F-061 Search for measures to prevent the extinction of the great apes based on natural and social sciences (Abstract of the Final Report)

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[Abstract]

The great apes are on the verge of extinction. Increasing human population and activities are the major cause for their threat. The objective of this project is to draw up a permanent preservation plan of the great apes to the future. We conducted research on 1) comparisons of great ape density across sites in relation to human activities and forest situation to specify the actual threats to great apes, 2) utilization of forest resources by local people to help frame a conservation plan in each area, 3) ape pathogens, their infection rates and infection route, 4) the effectiveness of tree planting to connect isolated habitat of great apes by the use of polypropylene tubes, 5) current status of on-going ecotourism and problems faced by local communities living in or near the protected areas to propose effective measures for *in-situ* conservation of apes.

Loss and destruction of great apes' habitat due to human activities were confirmed. Population densities of apes have been relatively stable in long-term research sites, while in other areas urgent conservation plans are needed to avoid extinction. People around the Kalinzu Forest do not largely rely upon the forest resources, whereas strict conservation of forest would aggravate the life of people in the Luo Reserve unless they are provided with alternative source of animal foods. Pathogens of wild apes differed between sites. Transmission of parasites and viruses between human and apes was confirmed. Intense ecotourism may heighten risks of human-ape disease transmission and apes' stress level. The use of polypropylene tubes in planting seedlings has proved to have the pros and cons. Arbors and direct planting of selected tree species were also effective. Finally, strong need of active participation by community members in collaboration with researchers to planning and executing the tourism and conservation is suggested.

1. Introduction

The great apes are not only the "key stone species" of the tropical rain forests and "umbrella species" whose existence guarantees the survival of many other creatures, but also the "flagship species" for the conservation of the animal kingdom. Moreover, the great apes, as the closest human relatives, teach us human biological background. However, the great apes are on the verge of extinction. With the rapid human population growth in many parts of Africa and Asia, human social and economical activities have intruded into the pristine natural environment that the great apes have been inhabiting safely far from villages and towns. When refugees brought out by armed conflicts enter the areas where people have coexisted peacefully with the great apes for a long time, they often

bring their own new customs such as ape hunting and unsustainable land use system.

To reform such serious situation, we first should investigate the distribution of populations and actual habitat conditions of great apes through the scientific research, and find the causes of threat to them in order to implement suitable steps without a moment's delay.

Creation of strict nature reserves by expelling human inhabitants is not always a realistic way for the conservation of great apes. Most important is the "bottom-up approach" in conservation planning. In other words, conservation planning that ensures the coexistence of both humans and apes, and that receives understanding and cooperation by local people is needed. So, it is necessary to study the extent of use of forests by local people, to estimate the influences of human activities on the ape habitats and to devise various methods of coexistence of people and great apes while taking the local conditions into consideration.

Ecotourism, emphasizing sustainable use of natural resources, is one of the means to provide positive economic effects to the local people and habitat countries. It is also a useful way to make local people recognize the value of natural resources. In order to promote ecotourism smoothly, we should devise the measures to assure sustainable use of natural resources, participation of the local people and economic gain of the local community.

Increasing human activity causes some novel problems such as the increase in the disease transmission risk between human and the great apes. Even the conservation activities such as ecotourism would be dangerous unless they are conducted with appropriate measures to prevent disease transmission. Frequent contact with humans is also a stress factor that aggravates health status and the reproductive rate of great apes. Examination of current status of infectious disease risk for great apes and human influence on the health of great apes is needed in order to establish valid conservation policies at each location.

Currently, many great ape populations live in the forest located close to human settlements. Human activities split the habitats of great apes into many isolated segments. This is a serious problem that may bring out genetic deterioration even if immediate local extinctions are avoided. We must have measures to connect these habitats by planting trees between them. We are implementing "The Green Corridor Project" at the Bossou-Nimba Biosphere Reserve in the Republic of Guinea and wish to extend this idea to many other areas if the project is successful.

