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Post-release adaptation of Javan gibbon (*Hylobates moloch*) in Mount Malabar Protected Forest, West Java, Indonesia

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Abstract. *Ario A, Kartono AP, Prasetyo LB, Supriatna J. 2018. Post-release adaptation of Javan gibbon (*Hylobates moloch*) in Mount Malabar Protected Forest, West Java, Indonesia. Biodiversitas 19: 1482-1491.* Post-release adaptation study of Javan gibbon (*Hylobates moloch*) was conducted in twelve months from April 2016 to March 2017 in the Mount Malabar Protected Forest, West Java. We studied eleven Javan gibbons released between March 2014 to August 2016. The purpose of this study was to assess the adaptive ability of the released Javan gibbons. Data collection was conducted by focal animal sampling method with 5-minute interval recording time and *ad libitum* method. The average time allocation of Javan gibbon activities was the following: feeding 23.02±1,62%; moving 26.95±3.07%; resting 40.88±3.81%; socializing 7.56±3.55%; sexual 0.26±0.24%; and vocalizing 0.95±0.21%. We compared activity allocation data from this study and those from wild Javan gibbons and found similarities as follows: 47.60% at a family of Jowo-Bombom-Yani-Yudi, 62.45% at a pair of Moly-Nancy, 51.70% at a pair of Robin-Moni and 52.58% at a family of Mel-Pooh-Asri. Post-release adaptation of Javan gibbon is influenced by internal and external factors. Internal factor includes the ability of each individual to develop wild behavior according to its gender and age group, in terms of natural fruit consumption, brachiation movement, morning calls and alarm calls, as well as affiliative bonds among individuals. External factors include the ability of Javan gibbon to adapt to the environment, namely weather conditions and human presence.

Keywords: Adaptation, behavior, Javan gibbon, post-release

INTRODUCTION

The Javan gibbon (*Hylobates moloch*) is one among nine primate species in the family Hylobatidae in Indonesia. The others were *Hylobates agilis, Hylobates albibarbis, Hylobates klossii, Hylobates lar, Hylobates muelleri, Hylobates abbotti, Hylobates funereus,* and *Symphalangus syndactylus* (Ross et al. 2014). It is found only on the Island of Java, particularly in conservation forest and protected forest in the western and central part of Java. In addition to habitat loss, hunting for pets is a serious ongoing threat for Javan gibbon (Nijman 2004; Supriatna 2006).

Fewer than 100 wild-caught Javan gibbons were in 8 rehabilitation centers and 11 zoos on the Islands of Java and Bali (Nijman 2004). Javan gibbons in rehabilitation centers were usually pets, which were confiscated by the government or given up voluntarily by the previous owners. Rehabilitation and release of Javan gibbon are not easy. Besides being monogamous, highly selective for food and mates, Javan gibbons have a strong sense of territoriality, resulting in a lengthy and costly rehabilitation process. Rehabilitation and reintroduction programs have been widely used as an element of conservation strategies for endangered species (Kleiman 1989). Reintroduction programs provide an opportunity for animals that have lived in captivity to have another chance of living in the wild and may be one way of re-establishing populations that have become locally extinct (Komdeur and Deerenberg 1997). The main species to be reintroduced are those that have small and declining population sizes, and limited distribution. Reintroduction should only be undertaken if the program does not threaten wild populations or ecological integrity in reintroduction areas (Baker 2002; IUCN 2002, 2012).

To successfully conserve species, preserving wild populations and their habitats is the most crucial factor; yet the wild populations can obtain benefit from rehabilitation and reintroduction programs, while raising public awareness to problems faced by the species (Cheyne et al. 2008). Problems that may emerge during reintroduction programs include mortality before reproduction, disappearance without recovery, no vocalization, no copulation, no development of mating behavior, lack of nutrients, and inability to brachiate. Mortality can be caused by hunting, disease, and starvation (Cheyne 2009).

