to respond quickly to slight changes in the environment. These unique characteristics make insects especially useful as potential indicator species to assess the state of an environment and monitor its response soon after a disturbance.

Studying insects in the tropics, although also offering many opportunities, confronts scientists with a few challenges. First, insect communities are difficult to sample exhaustively and it usually takes much effort before one obtains representative samples of the fauna living in one area. Second, little is known yet about tropical insects, with a few exceptions, and few specialists can formally identify them to species level. Third, insect communities are known to vary greatly with the seasons, which further complicates their study.



The Major of the town of Gamba (foreground) visits the Smithsonian Institution Biodiversity Center. Here, parataxonomist Elie Tobi explains arthropod ecology and the value of the center's reference collection.

To overcome these challenges, the arthropod project was organized differently from the projects on the other groups. First, the team decided to focus its attention on the Gamba area alone and to sample insects over a full-year cycle, so that representative samples could be accumulated accounting for seasonal variations. Second, the team aimed at comparing the insect fauna in four habitats (old forest, young forest, grassland around oil wells and cultivated gardens), chosen to represent the broad ecological conditions and levels of human interaction encountered around Gamba. Third, the team chose to study the overall insect fauna, not just a particular family, to ascertain the overall pattern of diversity for insects in Gamba. Regardless, not all insects could be treated at the species level. The study was therefore divided in two stages; firstly at the family-order level for all insects, and secondly at the species level for 22 target taxa (Table 2) chosen to embody a wide taxonomic range and represent the major feeding guilds.

The overall objective of the study was to examine how current human activities around Gamba affect insect communities. To deal with the vast number of insects to be processed in this study, Smithsonian staff trained a team of eight parataxonomists selected from the local workforce who had little formal knowledge about insects beforehand. Parataxonomists are very useful when completing many labor-intensive tasks associated with an inventory. These tasks include: sampling, sorting specimens into orders and families, preparing specimens, entering data and sorting into morpho-species (Basset *et al*. in review; Basset *et al.* in press). Our team excelled in their respective tasks and their results are outlined below.

The arthropod study component of the Gabon Biodiversity Program is led by Alfonso Alonso and Francisco Dallmeier, MAB Program; Scott Miller, Smithsonian National Museum of Natural History; Yves Basset, Smithsonian Tropical Research Institute (and local team leader until December 2001); and Olivier Missa, MAB Program and Research Associate with the Royal Institute of Natural Sciences of Belgium (local team leader since January 2002). The team of parataxonomists includes Bruno Amvame, Nadine Koumba, Serge Mboumba, Gauthier Moussavou, Patricia Ngoma, Judicaël Syssou, Landry Tchignoumba and Elie Tobi, all with The Smithsonian Institution Biodiversity Center.

4.2. Methods

Twelve sites, including three replicates for each habitat, were sampled for a full-year (July 2001 to July 2002) with traps that target flying and crawling arthropods in the understory and forest litter. Each site was equipped with one ground Malaise trap, four yellow pan traps set on the ground and five pitfall traps. In addition, the team established four flight-interception traps at three meters in four of the six forest sites, totaling 124 traps. All traps were run weekly for three consecutive days, Friday to Monday. Over this year-long study, researchers sampled 38 of 52 weekends, and processed more than 440,000 insects. For the 20 target taxa sorted by the team of parataxonomists (Formicidae and Dolichopodidae are going to be directly sorted by the specialist), 15,632 specimens were prepared and sorted into more than 1,500 morpho-species (Table 2). Leading experts are currently verifying these samples to formally identify the species.

This arachnid is one of the more than 400,000 arthropods studied by the arthropod team.

4.3. Results and Discussion

Preliminary results, based on the first 13 weeks of sampling, have already been analyzed and will be published shortly (Basset *et al*. in review; Basset *et al.* in press). These results showed that 1) insects are indeed an interesting group to study when comparing different habitats and 2) extensive information can be gained at the family level, without having to analyze data at the species level. Presently, the team is conducting a full analysis of the complete data set tackling many interesting questions. These research questions include:

- Which insect group and habitat is the most affected by seasonal variations?
- Which habitat is the most diverse in species?
- Which habitat has the most peculiar fauna?
- Do we see a progressive impoverishment of the fauna from forested habitats to grasslands and cultivated gardens?
- Which insect groups are the most useful to monitor the state of those habitats?
- What is the overall impact of human activities on the insect fauna?