2. Research Objective

The ultimate objective of our study is to draw up a permanent preservation plan of the great apes to the future. First, for several habitat types of great apes, we collect basic data for the influences of human activities on the apes' habitat conditions. By comparing the population density of great apes across sites, we elucidate the natural and artificial factors that limit the existence of great apes.

Second, we obtain the data on daily consumption of food and energy items and utilization of forest resources by local people, which would help frame a conservation plan in each area. We also evaluate which types of human activities give which degree of damage to the forest by monitoring changes in forest vegetation and human activities.

Third, we identify great ape pathogens, anthropo-zoonotic ones in particular, their infection rates and infection routes among wild populations. We also investigate the effects of human activities including eco-tourism on great ape health status. Thus, we construct the scheme to prevent the prevalence of infectious diseases among great apes.

Fourth, we investigate current status of on-going ecotourism in order to find and propose the necessary improvements and effective measures for *in-situ* conservation of great apes.

Fifth, in order to connect small isolated groups into a viable self-perpetuating population, we investigate the effectiveness of tree planting by the use of the polypropylene tubes (Hexatube®).

3. Methods

We conducted extensive and intensive surveys in the following nine areas: Mahale Mountains National Park and Ugalla Area Forest Reserve in the United Republic of Tanzania, Kalinzu Forest Reserve in the Republic of Uganda, Luo Scientific Reserve and Kahuzi-Biega National Park in the Democratic Republic of Congo, Moukalaba-Doudou National Park in Gabonese Republic, Bossou-Nimba Biosphere Reserve in the Republic of Guinea, Kutai National Park in the Republic of Indonesia, Danum Valley Conservation Area in Malaysia (Figure 1).

