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Author(s)	ANDO, Chieko; IWATA, Yuji; YAMAGIWA, Juichi
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## PROGRESS OF HABITUATION OF WESTERN LOWLAND GORILLAS AND THEIR REACTION TO OBSERVERS IN MOUKALABA-DOUDOU NATIONAL PARK, GABON

Chieko ANDO, Yuji IWATA, Juichi YAMAGIWA  
*Laboratory of Human Evolution Studies, Graduate School of Science,  
Kyoto University*

**ABSTRACT** We have conducted habituation of western lowland gorillas since May 2003 during a long-term socio-ecological survey on primates in Moukalaba-Doudou National Park (Moukalaba N.P.) in Gabon. After a training program to increase the skills of trackers to search for gorillas in tropical forest, we identified one group named 'Group Gentil' (GG). Since October 2005, we have focused our efforts on habituating this group and carrying out all-day follows that have resulted in the identification of most adult and subadult individuals in GG. Here, we describe the habituation process of GG and the major problems we faced in habituation. First, we had to employ inexperienced trackers and modify our methods according to the gorillas' responses. Subsequently we continued to employ the same trackers and formed two teams consisting of researchers and trackers to search for gorillas on a daily basis. The skills of our trackers in performing constant and reliable follows of GG have gradually increased. Furthermore, our persistent follows seemed to have a less disruptive effect on their ranging patterns. Once all-day follows were achieved, GG came to tolerate our presence. Juveniles approached us with curiosity when the silverback male remained nearby. Males were habituated more quickly than females, as observed in other habitats. However, distinct differences were found in the responses to human observers between the silverbacks and females. Unlike mountain gorillas and eastern lowland gorillas, female western gorillas at Moukalaba showed aggressive responses to our approaches and occasionally attacked us with threatening vocalizations. Such female aggressiveness resembled that observed at Mondika in the process of habituation. However, while the silverback male usually ignored female aggression at Mondika, the silverback frequently rushed onto aggressive females to stop them at Moukalaba. Based on these similarities and differences in the habituation process at Moukalaba, we propose recommendations for achieving successful habituation.

**RÉSUMÉ** Nous avons réalisé un travail d'habituation des gorilles depuis mai 2003 au cours d'une étude longitudinale sur l'écologie sociale des primates du parc national de Moukalaba-Doudou au Gabon. A la suite de la formation des pisteurs pour chercher les gorilles en milieu forestier, nous avons identifié un groupe que nous avons appelé « Groupe Gentil » (GG). Depuis octobre 2005, nous avons focalisé nos efforts d'habituation sur ce groupe. Aujourd'hui, la plupart des adultes et subadultes du groupes sont identifiés et nous pouvons les suivre sur une base journalière. Dans le présent article, nous décrivons le processus d'habituation du groupe « GG » et les principaux problèmes que nous avons rencontré. Nous avons dû employer des pisteurs inexpérimentés et adapter nos méthodes de recueil de données en fonction de la réponse des gorilles au suivi. Suite à cette formation, nous avons constitué deux équipes associant des chercheurs et des pisteurs pour suivre les gorilles sur une base journalière. Les compétences des pisteurs se sont accrues au cours des suivis successifs et sont aujourd'hui d'une grande fiabilité tandis que les suivis répétés nous ont permis d'habituer graduellement et lentement les gorilles à notre présence en limitant les dérangements inhérents à ce processus. Ainsi, à la fin de notre étude, les individus du groupe « GG » toléraient notre présence. Les

jeunes faisaient montre de curiosité et nous approchaient alors que le dos argenté se trouvait à proximité. Les mâles ont été habitués à notre présence plus vite que les femelles, comme cela est observé dans d'autres habitats. Cependant, des différences distinctes ont été observées dans la réponse apporté par le dos argenté et les femelles à la présence d'observateurs humains. Comme chez les gorilles de montagnes et ceux des plaines de l'est, les femelles des gorilles occidentaux ont présenté des réponses agressives à nos approches et occasionnellement ont cherché à nous intimider en poussant des vocalisations. Cette agressivité des femelles ressemble à celle observée au cours du processus d'habituation à Mondika. Mais, alors que le dos argenté de Mondika ignore le comportement agressif des femelles, celui de Moukalaba les a plusieurs fois chargé pour stopper les agressions. Sur la base de ces similarités et différences dans les processus d'habituation, nous proposons des recommandations pour que celles-ci soient des succès

Key Words: Western lowland gorilla; Habituation; Moukalaba-Doudou N.P.; Tracking skills; Female aggression.