Table 2 – Number of specimens and species for the 20 insect target taxa processed by the parataxonomist team.

Target taxa	Number of Individuals	Number of Morpho-species
Mantodea	40	22
Orthoptera Acridoidea	356	39
Homoptera		
Fulgoroidea	2803	241
Membracidae	35	14
Coleoptera		
Buprestidae	96	17
Cerambycidae	147	53
Chrysomelidae	1,971	165
Cleridae	38	19
Coccinellidae	1,203	34
Histeridae	625	25
Scarabaeidae	2,038	88
Tenebrionidae	643	58
Neuroptera	169	24
Diptera		
Asilidae	350	50
Pipinculidae	97	16
Syrphidae	374	34
Tephritidae	428	34
Hymenoptera		
Apoidea	1,068	93
Chalcidoidea (> 2mm) [1]	1,313	176
Ichneumonidae	1,838	300+
Total target taxa in collection [2]	**15,632**	**1,502+**

[1] Chalcidoidea: mostly Chalcididae, Torymidae, Encyrtidae and Eurytomidae, with some Agaonidae, Elasmidae, Eucharitidae, Eulophidae, Eupelmidae, Leucospidae, Perilampidae, Pteromalidae and Tetracampidae.

[2] Several thousand Dolichopodid flies and Ants have also been collected, but are in alcohol for the most part and will be directly sorted by specialists.

5. Photographic Documentation of the Gabon Biodiversity Program

5.1. Introduction

MAB is conducting biodiversity research in the Gamba Complex of Gabon and laying the groundwork for long-term conservation and sustainable development in the region. For conservation efforts to succeed, it is important that scientific information and ecologically based values are effectively communicated to the public. Photographic documentation, in combination with solid biodiversity research, is a powerful tool for accomplishing this goal. In addition to the scientific value of visually documenting biodiversity and biodiversity research, photography serves the broader purpose of raising environmental awareness and increasing the publicly perceived value of biodiversity.

The role of disseminating ecological information and influencing public perceptions are especially important for the Gabon Biodiversity Program. This is true for several reasons. Rigorous ecological research in the region is just beginning, and biodiversity information has not been widely distributed to the scientific community or the general public. On a local scale, there is little science-based appreciation for the diversity of wildlife in the Gabonese forests, and on an international scale, few people are aware of Gabon or its ecological wealth. Photography, paired with documents disseminating biodiversity research, can educate and help change publicly held perceptions of conservation. Local understanding of biodiversity in the Gamba Complex will help foster more sustainable land-use practices, and international awareness will provide the perspective and resources needed to make conservation a reality.

The photographic team was composed of Carlton Ward Jr. and Yvonne Malch. The objectives for the photography component of the Gabon Biodiversity Program were to document specimens for scientific records and produce photographs for MAB publications that will highlight the diversity of life in the region.

5.2. Methods

The photographic documentation of the Gabon Biodiversity Program involves a combination of field and studio photography. The team focused on photographing three components of the Gamba Complex in the field, landscapes, wildlife and people. The goal of the studio photography was to photograph small plants and animals that are rarely seen in the wild. The team photographed animals such as reptiles, amphibians, insects and small mammals in a controlled environment. The team also developed a bird studio to photograph birds and bats in a closed environment.

5.3. Accomplishments to Date

The photography team has documented the landscapes, plants, wildlife and people of the Gamba region, Rabi/Toucan and Loango National Park. The team created a library of high quality images for MAB publications, articles and posters.

The images have supported the following documents:

- FieldNotes – 11 MAB newsletters, rich in photographic content, have been published from the field and made available over the Internet.
- Briefing Papers #5 and #6 that describe the project evolution after major field activities.
- A series of presentations to scientists, local communities and Shell executives.
- 2001 Shell Gabon Desk Calendar.

- 2002 Shell Gabon Desk Calendar.
- Shell Gabon Newsletter.
- Shell Gabon Annual Report.
- Libreville Newspaper.
- Shell International Posters and Presentations.
- Shell International Exploration and Production Business.
- MAB T-shirts.
- Distribution of species ID photos to scientists (in initial phase).
- Four poster and other media presentations at international scientific meetings.
- Article for Smithsonian Institution *Torch* newsletter.
- Feature article on Gabon Biodiversity Program for Smithsonian Institution *Zoogoer* Magazine.
- Studio documentation of fish and other aquatic organisms.
- MAB Holiday cards.