Post-release monitoring is a crucial step in the rehabilitation process to ensure that wild behavior is developed. Without post-release monitoring, we can not measure objectively and scientifically whether a

rehabilitation program is successful (Cheyne 2010; Cheyne et al. 2012).

Javan gibbon's ability to adapt after being released is an indicator of a successful rehabilitation and reintroduction program. This adaptive ability in released Javan gibbon had not been studied previously. Therefore, this research was conducted, aiming to assess the adaptive ability of released Javan gibbons.

MATERIALS AND METHODS

Time and Location of Study

The study was conducted in 12 months from April 2016 until March 2017 in Mount Malabar Protected Forest (MMPF), West Java, Indonesia. It has an area of about 8.894,47 hectares located in Bandung District, West Java. The research site was located at 07°07'20.52" S and 107°36'28.48" E, at altitudes of 1,000 to 2,300 m asl (Figure 1). The average temperature was 18-23°C with annual rainfall between 2,000 and 2,500 mm.

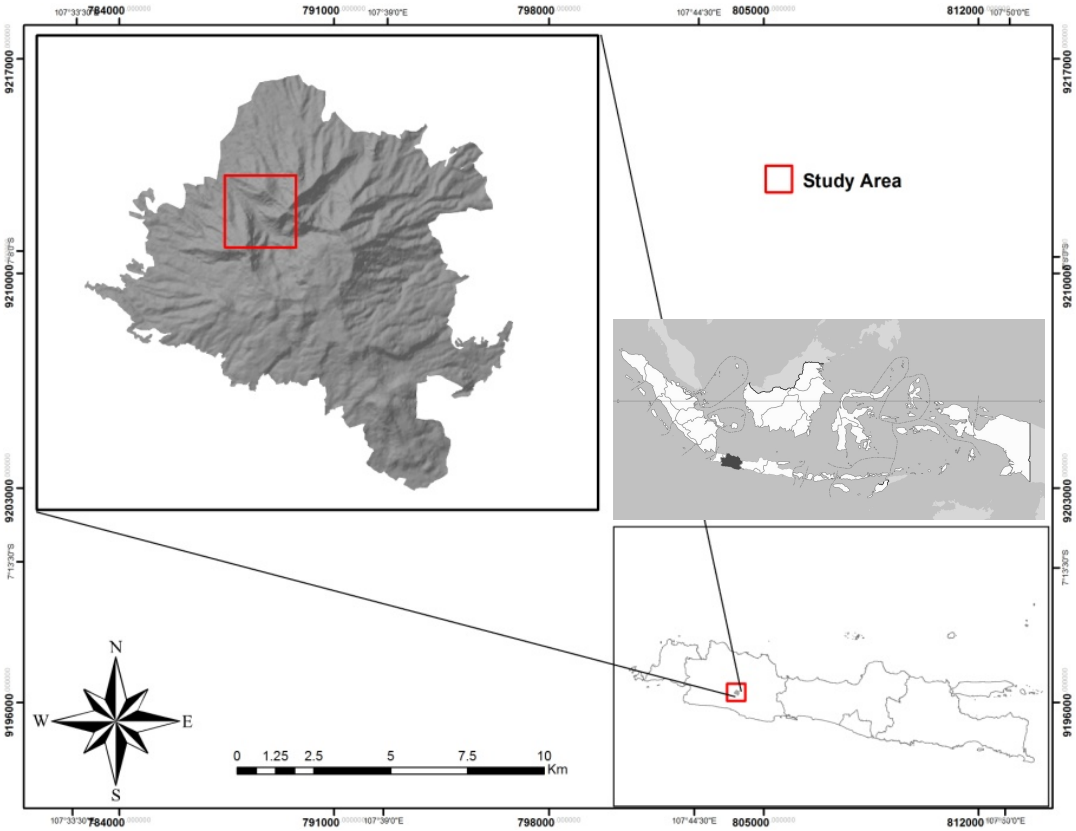

Figure 1. The map of study area of Javan gibbon in Mount Malabar Protected Forest, West Java, Indonesia