## INTRODUCTION

Habituation of wild gorillas has been conducted without provisioning to observe their behavior directly, with the aim of developing both research and eco-tourism (Schaller, 1963; Fossey, 1983; Tutin & Fernandez, 1991; Bermejo, 1997; Butynski & Kalina, 1998; Yamagiwa & Kahekwa, 2001; Cipolletta, 2003; Williamson & Feistner, 2003; Blom *et al.*, 2004; Doran-Sheehy *et al.*, 2007). It is possible to conduct various ecological studies, such as diet, group size and density estimation, without habituation by collecting data on feeding signs, feces, and nests. However, social or behavioral ecology is usually accomplished by direct observations. Habituation is crucial to observing wild animals, such as gorillas, that inhabit dense forests.

Habituation of mountain gorillas in the Virunga Volcanoes has generally taken a few years or at least several months (Schaller, 1963; Fossey, 1983), as is the case for eastern lowland gorillas (Yamagiwa & Kahekwa, 2001; Yamagiwa, 2003). Their terrestrial locomotion leaves distinct signs on the ground, and their feeding signs are always visible on their fresh trails in dense herbaceous vegetation. These conditions may facilitate tracking gorillas in the montane forests. The high cohesiveness of their grouping may also enable the observers to habituate all members of a group simultaneously (Doran-Sheehy *et al.*, 2007). By contrast, due to sparse undergrowth and their arboreal locomotion, tracking western gorillas is difficult (Tutin & Fernandez, 1991; Tutin, 1996; Bermejo, 2004). Their fresh trails are invisible and frequently lost during tracking. Strong hunting pressure, a threat that persists to the present, may also prevent them from accepting a human observer. Habituation of western gorillas requires improvements in tracking technology and skills, and it takes a longer time than with mountain gorillas and eastern lowland gorillas before success is achieved in the focal follows of individuals.

Habituation processes for western lowland gorillas have been described at three study sites (Lopé, Gabon, Tutin & Fernandez, 1991; Williamson & Feistner, 2003; Bai Hokou, CAR, Cipolletta, 2003; Blom *et al.*, 2004; and Mondika, CAR, Doran-

Sheehy *et al.*, 2007). The behavioral responses of gorillas to human observers differ between sexes. Males are more aggressive than females, who usually show fear at Lopé and Bai Hokou (Tutin & Fernandez, 1991; Cipolletta, 2003), while females are more aggressive than males after the initial phase of habituation at Mondika (Doran-Sheehy *et al.*, 2007). Habituation affected daily path length of gorillas at Bai Hokou (Cipolletta, 2003). Group size and cohesion influenced the habituation process at Mondika (Doran-Sheehy *et al.*, 2007). These reports suggest variations in gorillas' responses between habitats and the different methods used for habituation. More information is needed on the changes in gorilla responses corresponding to the habituation process, as well as a comparison between habitats in order to establish an optimal method of habituation.

Since May 2003, we have conducted habituation of a group of western lowland gorillas with the aim of collecting long-term data on their socio-ecology in Moukalaba-Doudou National Park, Gabon. We selected this site for several reasons; 1) high gorilla density (more than 3 gorillas/km<sup>2</sup>), 2) sympatric coexistence with chimpanzees, and 3) absence of hunting pressure on the great apes by nearby villagers. Until September 2007, we have applied different methods of habituation according to the responses of gorillas, who have gradually tolerated the presence of human observers. Here, we describe the habituation process and compare the behavioral responses of gorillas to our approaches with those to approaches taken at other sites. We discuss factors facilitating the habituation of gorillas and implications for their conservation.

## METHODS

### I. Study Site and Study Subjects

We conducted this study in Moukalaba-Doudou National Park (Moukalaba N.P.), Gabon (Fig. 1). Moukalaba N.P. is located about 700 km to the south of the Capital City, Libreville and covers 5,028 km<sup>2</sup>. Vegetation types are mixed with primary forest, secondary forest, riverine forest, montane forest, and savanna. Our study site is located on the southwest side of the park. Its area (about 30 km<sup>2</sup>) is comprised of three zones: Boutsiana, Dougetsi and Riv. Moukalaba. The study site is roughly divided into four vegetation types: old secondary forest, riverine forest, young secondary forest (ancient plantation of *Musanga cecropioides* and *Aframomum* sp. are dominant), and savanna. Annual rainfall in the study area fluctuated from 1,582 mm to 1,886 mm for three years (2004–2006). Mean monthly minimum and maximum temperature ranged from 21.3 to 24.1°C, and 29.3 to 33.7°C, respectively. Two seasons are distinct: a rainy season from October to April and a dry season from May to September. During the three month in the middle of dry season, it seldom rains. Local people have mentioned a short dry season around December-January, but it is not always distinct.