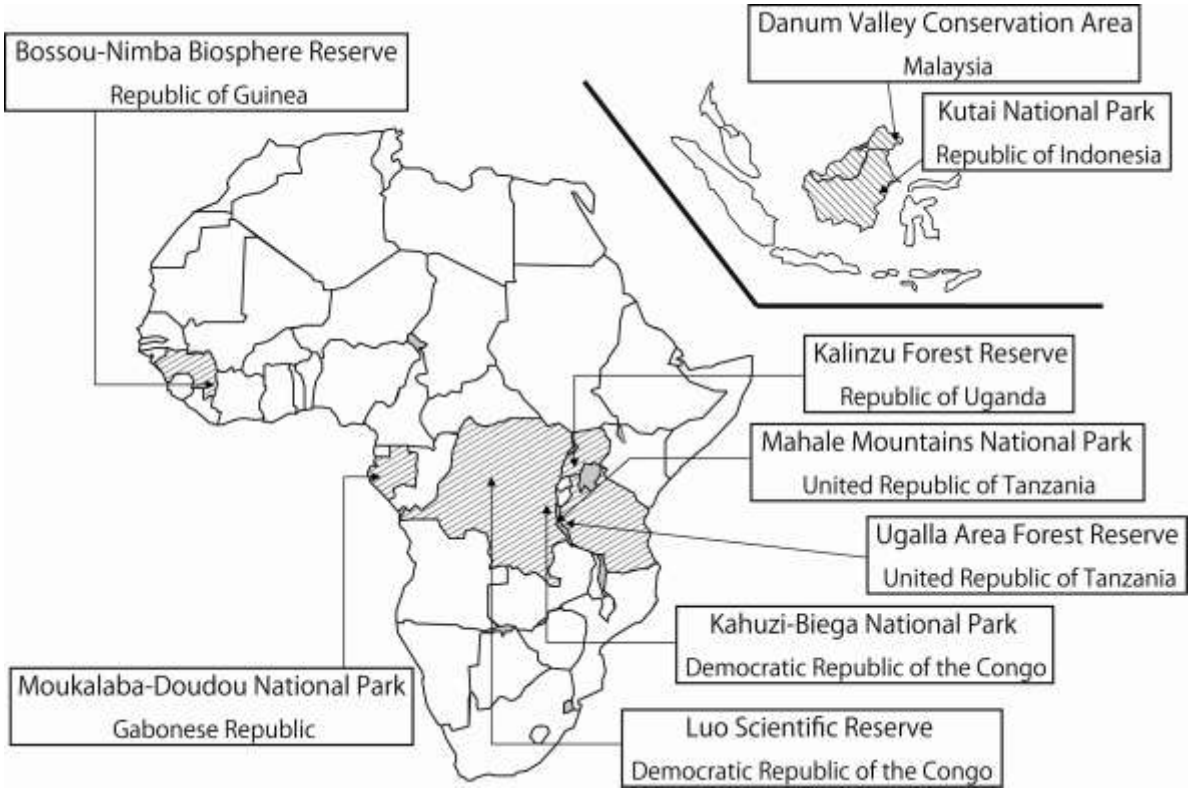

Figure 1. Study Sites

We studied the ape distribution and habitat condition from direct observation and inquiry from local people in the above all nine areas. We used "nest count" [1), 2)], "marked-nest count" [3), 4)] and "dung pile count" [5), 6)] methods for population estimates of great apes. We used GPS to take an accurate measurement of observation points. We recorded vegetation types, direct and indirect evidence of apes, numbers and encounter frequencies of larger mammals and plant species with >5 cm in DBH (diameter at breast height) in 4 m width on the census route. We made 20 m x 20 m vegetation quadrates in the point of vegetation change. We also collected information on climates and geographical and geological features. Moreover, we studied frequency and scale of poaching, felling, reclamation and population movements, and compared those factors with population density of great apes.

For the study of use of forests by inhabitants, we selected 10 to 20 families in villages adjacent to protected areas, and asked them to keep records on the daily consumption of food and energy items and forest resources. We enumerated trees and their fruit production while walking on the line transect.

We also recorded the type and location of daily human activities in the forest. In order to survey actual condition of community-based forest resource management, we performed hearing from various specialists on forest administration and forest management in D.R. Congo, Belgium and the International Tropical Timber Organization (ITTO).

In order to investigate the pathogens for the great apes, we constructed a protocol for collection of non-invasive samples such as feces, urine, and saliva in the fields. Following this protocol, we collected 910 samples from six fields, Mahale, Moukalaba-Doudou, Bossou, Kahuzi-Biega, Luo, and Danum Valley. We detected viruses, bacteria and parasites in these samples. In order to estimate potential risk of human-ape disease transmission, we investigated pathogens and antibodies of captive chimpanzees who are always in close contact with humans and possibly exposed to various human specific pathogens. We systematically recorded symptoms of respiratory diseases by visual observation for identified chimpanzees in Mahale. We measured the cortisol level of fecal samples of gorillas and chimpanzees in Moukalaba-Doudou by enzyme-immunoassay (EIA) method to investigate the apes' stress level. We also examined medical records of a hospital close to Mahale regarding the rate of patients suffering from pneumonia and/or acute respiratory illness, as an indicator of trend of these diseases among local people around Mahale.

At Bossou we planted 1948 nursery trees, and set polypropylene tubes in September 2006, which keep moisture around the trees and protect against feeding damages by animals. Moreover, we made fire break zone around the site in October 2006 and January 2007 respectively. We collected basic data for planting trees in Kalinzu. We collected 215 and 77 fecal samples for two groups of chimpanzees respectively and identified tree species of the seeds from which we select tree species for planting trees.

In five research sites, Kahuzi-Biega, Mahale, Kalinzu, Bossou and Luo, we made several meetings with local people and administrative officers and discussed the current problems of protected areas, problems of lives of local people, knowledge of environmental conservation and great apes, and knowledge about costs and benefits of eco-tourism. Compiling such information from five sites we compared the current status of eco-tourism on great apes among sites to consider the wise management of resources and conservation planning.