Table 1. Research subjects of Javan gibbon in Mount Malabar Protected Forest, West Java, Indonesia

Nickname	Sex	Estimated birth	Rearing phase	Rehabilitation phase	Group status
Jowo	M	1999	1999-2008 (±9 years)	2008-2014 (±6 years)	
Bombom	F	1999	1999-2008 (±9 years)	2008-2014 (±6 years)	Family
Yani	F	21 July 2010	Birth at JGC	2010-2014 (±4 years)	
Yudi	M	7 July 2013	Birth at JGC	2014 (±1 year)	
Nancy	F	1998	1998-2004 (±6 years)	2004-2015 (±11 years)	Pairs
Moli	M	2002	2002-2004 (±2 years)	2004-2015 (±11 years)	
Moni	F	2004	2004-2005 (±1 year)	2005-2015 (±10 years)	Pairs
Robin	M	2002	2002-2008 (±6 years)	2008-2015 (±7 years)	
Mel	M	1997	1997-2008 (±11 years)	2008-2016 (±8 years)	
Pooh	F	2000	2000-2008 (±8 years)	2008-2016 (±8 years)	Family
Asri	F	9 Feb 2015	Birth at JGC	2015-2016 (±1 year)	

Note: JGC=Javan gibbon Center, M=Male, F=Female

Research subjects

The subjects in this research were eleven released individuals of Javan gibbon. They consisted of four groups: Jowo-Bombom-Yani-Yudi, released on 27 March 2014; Robin-Moni and Moli-Nancy, two pairs of gibbon released on 24 April 2015; and Mel-Pooh-Asri, released on 10 August 2016. They also consisted of 8 adults, Jowo, Bombom, Nancy, Moli, Moni, Robin, Mel, and Pooh, at the ages of ±13-21 years; 1 subadult, Yani at the age of ±6 years; 1 juvenile, Yudi at the age of ±3.5 years; and 1 infant, Asri at the age of ±1.5 years (Table 1).

Data collection and analyses

Javan gibbon behaviors observed in this study were feeding, moving, resting, social, sexual, and vocalization. To collect the behavioral data, we used the focal-animal sampling method with 5-minute intervals (Altmann 1974), during Javan gibbon active period, from the time they awoke in the morning until they slept in the evening (Cocks 2000). Data collection was combined with ad libitum method, to note important events that occurred outside the observation time intervals (Martin and Bateson 2007).

To assess the pair bond between the released Javan gibbons, we recorded proximity and position among individuals in a group with a range of 0-10m, 10-20 m, 20-30 m, and >30 m. We also documented their forest strata use, with ranges of 0-10m, 10-20 m, 20-30 m, and >30 m.

We analyzed the behavioral data using qualitative approach. In addition, we also compared the behaviors of the released Javan gibbon with those of the wild Javan gibbon based on literature. Gibbon coordinates obtained from Global Position System (GPS) and the home range area was mapped using Minimum Convex Polygon (MCP) approach with ArcGIS 9.3.

RESULTS AND DISCUSSION

Activity budget of Javan gibbon

We analyzed the behavioral data and found that the eleven released Javan gibbons allocated their time as on table 2. Several studies on wild Javan gibbon behavior in Mount Gede-Pangrango National Park (MGPNP), Mount Halimun National Park (MHNP), and Leuweung Sancang Nature Reserve (LSNR) found that the average time allocation was: feeding 39.20±6.84%, moving 24.56±11.29%, resting 28.30±9.61%, socializing 3.46±1.91%, vocalizing 3.17±2.80% and sexual 1.30±0.24 (Landjar 1996; Fithriyani 2007; Iskandar 2007; Arifin 2007; Malone 2007; and Ario 2011). We compared behavior allocation data from this study and data from wild Javan gibbon and found as on Table 3.