The Moukalaba area was inscribed as a Forest Reserve in 1962 and as a National Park in 2002. Selective logging started in 1962 and many routes were constructed in the reserve for timber transportation. Local people living near the

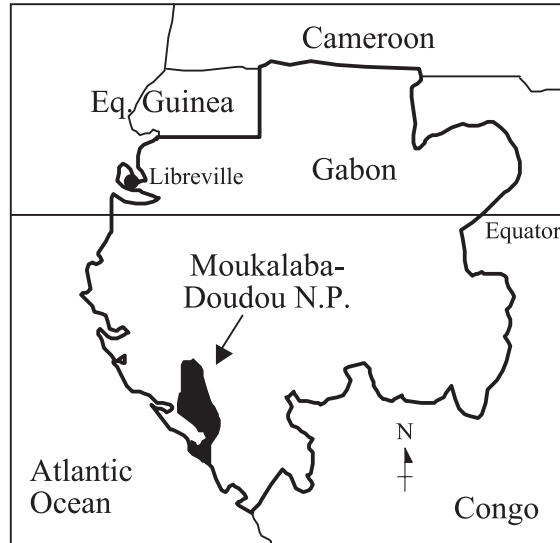


Fig. 1. Study site: Moukalaba-Doudou National Park in Gabon.

Park say that gorillas had been hunted in this period when logging was actively carried out. The Gabonese Government decided to prohibit hunting and collecting wildlife in 1986. The logging company left Moukalaba 1988, and no poaching of gorillas has been recorded since then. We started ecological studies on a sympatric population of gorillas and chimpanzees in this area in 2001, after a preliminary survey by Yuji Takenoshita in 1999. We made an extensive survey of vegetation types in the study area and of the abundance of gorillas and chimpanzees. We also followed several groups, mostly collecting fecal samples and feeding remains. At least three groups of gorillas, two or three solitary male gorillas, and one unit group of chimpanzees inhabit our study area. In January 2004, we decided to habituate a group of gorillas named Group Gentil (GG), which consisted of 16–19 nest builders with at least three suckling infants, estimated by nest counts along with measurements of feces.

## II. Research Methods

We employed Local people (farmers) inhabiting three villages (Konzi, Doussala, and Mboundou) adjacent to Moukalaba N.P. as trackers. We were based with them at the Boutsiana Camp, which is located 4km from Doussala, the nearest village. Two to five trackers rotated every three to four weeks. One to three teams, each consisting of a researcher and one or two trackers, were formed to search for gorillas and chimpanzees. We also employed women villagers as camp keepers and two keepers rotated every three weeks.

Every morning, we left the camp at dawn and walked on research routes or elephant paths to find fresh signs of gorillas such as feeding remains, foot prints, feces, or nests. When we found fresh signs of gorillas, we followed the trail until

we encountered the gorillas. We were able to confirm GG with some individuals who had already been identified.

When we found gorillas, we approached slowly to observe them and announced our presence with belch vocalizations (Fossey, 1972). We recorded the number of gorillas seen, ages, sexes, and their activities (feeding, resting, playing, etc.). We applied age classes as Silverback: +13 years, Blackback: 10–12 years, Adult female: +10 years, Subadult: 7–9 years, Juvenile: 4–6 years, and Infant: 0–3 years (Schaller 1963). We also recorded their faces and other characteristics by camera and video for identification. We counted the number of nests and measured nest diameters and feces to estimate the age-sex composition of the group.

Our contacts with gorillas included both visual and indirect (auditory) encounters. Observers were sometimes unable to observe gorillas directly due to thick vegetation. We include such cases as indirect contacts when we could confirm their presence within 20 m from us, judging from their voice and sound. Direct contact time was defined as the time in which at least one individual gorilla was seen. A contact time started when gorillas were aware of our presence and finished when the last individual or observer moved outside the range of auditory contact (about 20 m).