In Mahale, we monitored tourist groups that came to see chimpanzees. We counted number of both visitors and tourist guides, observed their behavior and roughly measured their distance from chimpanzees.

4. Results

We estimated the population density (head/km^2) of great apes in 9 field sites as follows; chimpanzees: Mahale 0.41-0.44, Ugalla 0.05-0.08, Kalinzu 1.90-5.50, Moukalaba-Doudou 0.57-0.86, Bossou 0.43 and Kahuzi-Biega 0.10-0.13; bonobos: Luo 0.60-0.74; eastern gorillas: Kahuzi-Biega 0.27-0.29; western gorillas: Moukalaba-Doudou 1.56-6.99; orangutan: Kutai 0.32-0.60 and Danum Valley 0.35-1.51. Our survey revealed that the distribution and number of great apes have been reduced in some field sites such as Ugalla, Kahuzi-Biega and Bossou. On the other hand, there were some field sites that have been stable or recovered in the population density of great apes. The existence of long-term field studies must be effective to deepen the local people's understanding of scientific research and thus promote a better understanding of the conservation of the great apes.

Loss and destruction of great apes' habitat due to human activities were confirmed in all study sites. For example, poaching, illegal residences within a national park, clearing of forests for cultivation, illegal logging, and prevalence of infectious diseases were found in many sites. Physically

handicapped chimpanzees caused by snares increased in some sites.

We compared two contrasting villages of central Africa in terms of forest utilization for daily commodity. In the villages adjacent to Kalinzu, dependence of people on the forest resources was restricted. They obtained about 50 % of firewood from the natural forest, but such collection of dead trees or branches did not give substantial damage to the forest. They obtained most of food materials from the field, market, or local people, and thus materials obtained from the forest were negligible.

In the villages in Luo, on the other hand, people obtained most of the firewood from slashed-and-burnt fields. They obtained considerable amount of food materials from the primary and secondary forests, and from the river.

Based on the hearing survey, we identified four major issues to be addressed for the successful community-based forest resource management: 1) law enforcement and capacity building of administrators, 2) capacity building of local communities, and 3) enforcement of media and NGO's to report actual condition of forest resource management.

We detected nematodes, cestodes, protozoa including the first report of some parasites in great apes from fecal samples. It is suspected that there may be human-ape transmission of *Strongyloides* spp. and that there may be livestock-ape transmission of *Fasciora*. There are inter-site differences in parasite species composition and abundance. Inter-site differences in genetic profiles in the same species are also detected. Although we did not detect malignant bacteria species, several bacteria that may cause enteritis were detected.

In 2006, flu-like diseases outbreak occurred and 12 chimpanzees disappeared from a study group in Mahale. From the sample at this outbreak we detected human metapneumovirus which may be transmitted from human. The rates of human patients of pneumonia and Acute Respiratory Infection around Mahale were high in 2005 and 2006, but seasonal trend did not always match with that of chimpanzee diseases. It is revealed by antibody test that human metapneumoviruses also spread with high ratio in captive chimpanzees. The captive chimpanzee also produced antibodies against parainfluenzavirus type 3 and *Bordetella pertussis* which might be infected from human.

Cortisol level of a group of gorillas in Moukalaba-Doudou was high at the beginning of habituation program, but decreased as habituation process progressed. However, it increased again when observation time increased and the distance between the gorillas and the human observers became closer.

At Bossou, in January 2007, we checked the condition of seedlings planted in the polypropylene tubes. Seventy per cent (1364/1948) of trees were found to survive. In the previous study without polypropylene tubes at the same site, only about 25% of planted trees survived. Thus, polypropylene tubes have proved to be useful at Bossou-Nimba area. However, in 2008, most of seedlings covered by polypropylene tubes were destroyed by bush fire. We started to use arbors for the protection of seedlings and to use tree cuttings of selected species instead of nursery trees covered with polypropylene tubes. These new trials have proved to be successful so far as we checked in January 2009.