The gibbons mostly ate fruits 60.05±3.42, followed by leaves 35.95±4.48, flowers 3.55±1.80 and insects 0.45±0.58. Brachiation 50.80±8.48 was the primary locomotion, followed by leaping 27±5.52, climbing 14.58±7.33, and bipedalism 7.62±3.37. They rested by sitting 84.24±9.03, lying 14.57±8.04, and sleeping 1.19±1.30. Social interaction among individuals was grooming 66.98±6.99, playing 30.02±6.51, and agonistic behavior 4.12±4.88. Sexual behavior between adults was as follow: courtship 81.43±12.13, pre-copulation 16.05±9.47, and copulation behavior 11.80±3.00. The gibbons mostly vocalized by doing short call 59.11±8.93, followed by morning call 27.11±14.14, and alarm call 13.78±8.27. Grooming, playing, and sexual are included in affiliative interaction among Javan gibbon. Average percentage behaviors for each gibbons group (Figure 2).

Table 2. Behavioral time allocation for each group of post-release Javan gibbon

Behaviors	The family of Jowo-Bombom-Yani-Yudi	The pair of Moli-Nancy	The pair of Robin-Moni	The family of Mel-Pooh-Asri
Feeding	20.67±4.29	23.59±1.30	23.50±0.74	24.32±2.07
Moving	31.07±10.35	27.47±4.87	24.98±1.47	24.29±7.44
Resting	35.45±12.08	43.98±4.43	41.14±2.12	42.94±12.50
Socializing	11.46±7.26	3.02±0.07	8.82±0.00	6.94±5.92
Vocalizing	0.95±0.52	0.92±0.44	0.71±0.13	1.23±0.19
Sexual	0.18±0.22	0.59±0.19	0.28±0.00	0.00±0.00

Table 3. Similarity level data on post-release and wild Javan gibbon

Behavior	Wild Javan gibbons ($\bar{x}$ ± SD)	Similarity level (%)			
		The family of Jowo-Bombom-Yani-Yudi	The pair of Moli-Nancy	The pair of Robin-Moni	The family of Mel-Pooh-Asri
Feeding	39.20±6.84	52.72	60.17	59.93	62.03
Moving	24.56±11.29	79.04	89.40	98.30	98.90
Resting	28.30±9.61	79.85	64.35	68.79	65.91
Socializing	3.46±1.91	30.19	87.28	39.23	49.87
Vocalizing	3.17±2.80	29.94	28.88	22.42	38.78
Sexual	1.30±0.24	13.85	44.62	21.54	0.00
Average		47.60	62.45	51.70	52.58