We divided the study's duration into five periods according to our methods and the responses of gorillas as follows:

- 1) Period 1: May–December 2003 (8 months). This covers the time from when we started long-termed study until we identified GG. Since the abilities and skills of local people hired as trackers were unknown, we employed 16 villagers who wanted to work with us. A team consisting of one researcher and two trackers was formed to search for gorillas within the study site on a daily basis. We regularly walked on the research routes in the Boutsiana zone and tried to find any gorilla group or solitary gorillas.
- 2) Period 2: January 2004–October 2005 (22 months). This was from when we identified GG until we began persistently following them. We selected seven trackers with high abilities to follow the fresh trails of gorillas and two or three trackers rotated every three weeks. As in Period 1, a team consisting of one researcher and two trackers was formed to search for GG everyday. When we could not find GG, we extended the search into the entire study area (30 km<sup>2</sup>), including Dougetsi and Riv. Moukalaba Zones. Although we usually walked all day to search for GG, we sometimes divided a day into two times (morning and afternoon). When we found other gorilla group, or solitary gorillas, we also tried to contact them.
- 3) Period 3: November 2005–January 2007 (15 months). This period was from when we started to persistently follow GG until when we made the first complete follow of GG during a whole day. Two teams (first team consisted of one tracker and one researcher and second team consisted of two trackers) were formed to search and follow GG only. We started tracking from the last place we had left GG or from the field sign of the previous day we had last seen GG. When we first encountered gorillas each day, we tried to confirm whether the group was GG by the presence of identified individuals. If it was not GG, we stopped following them and started searching for GG again. We

- continued to observe them until they moved off and recorded their activities as long as possible. If we were attacked by gorillas, we stopped approaching them. When they moved away out of sight, we resumed following them to reestablish contact, but this was done only up to three times per day to avoid increasing their stress. When we contacted them, trackers of another team followed the trails of GG backward to nest sites and recorded the number of nests and measured the feces remaining in each nest. The two teams always communicated using hand-held radios to exchange information. We also recorded their daily path and the location of their nest sites by GPS (Global Positioning System). We have used radio to communicate since June 2006.
- 4) Period 4: February–June 2007 (5 months). This was the preliminary period of complete follows of GG during an entire day. Several times a month, we tried to track them from morning to evening until they constructed their new nests. Two teams were formed as in Period 3. We decided to keep about 20 m as minimum distance from GG while contacting them. We contacted with GG up to three times a day, except for days of complete following.
  - 5) Period 5: July–September 2007 (3 months). This period was characterized by complete following over an entire day. Three teams consisting of one researcher and one tracker started the all-day following everyday. After we contacted GG, the first team always followed GG and the second team searched for their nest site. The third team changed with the first team to follow GG at noon and continued tracking until when GG made their nests in the evening. In September 2007, one researcher and three trackers formed two teams, which alternately followed GG and searched for nest sites everyday. We always kept about 20 m as a minimum distance from GG, except when gorillas approached us.

## RESULTS

From May 2003 to September 2007 (53 months), we devoted our efforts to the habituation of gorillas for 1,340 days (average 25.3 days/month). Between May and June 2004, and between March and May 2005, the tracking was conducted only by trackers due to the absence of researchers for five to seven days per month. Average tracking time (at least one team working in the field) was 6 hours 4 minutes between Period 1 and Period 4. In Period 5, when we started the all day following, the average tracking time was 9 hours 15 minutes.

### I. Progress of Following Methods

In Period 1, we started walking regularly on the research routes in the Boutsiana zone to find new field signs of gorillas. Since dietary features and ranging patterns of gorillas in Moukalaba N.P. were unknown at that time, we only tried to find their fresh field signs and to track forward, instead of anticipating their location. However, it was difficult to track their trails, due to poor undergrowth. Their footprints did not remain on the hard ground surface during the dry season and

disappeared quickly during the rainy season. Small and fragmented feces remained on their trails, but due to the gorillas' arboreal locomotion and long daily path length, such evidence did not constitute a good indicator for tracking. Adding to these difficult conditions, the trackers had no experiences in following the trails of wild animals, especially those of gorillas, although some of them had experience working for logging companies and some knowledge of the trees and plants in the tropical forests of Gabon. It took months or even years for each tracker to establish the skills needed for tracking the trails of gorillas.