Preliminary analysis in Kalinzu showed that chimpanzees less often used the area where heavy logging had occurred or the area where many trees had stood dead because of drought in 1999. All fecal samples for one study chimpanzee group included seeds. Among the 15 those species that we identified, *Ficus* spp. and *Musanga leo-errerae* were the two most common species in chimpanzee feces, that were found in 84% and 54% of fecal samples, respectively. We made tree nursery using seeds found in the chimpanzee feces and seedling found in the forest. We planted these nursery trees with/without polypropylene tubes in the two habitat types (open/semi-open places) to examine the

effectiveness of polypropylene tubes. We found that nursery trees tended to grow faster with polypropylene tubes than without them, especially in the open place.

Based on comparisons of ecotourism related topics among sites, we found three common problems. First, due to insufficient environmental education, local people do not fully understand the importance of conservation for their daily life. Second, neither visitors nor local people are fully satisfied with the current style of ecotourism. Thirdly, income and profits from the ecotourism are not properly distributed to the local people and more reasonable planning for tourism is needed.

In Mahale, number of tourists in one group did not exceed the upper limit in most cases. However, total number of observers, i.e. sum of tourists and guides sometimes exceeded 10 persons, that is more than the average number of chimpanzees in a temporal subgroup. The park's regulations were not strictly respected.

5. Discussion

Vegetation types of the all field sites of this study project varied from moist rain forest, lowland evergreen forest, and montane forest to arid woodland. Different great apes tend to prefer different environment, while a single great ape species can exist in different environments. Moreover, different species sometimes coexist in some areas. These results suggest the high adaptability of the great apes to various ecological conditions.

However, great apes have been decreasing their distribution and population density. Human activities, deforestation and bush meat trade, in particular, threaten their survival directly. Movement of refugees caused by armed conflicts transform customs of traditional sustainable lifestyles to those destructive to great apes.

The sites where existence of chimpanzees was newly confirmed are savanna woodlands dominated by deciduous trees, locally called "miombo woodland." The area is a hard environment for chimpanzees to live. Further surveys are needed for understanding historical changes in the chimpanzees' distribution and adaptation to arid surroundings. The population density and the habitat use in this area should be compared with other sites. This would make it possible to re-evaluate the distribution of chimpanzees and other apes.

In Kalinzu, creation of job opportunities and supplementary income by ecotourism and research/conservation activities may help the local people to understand the vital importance of the conservation of forest and animals for their current and future life. In Luo, however, restriction on the use of forest resources would give serious damages to the daily life of local people, especially concerning foods. In this area, therefore, we may need to help establish the means for transportation for agricultural products between the villages and big cities, which we are undertaking as a part of this research project.

The monitoring research in other study sites would help developing realistic plans for conservation in each area and also model plans for various environments, which we may propose at international workshops for conservation planning.

In order to realize those plans, we would also need to perform attempts for law enforcement and capacity building of administrators, local communities, NGO's, and unbiased media.

It was shown that non-invasively obtained materials such as feces are useful to monitor the extent of infection with pathogens and stress level of wild populations of great apes. Visual consultation of symptoms also incurs low cost and makes an accurate method. Applying these methods to *in situ* disease/stress investigation of great apes, we may devise a scheme to control the number of tourists and researchers effectively by considering the infection rate and/or stress level.

Composition and abundance of parasites that infect great apes differed between field sites. Thus,

measures to prevent parasite infection to great apes should also be differentiated across field sites, based on the detailed information of parasite diversity in each field.

Analysis of pathogens/antibodies in captive chimpanzees indicates that great apes might be infected to human specific pathogens when they are in close contact with humans. Also, we confirmed human-chimpanzee transmission of metapneumovirus did occur in the wild. These results help us to convince tourists and those who are in charge of ecotourism that it is important to wear mask, keep a certain distance from great apes, limit the number of tourists at once, etc.

The change in cortisol level during gorilla habituation process at Moukalaba-Doudou suggests that intensive observation activity can cause stress to the great apes even when they are well habituated. Researches or tourists must be advised to observe the viewing rules in order to minimize their stress level.