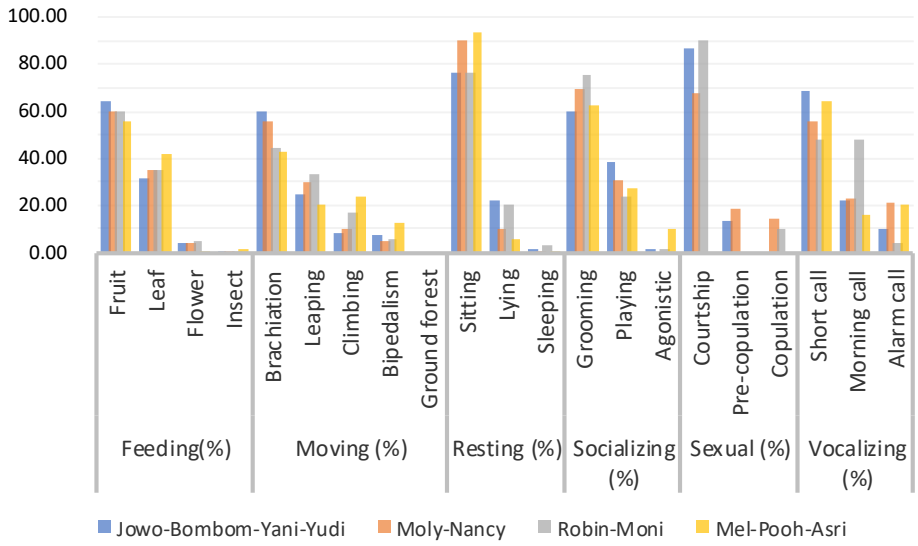

Figure 2. Average percentage for each Javan gibbon group behavior

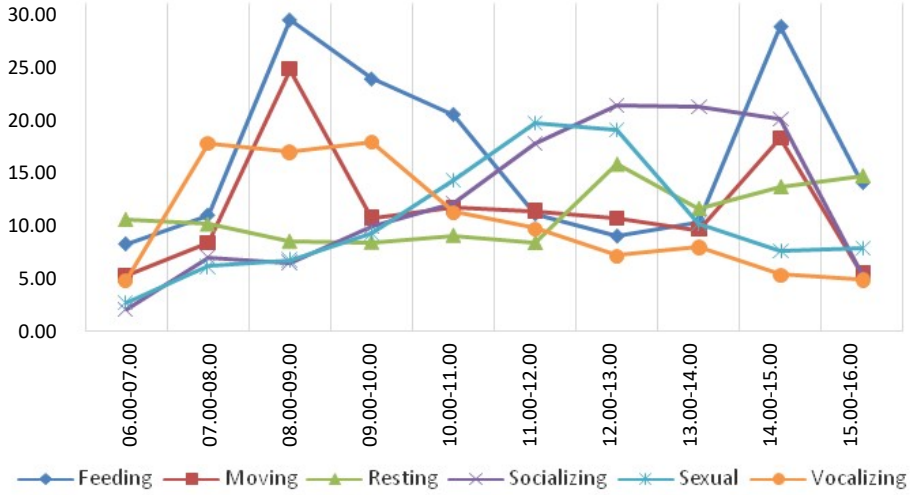

Figure 3. Daily activity patterns of the post released Javan gibbon

The highest daily activity of eleven Javan gibbons was 12.84% at 08: 00-09: 00 a.m. and 12.95% at 02: 00-03: 00 p.m. In contrast, the lowest activity was 4.65% at 06: 00-07: 00 a.m. and 7.23% at 03: 00-04: 00 p.m. (Figure 3).

Based on gender and age group, we consider key behaviors for assessing successful adaptation of Javan gibbon consist of fruit consumption, brachiation, communication (i.e. morning call and alarm call), and affiliative interactions (i.e. grooming playing and sexual). The average proportions of fruit consumption by adult male and adult female, also based on age group were more than 50%. The average percentages of brachiation in subadult, juvenile, and infant higher than male and adult female. Morning call was always sung by adult female, alarm call was produced by both male and female, and only adult performed the alarm call. Affiliative interactions were found in adult, subadult, juvenile, and infant. The average proportions for each key behavior (Table 4).

Adaptation based on gender and age group

The released Javan gibbon certainly has limited behavioral ability compared to wild Javan gibbon. The released gibbons need time to adapt to the environmental conditions in the wild, including exploration to locate food. Moreover, these gibbons underwent behavioral changes and high dependence on humans when they were pets. Thus, they need gradual adaptation process, with different adaptive ability in each individual.

Table 4. The average proportions for each key behaviors of Javan gibbon

Key behaviors	Gender		Age group			
	Adult male	Adult female	Adult	Subadult	Juvenile	Infant
Consuming natural fruits	59.81±5.37	56.32±3.05	58.06±4.45	75.83	69.58	54.37
Brachiation	48.15±8.45	49.23±8.26	48.69±7.75	70.30	74.88	35.53
Morning call	0.00±0.00	15.43±3.64	15.43±3.64	0.00	0.00	0.00
Alarm call	26.26±13.56	19.65±19.07	22.96±15.72	0.00	0.00	0.00
Affiliative interactions	39.52±3.30	45.37±10.85	42.44±8.06	49.02	48.97	48.91