The bird team returns to Loango base camp after a long day in the field. More than 100 km of uninhabited beaches add to the beauty and value of Loango National Park.

The next goals for the photography team are to document the biodiversity of Moukalaba-Doudou National Park, provide images for a book highlighting the biodiversity of the Gamba Complex, provide photographs for magazine articles, continue to support the development of FieldNotes, more presentations to local and international communities and continued expansion of the MAB Biodiversity Image Library.

6. Communications

Communications with stakeholders continue, concentrating on government agencies such as la Direction de la Faune et de la Chasse (DFC), l'Institut de Recherche en Agronomie Forestière (IRAF), and l'Institut de Recherche en Ecologie Tropicale (IRET). Staff members from the DFC were involved in field activities at Loango. MAB staff from the Smithsonian Institution Biodiversity Center provided outreach to schools in Gamba, to Shell staff and to the Yenzi community. MAB staff also worked with staff of the local World Wildlife Fund office, supported Wildlife Conservation Society efforts in Gamba, and interacted with the local brigade and Projet Loango. The overall outcome has been increased awareness of the Gabon Biodiversity Program and new and stronger partnerships for the future.

A goal is to link biodiversity, *in-situ* research and conservation to the Smithsonian live and museum collections as well as to disseminate the results of research and the lessons learned as widely and as timely as possible. The partnership is achieving this goal by promptly informing national and international stakeholders of research findings and indicating the value of research in advancing the conservation of biodiversity. Several venues serve this process, as follow.

6.1. Field Notes

The teams have continued to distribute the newsletters describing ongoing events. The 11 newsletters produced from the field introduced the teams and participants involved, outlined the objectives, highlighted special events and illustrated the amazing biodiversity of the region through photographs and stories. The newsletters were circulated among stakeholders and other parties interested in the Program. MAB received many positive comments. The newsletters are all available on the MAB website (www.si.edu/simab).

6.2. Media

The website for the Gabon Biodiversity Program continues to be updated. The Program's page is located within the Shell Foundation site, directly at: http://www.shellfoundation.org/biodiversity/index.html. The site provides a rationale for the initiation of the Program, discusses the roots of the partnerships, the Program's objectives and current and future activities. It also posts the field notes and the briefing papers produced to date. The website allows stakeholders to keep abreast of Program activities and accomplishments and seeks to educate others.

6.3. Initiative for the Congo Basin Forest Partnership

The government of Gabon recently announced that the country is setting aside 10% of its land as national parks. To assist the government in meeting this ambitious goal, the government of the United States has agreed to assist Gabon. In September 2002, U. S. Secretary of State Colin Powell traveled to Gabon to discuss the new partnership and announce the Congo Basin Forest Partnership. Secretary Powell met with Gabonese president Omar Bongo and a group of conservation leaders. Francisco Dallmeier, director of MAB, was invited to join the delegation as the Smithsonian representative for the new initiative. The discussions continued with an international meeting of the stakeholders in Paris in January, 2003. Francisco Dallmeier and Alfonso Alonso attended this meeting as the Smithsonian representatives.

6.4. U. S. Delegation Visits Loango Study Site

The MAB team was honored by a special U.S. delegation visit to our remote camp. The delegation included John Turner (Assistant Secretary of State for Oceans and International Environmental and Scientific Affairs), Walter Kansteiner (Assistant Secretary of State for African Affairs), James Dunlap (Special Advisor to the Assistant Secretary of African Affairs), Ken Moorefield (U.S. Ambassador to Gabon), David Barron (lobbyist), Mrs. Green (government advisor for financial investments), Ron Johnson (U.S. Embassy in Gabon) and Michael Fay (Wildlife Conservation Society). Their visit provided an introduction to the value of continued studies in the new national parks of Gabon.

John Turner, U.S. Assistant Secretary of State for Oceans and International Environmental and Scientific Affairs, was part of a U.S. government delegation to visit the Smithsonian Gabon Biodiversity Program teams in Loango National Park. The delegation's goal was to observe, first hand, the biodiversity and conservation value of Loango.