In Period 2, we selected seven trackers who had the abilities and skills to work in the forest. We discussed how to track the trails of gorillas each time, and their tracking skills were gradually improved. When we could not find any fresh sign of gorillas in the Boutsiana zone, we extended our searching area to the Dougetsi and the Riv. Moukalaba zones. We also walked on elephant trails frequently to search for field signs of gorillas, since they occasionally passed elephant trails. Consequently we found some signs of gorillas in other zones during the absence of gorillas in the Boutsiana zone, and thus recorded the migration of gorillas across zones. Based on these results, we expanded the size of our study site.

In Period 3, we focused our searching efforts on one group of gorillas (GG). We discussed every evening how to adjust our tracking to GG's daily path appropriately and how to approach GG without threatening them. The trackers' increased knowledge of the ranging patterns of GG raised our expectations of their location and tracking skills little by little.

In Period 4, we tried all-day following of GG for a few days a month. During 11 days in which we followed GG throughout the daytime, we did not find any evidence that GG avoided us or changed their ranging area in comparison with their usual movement. We attained high success in contacting GG on the next day after completing an all-day following. Therefore, we confirmed that all-day following was an effective method to increase the opportunity of contact with GG as long as our contacts don't give the gorillas much stress.

In Period 5, we established a system of all-day following and achieved a total of 40 days of all-day following during 89 tracking days (45%). We also succeeded in tracking their daily path completely (nest to nest) on most of those days.

## II. Change in the Number of Days We Encountered Gorillas

During the study period, we encountered gorillas a total of 737 days (403 days with GG, 82 days with other identified groups/solitaries, and 252 days with unidentified groups/solitaries). The number of days on which we encountered unidentified groups/solitaries has gradually decreased with time, while that with GG has increased (Fig. 2). GG was included as an unidentified group when we started searching for gorillas. We had probably frequently encountered GG in the period before we identified them. Monthly number of encounter days with all gorillas was limited below 20 days in Periods 1 and 2, started to increase in the last half of Period 3, and prominently increased in the Period 5.

The number of encounter days with GG started to increase in Period 3 when we focused our search efforts on GG by forming two teams of trackers. The



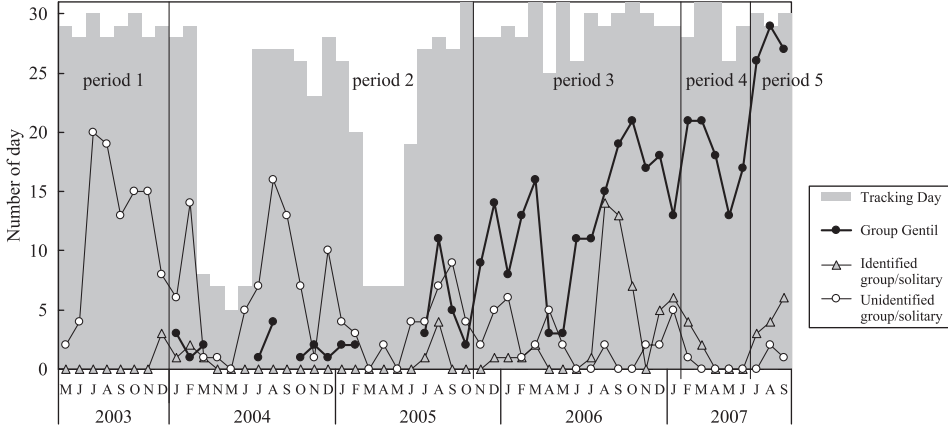


Fig. 2. Monthly change in the number of encounter days with gorillas.

number of encounter days with GG fluctuated until June 2006. Those in April and May 2006 were very low, due to the absence of researchers. Only one team of trackers searched for field signs of GG without researchers during these months. Their low success in encounters with GG suggested that the collaboration of two teams was crucial for successful tracking. Since June 2006, we have again worked with two teams including two researchers. In addition, we started using radios for communication between the two teams. When one team found a new field sign of GG, they informed the other team and discussed how to follow their trail effectively. The number of encounter days with GG increased again, and it has been maintained at a high level of success until the present. The trackers also learned effective methods of following GG from their daily path routes and ranging patterns. They could anticipate the location of GG correctly when we lost their trails.