The use of polypropylene tubes in planting seedlings has proved to have the pros and cons. They do help the faster growth of plants, at least in some environments, if we select appropriate tree species. However, they have shortcomings of being flammable and costly. We propose that in addition to the use of polypropylene tubes we also should mobilize local traditional knowledge of seedling protection by arbors and direct planting of some selected species in Green Corridor Project because this is much less costly, more attractive to local people, and provides local employment as much as the alternative.

One of the common problems on community conservation among study sites is that local inhabitants do not understand the reason for conservation of great apes, impact of human activities to great ape survival and the purpose of creation and management of protected areas. Another problem is lack of consensus between local habitants and public administrations about what kind of alternative benefits are to be returned to local habitants as a compensation for giving up using natural resources in protected areas. These are the ultimate causes of conflicts between local habitants and those who are in charge of great ape conservation. Also, community structures of local habitants are violated by rapid change in their lifestyles and increasing amount of commercial materials. Thus, it is very difficult for local communities to entertain their future perspectives by themselves.

However, we have conducted scientific research on great apes in all the study sites where many local people have worked with us as the research assistants. Thus, many local people understand the present situation of great apes and show the positive attitude to improve it. In order to promote practical use of ecotourism for the community-based conservation, we recommend the local-initiative type of ecotourism involving resident people, an enterprise which is based on the long-term anthropological and scientific research of both humans and great apes.

References

1) Ghiglieri MP. 1984. The Chimpanzees of Kibale Forest. Columbia University Press, New York.
2) Tutin CGE, Fernandez M. 1984. Nationwide census of gorilla (*Gorilla g. gorilla*) and chimpanzee (*Pan t. troglodytes*) population in Gabon. *Am. J. Primatol*. 6:313-336.
3) Hashimoto C. 1995. Population census of the chimpanzees in the Kalinzu Forest, Uganda: Comparison between methods with nest counts. *Primates* 36:477-488.
4) Plumptre AJ, Reynolds V. 1996. Censusing chimpanzees in the Budongo Forest, Uganda. *Int. J. Primatol.* 17:85-99.
5) Backland ST, Anderson DR, Burnham KP, Laake JI. 1993. *Distance Sampling: Estimating Abundance of Biological Populations*. Chapman & Hall, London.
6) Ross C, Reeve N. 2003. Survey and census methods: population distribution and density. Joanna M. Setchell, Deborah J. Curtis (eds) In: *Field and Laboratory Methods in Primatology: A*

Practical Guide. Cambridge University Press, Cambridge. pp.90-109.

Major Publications

1)Ogawa H, Moore J, Kamenya S. 2006. Chimpanzees in the Ntakata and Kakungu areas, Tanzania. *Primate Conserv* 21: 97-101.

2)Ogawa H, Idani G, Moore J, Pintea L, Hernandez-Aguilar A. 2007. Sleeping parties and nest distribution of chimpanzees in the savanna woodland, Ugalla, Tanzania. *Int J Primatol* 28: 1397-1412.

3)Ando C, Iwata Y, Yamagiwa J. 2008. Progress of habituation of western lowland gorillas and their reaction to observers in Moukalaba-Doudou National Park, Gabon. *Afr Study Monogr Suppl* 39: 55-69.

4)Carvalho S, Cunha E, Sousa C, Matsuzawa T. 2008. Chaînes opératoires and resource-exploitation strategies in chimpanzee (*Pan troglodytes*) nut cracking. *J Hum Evol* 55 (1): 148-163.

5)Hanamura S, Kiyono M, Lukasik-Braun M, Mlengeya T, Fujimoto M, Nakamura M, Nishida T. 2008. Chimpanzee deaths at Mahale caused by a flu-like disease. *Primates* 49: 77-80.