The highest daily activities of eleven Javan gibbons occurred at 08: 00-09: 00 a.m. and at 02: 00-03: 00 p.m. This was due to increasing morning activities to find and consume food, and morning call vocalization. In the afternoon, increasing feeding activity usually happened near sleeping time. In contrast, the lowest activities occurred at 06: 00-07: 00 a.m. and at 03: 00-04: 00 p.m., due to weather conditions at the observation site which was usually cold, foggy, and occasionally raining, causing delayed activities. When the sun shines in the morning, most Javan gibbons travel to the tops of the trees to catch the sunshine. This is done to warm their bodies before starting activities. After the sun rises, Javan gibbon usually does vocalization and then eats (Rinaldi 2003). The wild gibbons show bimodal pattern in their daily activities, i.e., two peaks for each activity. The first peak happens after the gibbon group leaves their sleeping tree and the second peak happens an hour before the group takes a long rest (Ravasi 2004).

Consuming natural fruits

The ability for consuming fruit of the released gibbon was lower (54.37-75.83%than that of the wild Javan gibbon in MGPNP and MHNP, i.e. 78-85.45% (Landjar 1996, Fithriyani 2007, Ario 2011). This was caused by the higher freedom of expression in obtaining choice of food besides the higher fruit availability outside the cages with unlimited time in the wild compared to that during the rehabilitation and acclimatization phase. During rearing, rehabilitation, and acclimatization, they had limitation in obtaining food depending on the time food was given.

Fruit consumption was higher in juveniles and subadults than in adults. This was because juveniles and subadults tend to travel more and are very active, so they need more food to replace the energy spent. Also, juveniles and subadults are inclined to try all kinds of food in the forest, imitating their parents, but with higher relative frequency compared to adults. The frequency of eating behavior of juvenile Javan gibbons is higher than the adults, because the juvenile is in a growing phase so they need a lot of nutritional intakes (Riendriasari 2009).

During observation, they seemed to be still in the process of locating food. They demonstrated selectivity in choosing food not only of fruits, but also leaves, flowers, and insects. This caused a balanced food proportion between fruits and leaves. Although fruit consumption in the released gibbons was still lower than those in the wild gibbon, their ability to obtain and consume natural fruit was more than 50%. The types of fruits, leaves, and flowers consumed reached 50 species in MMPF (Table 5).

Table 5. List of species of plants consumed by the Javan gibbon in Mount Malabar Protected Forest, West Java, Indonesia

Local name	Scientific name	Organs consumed		
		Fruits	Leaves	Flower
Walen	*Ficus ribes*	✓	✓	
Beunying	*Ficus pistulosa*	✓	✓	
Anggur hutan	*Tetracera scandens*	✓		
Kibeusi	*Rhodamnia cinerea*	✓	✓	
Kiara peer	*Ficus pubinervis*		✓	
Nangsi	*Villebrunea rubescens*	✓	✓	
Hamerang	*Lithocarpus pallidus* [1]	✓	✓	
Pasang	*Lithocarpus pallidus* [2]		✓	
Jarak Anak	*Castanopsis acuminatissus*		✓	
Hampelas	*Ficus parietalis*	✓	✓	
Harendong	*Melastoma affine*	✓		
Putat	*Barringtonia spicata*		✓	
Panggang	*Trevesia sundaica*		✓	
Kiasahan	*Tetracera indica*	✓	✓	
Baros	*Manglietia glauca*	✓	✓	
Kondang	*Ficus variegata*	✓		
Pisang kole	*Musa acuminata*		✓	
Kileho	*Sauraija pendula*	✓		✓
Canar	*Smilax leucophylla*	✓		
Cecendet	*Physalis angulata*	✓		
Saliara	*Lantana camara*	✓		
Rukem	*Flacourtia rukam*	✓		
Rasamala	*Altingia excelsa*		✓	
Binbin	*Pinanga coronata*	✓		
Tepus	*Achasma coccineum*		✓	
Kilame	*Alstonia scholaris*	✓		
Kijeruk	*Acronychia laurifolia*	✓		
Sintrong	*Crassocephalum crepidioides*		✓	
Caringin Areuy	*Ficus benjamina*	✓		
Kisampang	*Evodia sarmentoda*	✓		
Seureuh Leuweung	*Piper* sp.		✓	
Lokwat	*Eriobotrya japonica*	✓		
Kisireum	*Syzygium rostratum*		✓	
Kihujan	*Engelhardia spicata*	✓		
Huru leuer	*Persea excelsa*	✓		
Kihampelas	*Ficus ampelas*	✓		
Puspa	*Schima wallichii*		✓	
Calik angin	*Mallotus paniculatus*	✓	✓	
Kaliandra	*Calliandra haematocephala*			✓
Konyal leuweung	*Passiflora lingularis*	✓		
Kiara	*Ficus involucrata*	✓		
Kanyere	*Bridelia glauca*	✓	✓	
Kawoyang	*Pygeum parviflorum*		✓	
Pisitan monyet	*Dysoxylum alliaceum*	✓		
Beleketebe	*Sloanea sigun*	✓		✓
Pohpohan leuweung	*Pilea trinervia*		✓	
Totongoan	*Debregia* sp.	✓		
Seserehan	*Cinnamomum parthenoxylon*	✓		
Hamirung	*Vernonia arborea*	✓	✓	
Haruman	*Pithecellobium montanum*		✓	