### III. Number and Duration of Contacts with GG

Table 1 shows the total number of contact days, total contact times, average monthly number of contact days with at least two repeated contacts, and average daily duration of contact time. Between January 2004 and September 2007, we contacted GG 403 days, for a total of 944 contacts. The total duration for contacts with GG was 19,840 minutes (330 hour 40 minutes). In Period 2, there were few repeated contacts per day with GG. The number of days with repeated contacts per day gradually increased in Period 3 and Period 4. In the Period 5, we contacted GG more than twice almost daily and the monthly number of days with repeated contact more than doubled (23.7 days) the previous periods. The duration of contact time varied from 0 (zero) to 281 minutes. Furthermore, the gorillas' observed activities varied (feeding, moving, and resting). However, the average daily duration of contact time increased clearly over time. Finally, we attained the ability to maintain stable contact with GG everyday for an average 126.1 minutes per day in Period 5.

**Table 1.** Number of contact days, contact times and duration of contact time with Group Gentil.

Period	Total number of contact days	Total contact times	Average monthly number of contact days with repeated contact more than 2 times	Average daily duration of contact time (min)
1 May–Dec. 2003 (8 months)	0	0	0	—
2 Jan. 2004–Oct. 2005 (22 months)	40	80	1.1	19.2 (N=61, SD=29.5)
3 Nov. 2005–Jan. 2007 (15 months)	191	288	3.9	30.7 (N=221, SD=37.7)
4 Feb.–Jun. 2007 (5 months)	90	198	11.6	78.8 (N=106, SD=51.5)
5 Jul.–Sep. 2007 (3 months)	82	400	23.7	126.1 (N=310, SD=23.3)
Total	403	944	4.0	60.9 (N=698, SD=38.7)

**Table 2.** Group composition of Group Gentil.

Age-class	Group composition
Silverback (+13 years)	1 (1)
Adult female (+10 years)	9 (8)
Subadult male (7–9 years)	1 (1)
Juvenile (4–6 years)	5 (2)
Infant (0–3 years)	6
Total	22 (12)

( ) shows the number of identified individuals

#### IV. Group Composition and the Number of Identified Individuals of GG

Table 2 shows the age/sex composition and the number of identified individuals of GG. We have tried to identify the individual members of GG since January 2004. However, the identification had not progressed well until Period 3 due to the low frequency of contacts with GG. GG always ran away soon after they noticed our presence. Since Period 3, we could identify individuals little by little while increasing our contacts with them. Finally, we confirmed a silverback male, a subadult male, 9 adult females, 5 juveniles and 6 infants, a total of 22 individuals in GG, 12 of which we identified and named.

#### V. Changes in Responses of GG to Human Observers

The responses of gorillas in GG to human observers changed with time as habituation progressed. In Period 2, almost all gorillas always ran away at encounters with us. Females screamed and the silverback male made “wraagh” vocalizations (Schaller, 1963; Fossey, 1972). They seemed to be scared at the encounters when they stayed in trees. Sometimes we approached gorillas without knowing their presence was close to us, and the gorillas were frightened away from us

very quickly.

In Period 3, since the frequency of encounters increased, the gorillas did not run away immediately after contact with us, but they still avoided staying with us. They sometimes continued feeding or resting at the place while noticing our presence. When we contacted GG while they were feeding in trees, they descended to the ground. But after several minutes they climbed up to feed again in the trees. However, if we contacted them near their nest sites, they tended to avoid us and to change nesting place. During this period, we had not yet decided to maintain a certain distance from GG. When most of the gorillas were frightened away in the encounters at close distance, only the silverback stayed behind and threatened us with “wraagh” vocalization while hiding in thick vegetation. He probably warned us to keep our distance. When we kept about 20 m from GG, the silverback appeared silently without threatening us. Some juveniles started approaching us within 10 m distance showing curiosity.

In Period 4, since we kept a distance of about 20 m from GG, gorillas had gradually stopped running away. However, when they did not initially notice our presence, they still showed fear in close contact with us. Therefore, we started to show our presence with the belch vocalizations before GG approached us within 10 m. Some females started to show us aggression and sometimes attacked us to grasp our legs with their hands. We sometimes followed them until evening and contacted them near their nest sites. Although they noticed our presence, they did not change the nesting place.

In period 5, the silverback male came to show no visible response to our presence. When we kept a distance of 20 m from GG, even if we contacted GG more than twice per day, the silverback did not threaten us. Finally, we could continue following them for a whole day. Some juveniles approached us frequently with curiosity, when the silverback stayed close to them. We have never seen the silverback or females to stop these juveniles from approaching us. However, some females screamed and roared in contacts with us, and attacked us aggressively. The silverback occasionally rushed onto these aggressive females as if he had intended to stop their attacks.