7. Upcoming Activities within the Gabon Biodiversity Program

7.1. Gabon Biodiversity Program Steering Committee

The principal stakeholders of the Gabon Biodiversity Program met in Gamba Gabon in January, 2003. The participants included executive staff members of the Smithsonian Institution Monitoring and Assessment of Biodiversity Program, Shell International, Shell Foundation and Shell Gabon. The objective of the meeting was to discuss and document accomplishments to date and to identify the activities and goals for 2003. The participants agreed to the following activities for 2003:

1) An assessment of the fish communities of the N'dogo Lagoon.
2) Verification of the vegetation data collected in Rabi/Toucan.
3) An assessment of the biodiversity of Moukalaba-Doudou National Park.
4) Create a comprehensive Geographical Information System and relational databases to improve data documentation.
5) Further development of the Biodiversity Center.
6) Publication of a natural history book documenting the biodiversity of the Gamba Complex.
7) Publication of the Gabon Biodiversity Book that highlights the biodiversity of the Gamba Complex through photography.

The participants have agreed to reconvene for the next meeting of the Steering Committee in June or July of 2003.

8. References

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Briefing Papers #1 through #5 are available on the MAB website: www.si.edu/simab

Appendix 1

Gabon Biodiversity Program
Participant List

MAB Management Team

Name	Organization	Telephone	Fax	Address and E-Mail
DALLMEIER, Francisco Program Director (Washington DC)	Smithsonian Institution Conservation and Research Center, NZP, MAB Program	202 357 4793	202 786 2557	1100 Jefferson Drive SW Suite 3123 Washington DC 20560 fdallmeier@simab.si.edu
ALONSO, Alfonso Director for Conservation (Washington DC)	Smithsonian Institution Conservation and Research Center, NZP, MAB Program	202 357 4793	202 786 2557	1100 Jefferson Drive SW Suite 3123 Washington DC 20560 aalonso@ic.si.edu
LEE, Michelle Scientific Coordinator (Gamba, Gabon)	Smithsonian Institution Conservation and Research Center, NZP, MAB Program	241 55 8553	241 55 8337	Smithsonian Institution S/C Shell Gabon BP 48 Gamba, Gabon Michelle.Lee@shell.com
CAMPBELL, Patrick Program Coordinator (Washington DC)	Smithsonian Institution Conservation and Research Center, NZP, MAB Program	202 357 4793	202 786 2557	1100 Jefferson Drive SW Suite 3123 Washington DC 20560 pcampbell@ic.si.edu
PACHECO, Tatiana Program Administrator (Washington DC)	Smithsonian Institution Conservation and Research Center, NZP, MAB Program	202 357 4793	202 786 2557	1100 Jefferson Drive SW Suite 3123 Washington DC 20560 tpacheco@ic.si.edu

Participating Scientists and Counterparts

Name	Organization	Telephone	Fax	Address and E-Mail
AMVAME, Bruno	Smithsonian Institution Biodiversity Center	241 55 9610		Smithsonian Institution S/C Shell Gabon BP 48, Gamba Gabon
ANGEHR, George	MAB Program and Smithsonian Tropical Research Institute	507 212 8024	507 232 5978	Smithsonian Tropical Research Institute Unit 0948, APO AA 34002-0948 angehrg@tivoli.si.edu
BODDICKER, Major	Rocky Mountain Wildlife Services Smithsonian Research Associate	970-484-2768	970-484-0807	PO Box 999 La Porte, CO 80535 USA critrcall@earthlink.net
BOUROBOU-BOUROBOU Henri	Institut de Recherche en Ecologie Tropicale Smithsonian Research Associate	241 734 786	241 313 160	henribourobou@hotmail.com
BRANCH, William	Port Elizabeth Museum, South Africa Smithsonian Research Associate			PO BOX 13147 Humewood, South Africa 6013 bitis@telkomsa.net
BURGER, Marius	Southern Africa Frog Atlas Project Smithsonian Research Collaborator	27 21 6502330	27 21 6503434	Southern African Frog Atlas Project Avian Demography Unit University of Cape Town Rondebosch 7701 South Africa Marius@maths.uct.ac.za
COMISKEY, James	Smithsonian Conservation and Research Center, NZP, MAB Program	202 357 4793	202 786 2557	1100 Jefferson Drive SW Suite 3123 Washington DC 20560 jac@ic.si.edu
GUIMONDOU, Sylvain	Direction de la Faune et de la Chasse	241 76 1444		
KOUMBA, Nadine	Smithsonian Institution Biodiversity Center	241 55 9610		Smithsonian Institution S/C Shell Gabon BP 48, Gamba Gabon
LAHM, Sally	Institut de Recherche en Ecologie Tropicale, Gabon Smithsonian Research Associate	241-90-34-73 (Gabon) 619-287-1375 (US)		B.P. 180, Makokou, Gabon
MAKAYA, Jean Luc	Smithsonian Institution Biodiversity Center	241 55 9610		Smithsonian Institution S/C Shell Gabon BP 48, Gamba Gabon