6)Hashimoto C, Tashiro Y, Hibino E, Mulavwa M, Yangozene K, Furuichi T, Idani G, Takenaka O. 2008. Longitudinal structure of a unit-group of bonobos: Male philopatry and possible fusion of unit-groups. In: Furuichi T, Thompson J (eds). *The Bonobos: Behavior, Ecology, and Conservation*. Springer. New York, pp: 107-119.

7)Idani G, Mwanza N, Ihobe H, Hashimoto C, Tashiro Y, Furuichi T. 2008. Changes in the status of bonobos, their habitat, and the situation of humans at Wamba, in the Luo Scientific Reserve, Democratic Republic of the Congo. In: Furuichi T, Thompson J (eds). *The Bonobos: Behavior, Ecology, and Conservation*. Springer, New York, pp: 291-304.

8)Inoue E, Inoue-Murayama M, Vigilant L, Nishida T, Takenaka O. 2008. Yasei chinpanjii ni okeru Y-STR takei. *DNA takei* 16: 21-24.

9)Inoue-Murayama M, Hibino E, Iwatsuki H, Inoue E, Nishida T, Hayasaka I, Ito S, Murayama Y. 2008. Interspecies and intrasoecies variations in the serotonin transporter gene intron 2 (VNTR) in nonhuman primates. *Primates* 49: 139-142.

10)Kaur T, Singh J, Humphrey C, Tong S, Clevenger D, Tan W, Szekely B, Wang Y, Li Y, Alex Muse E, Kiyono M, Hanamura S, Inoue E, Nakamura M, Nishida T. 2008. Descriptive epidemiology of fatal respiratory outbreaks and detection of a human-related metapneumovirus in wild chimpanzees (*Pan troglodytes*) at Mahale Mountains National Park, western Tanzania. *Am J Primatol* 70: 755-765.

11)Matsuzawa T, Kourouma M. 2008. The Green Corridor Project: Long-term research and conservation in Bossou, Guinea. In: Wrangham R, Ross E (eds). *Science and Conservation in African Forests: The Benefits of Long-term Research*. Cambridge University Press, Cambridge, pp: 201-212.

12)Nishida T, Nakamura M. 2008. Long-term research and conservation in the Mahale Mountains, Tanzania. In: Wrangham R, Ross E (eds). *Science and Conservation in African Forests: The Benefits of Long-term Research*. Cambridge University Press, Cambridge, pp: 173-183.

13)Ohashi G. 2008. Ecology and conservation of chimpanzees living over a national boundary. *Ecosphia* 20: 97-105. (in Japanese)

14)Takenoshita Y, Ando C, Iwata Y, Yamagiwa J. 2008. Fruit phenology of the great ape habitat in the Moukalaba-Doudou National Park, Gabon. *Afr Study Monogr Suppl* 39: 23-40.

15)Takenoshita Y, Yamagiwa J. 2008. Estimating gorilla abundance by dung count in the northern part of Moukalaba-Doudou National Park, Gabon. *Afr Study Monogr Suppl* 39: 41-54.

16)Yamagiwa J, Basabose AK, Kaleme KP, Yumoto T. 2008. Phenology of fruits consumed by a sympatric population of gorillas and chimpanzees in Kahuzi-Biega National Park, Democratic Republic of Congo. *Afr Study Monogr Suppl* 39: 3-22.

17)Corp N, Hayaki H, Matsusaka T, Fujita S, Hosaka K, Kutsukake N, Nakamura M, Nakamura M, Nishie H, Shimada M, Zamma K, Wallauer W, Nishida T. 2009. Prevalence of muzzle-rubbing and hand-rubbing behavior in wild chimpanzees in Mahale Mountains National Park, Tanzania. *Primates* 50:184-189.

18)Nakamura M. 2009. Interaction studies in Japanese primatology: their scope, uniqueness, and the future. *Primates* 50:142-152.

19)Nishida T, Matsusaka T, McGrew WC. 2009. Emergence, propagation or disappearance of novel behavioral patterns in the habituated chimpanzees of Mahale: a review. *Primates* 50: 23-36.