## VI. Activity of GG during Habituation

We observed interesting behavior of GG during the habituation process. When we followed GG, two females having juveniles aged from 4 to 5 years old occasionally showed aggression to us. Their aggression has increased since we started all day following of GG in February 2007. After some repeated contacts with us, these females hid themselves in the bush to wait for our next approach, even when other members had already left, and tried to threaten us with aggressive vocalizations. They sometimes attacked us by grasping our legs with their hands to bite them. Here we show some examples of female aggression at encounters with us.

Case 1: from 16:28 to 16:35 (7 minutes) on August 15, 2007

Before this encounter, we had already contacted GG 8 times in the day. GG probably knew that observers followed behind them. Most of the gorillas fed on

the pith of *Aframomum* sp. on the ground at a distance of 15 m from us. One female glanced at us in the open space from a distance of 10 m. She emitted an alarm vocalization such as ‘wu, wu, wu’ and started to rush onto us with aggressive vocalizations (bark). Then she hid herself in thick undergrowth at a distance of 5 m from us. The silverback immediately rushed onto the female to grasp her with “wraagh” vocalization. The female became calm and the silverback left the place. However, the second female started to attack us with aggressive vocalizations as did the first female. The silverback returned to rush onto the second female. After a while, both females started to move calmly together.

Case 2: from 8:48 to 8:55 (7 minutes) on September 11, 2007.

We contacted GG for the second time this day. One female walked behind the silverback. She noticed our presence and emitted an alarm vocalization. She rushed onto us until a distance of less than 4 m from us and hid herself in thick vegetation. The silverback rushed onto this female with “wraagh” vocalization. The female moved away from us and became calm. The silverback emitted a vocalization ‘Grurururu’ which was usually heard in tense situations, probably with a function to ease tension. GG, including the silverback and the female, rested together in that place until 9:00 and then moved away for foraging.

In Period 5, females showed aggressive responses to us in 22% of our total contacts with GG. In most cases, the silverback ran after these aggressive females emitting “wraagh” vocalization, pulled them down to the ground, or just stopped their movements. Such positive preventive actions by the silverback occurred in 70%, no response in 24%, and unknown in 6% of the total cases of female aggression to human observers.

## DISCUSSION

Habituation of western lowland gorillas in the Moukalaba-Doudou National Park described in this paper took a similar process to those used in other habitats of western gorillas (Lopé, Tutin & Fernandez, 1991; Bai Hokou, Cipolletta, 2003; Blom *et al.*, 2004; Mondika, Doran-Sheehy *et al.*, 2007). Since we focused our search efforts on a single group of gorillas (GG), it took 21 months until achievement of all-day follows. This is comparable to 23 months at Mondika for achievement of all-day focal follows of a silverback male (Doran-Sheehy *et al.*, 2007).

Habituation of gorillas in the tropical forests of Central Africa requires high tracking skills prior to making the decision of which particular group to follow. As our study shows, it is important to employ the same trackers to continue searching gorillas in the forest in order to increase their tracking skills and techniques. These abilities includes:

- 1) Identifying the trails of gorillas from field signs (feces, foot print, feeding remains, etc);
- 2) Identifying vocalization of gorillas or noise made by gorillas, and to locating gorillas by judging the direction of these sounds;
- 3) Tracking the fresh trails of gorillas as long as possible in order to encounter gorillas.

Accumulated experience in the forest and discussion on how to anticipate their location on a daily basis may help us to reliably and consistently follow trails of gorillas. Researchers should change the methods of habituation according to the skills of trackers and the socio-ecological features of gorillas. In other study sites, hunter-gatherers are usually employed as trackers, due to their high abilities to track wild animals in the tropical forests (Tutin & Fernandez, 1991; Cipolletta, 2003; Doran-Sheehy *et al.*, 2007). However, no such hunter-gatherers inhabit the areas around the Moukalaba N.P. Therefore, we employed as tracker farmers from the villages adjoining the Park. When we started our research project, it was very difficult for these inexperienced trackers to find and track the trails of gorillas. Our study suggests that even such inexperienced trackers increased their skills to attain reliable follows of wild gorillas under the difficult conditions of the tropical forests of Central Africa.