Name	Organization	Telephone	Fax	Address and E-Mail
MALCH, Yvonne	Photographic Consultant			2645 Clearbrook Circle, Orlando FL 32810 USA yvonnemalch@yahoo.com
MBOUMBA, Serge	Smithsonian Institution Biodiversity Center	241 55 9610		Smithsonian Institution S/C Shell Gabon BP 48, Gamba Gabon
MCSHEA, William	Smithsonian Institution Conservation and Research Center, National Zoological Park	540 635 6563	540 635 6506	1500 Remount Road Front Royal, VA 22630 USA wmcshea@crc.si.edu
MIKOLO, Emerie	Direction de la Faune et de la Chasse, Gabon			BP 1128 Libreville, Gabon
MISSA, Olivier	Smithsonian Institution Biodiversity Center	241 55 9610		Smithsonian Institution S/C Shell Gabon BP 48, Gamba Gabon
MOUSSAVOU, Gauthier	Smithsonian Institution Biodiversity Center	241 55 9610		Smithsonian Institution S/C Shell Gabon BP 48, Gamba Gabon
NGOMA, Patricia	Smithsonian Institution Biodiversity Center	241 55 9610		Smithsonian Institution S/C Shell Gabon BP 48, Gamba Gabon
NJIE, Francis	BirdLife International Cameroon Ornithological Club			P O Box 3055, Messa, Yaoundé, Cameroon coc@iccnet.cm
NZABI, Thomas	National Herbarium at Libreville	241 53 71 34	241 31 3160	
O'BRIEN, Carrie	Smithsonian Institution Conservation and Research Center, National Zoological Park	540 635 6563	540 635 6506	1500 Remount Road Front Royal, VA 22630 USA
OMBENOTORI, Martin Erere	Brigade de Faune Sette Cama			Sette Cama, Gabon
PAUWELS, Olivier	Institut Royal des Sciences Naturelles de Belgique Smithsonian Research Associate	32 2 4266633	32 2 4266633	osgpauwels@hotmail.com
RIVERA, Pedro	Smithsonian Institution Conservation and Research Center, NZP, MAB Program	202 357 4793 787 886-5309		PO Box 22768 San Juan Puerto Rico 00931-2768 coabey@caribe.net
ROBIN, Phillipe	Project Loango			Iguela, Gabon

Name	Organization	Telephone	Fax	Address and E-Mail
SCHMIDT, Brian	Smithsonian Institution, National Museum of Natural History	202 357 2030	202 633 8084	10th St. and Constitution Ave., NW Washington, DC 20560 Schmidt.brian@nmnh.si.edu
SYSSOU, Judicael	Smithsonian Institution Biodiversity Center	241 55 9610		Smithsonian Institution S/C Shell Gabon BP 48, Gamba Gabon
TEZI, Jean Pierre	Smithsonian Institution Biodiversity Center	241 55 9610		Smithsonian Institution S/C Shell Gabon BP 48, Gamba Gabon
THOMAS, Duncan	Oregon State University	541-929-4155		529 NW Thirty-first Street Corvallis, Oregon 97330 USA
TOBI, Elie	Smithsonian Institution Biodiversity Center	241 55 9610		Smithsonian Institution S/C Shell Gabon BP 48, Gamba Gabon
WARD, Carleton	Smithsonian Institution Conservation and Research Center, NZP, MAB Program and University of Florida	352 377 0757		1824 NW Third Place #34 Gainesville, FL 32603 carltonward@yahoo.com