Once we attained the skills to localize the GG group, we could contact them continuously and repeatedly. Cipolletta (2003) reported that the presence of human observers influenced the ranging of gorillas during the initial phase of habituation at Bai Hokou. However, we did not get such impression of ranging by GG. Our continuous follows did not affect their daily path length or the direction of their travel. Seasonal change in the availability of their preferred fruits, rather than human presence, may affect their ranging, based on their reuse of the particular sites for nest building (Iwata & Ando, 2007).

Our study suggests that successful habituation needs constant contact with the same group and the same individual for habituation. However, it is difficult to contact the same individual repeatedly, due to the dispersion of western lowland gorillas (Tutin, 1996; Remis, 1997). Owing to the different responses between sexes to the presence of humans, silverback males are more quickly habituated than females in both mountain gorillas (Fossey, 1983) and western lowland gorillas (Tutin & Fernandez, 1991; Cipolletta, 2003; Doran-Sheehy *et al.*, 2007). Our study also supports these previous reports. When the silverback male tolerated our presence at any time in Period 5, most of the females still avoided contact with us.

The previous studies reported that males were more aggressive than females during the course of habituation (Fossey, 1983; Tutin & Fernandez, 1991; Cipolletta, 2003). By contrast, our study found more aggression by females than silverbacks in their responses to our approaches. Such female aggression has never been reported in the process of habituation of mountain gorillas and eastern lowland gorillas. Doran-Sheehy *et al.* (2007) reported similar female aggressions in the encounters with us during the process of habituation at Mondika. Females at Mondika were very aggressive, routinely attacking and occasionally biting humans before complete habituation. However, responses of silverback males to female aggression are different between Mondika and Moukalaba. At Mondika the silverback rarely joined female attacks on human observers and mostly ignored them, even if females attempted to enlist his support at Mondika. By contrast, the silverback rushed onto females who attacked us with aggressive vocalization and probably stopped them by grasping or pulling them down to the ground. These observations suggest variations in social relations among group members

between habitats of gorillas, although we need more observations on their social interactions in agonistic contexts before interpreting such variations.

Juvenile gorillas always showed curiosity and were the first to allow observers to approach them. They sometimes approached us within 10 m and played with each other for a prolonged period, especially when the silverback stayed near by. On the other hand, the silverback tolerated our presence when we kept our distance and did not approach us. When we tried to approach him within 10 m without first announcing our presence, he always threatened us. These observations suggest contacts with gorillas within 10 m should be avoided, as indicated by Blom *et al.* (2004). This distance is also appropriate for avoiding the risk of disease transmission between gorillas and human observers.

Doran-Sheehy *et al.* (2007) suggested that larger gorilla groups took a longer time to habituate than smaller groups, due to their weaker cohesiveness. Since the group size of GG (22 gorillas) is larger than average group size (about 10 gorillas) in other habitats of western gorillas (Tutin, 1996; Magliocca *et al.*, 1999; Parnell, 2002), it may take more time for complete habituation, especially for habituation of females. Adding to the difficult conditions derived from social (group size and cohesion) and ecological (poor undergrowth and arboreal locomotion) environments, other problems for habituation include: 1) External characteristics of juveniles change rapidly making them difficult to identify, although they frequently approach observers, and 2) Frequent immigration and emigration of females without infants occur, as suggested in other habitats of western gorillas (Magliocca *et al.*, 1999; Stokes *et al.*, 2003). Although we can anticipate the daily travel routes of GG based on accumulated data on their ranging for three years, we are still in the process of habituation. Further efforts will be made until we achieve a level of complete tolerance from all members of GG, by increasing the duration of contact time and increasing the number of identified individuals.

In conclusion, we propose the following recommendations for habituation of western gorillas for long-term research. The implementation of these measures is based on the skill of trackers and the situations surrounding a particular group of gorillas.

- 1) Changing methods according to the skills of trackers and to the responses of gorillas;
- 2) Focusing on a single group for habituation;
- 3) Improvement of tracker skills and techniques in searching for gorillas;
- 4) Localization and anticipation of their movements prior to contact with gorillas;
- 5) Increasing the frequency of contact with gorillas;
- 6) Increasing the duration of contact with gorillas;
- 7) Increasing the number of identified individuals.

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Correspondence Author's Name and Address: Chieko ANDO, *Laboratory of Human Evolution Studies, Department of Zoology, Graduate School of Science, Kyoto University, Sakyo, Kyoto 606-8502, JAPAN.*

*E-mail: pontapuku@yahoo.co.jp*