Brachiation

Proportion of brachiation in the released male or female Javan gibbons was higher than that in wild gibbon in MGPNP, i.e., 35.53-70.30% compared to 44.05% (Ario 2011). This was because the release location was a new area for the gibbon family, so they had to explore the area to obtain food, cover, and territory.

Brachiation proportion in juveniles and subadults was higher compared to that of adults. This was because juveniles and subadults were more active; they moved and played near their parents. During juvenile and subadult age, they have learned to imitate their parents' movement, so adaptation to brachiation started early in life.

The ability to do brachiation or other movement is related to the rehabilitation process they have experienced. Using forelimbs for brachiation is very important in their adaptation after release. While undergoing the rehabilitation process in JGC, they have been trained to use their forelimbs via enrichment behavior by placing movement aids such as ropes and bamboo in the cage. Javan gibbon primary locomotion is brachiation. Other types of locomotion include climbing, leaping, and bipedalism. Brachiation is moving horizontally using both forelimbs to keep body weight and swing among tree branches (Matsumoto-Oda and Oda 1998).

Communication

The ability to do morning calls was only found in adult females, and not found in adult males, subadults, juveniles, or infants. The morning call behavior by adult females is an effort to communicate with other groups and express territoriality (Kappeler 1981). Vocalization in Javan gibbon is unique compared to that of other Hylobatids, that is females have a bigger role in keeping territory (Geissmann et al. 2005).

The ability to produce alarm calls can be done by either adult males or females, but not by subadults, juveniles, or infants. The ability to do morning calls and alarm calls had been demonstrated since the gibbons were still in the rehabilitation process at JGC.

The released female gibbons usually did morning call activity between 07: 00-08.00 a.m. after the sun rose, rain stopped, and mist decreased. If an adult female performed morning call, other groups would usually follow it. However, morning activity did not always start with morning call. Sometimes it rained in the morning, and the temperature dropped to 18°C-20°C, and these also affected the time the morning call was sung. The female Javan gibbon in MGPNP performed morning call at 05.30 a.m., however, if the weather was cloudy and foggy, morning call was done at 06: 00-07: 00 am (Iskandar 2007).

Vocalization displayed by males Javan gibbon at study site was a short call as a communication between individuals, alarm call by both males and females were made whenever a potentially dangerous object or threat was observed by the group, such as wild boar, snake, or Javan leopard. Also, sometimes they began singing before the females sang the morning call, but stopped when the females started the great call. A duet male and female singing is not the case in Javan gibbon. The males appeared to abort their song bouts each time a female started to sing. A male Javan gibbons may occasionally call together with females in alarm call (Geissmann et al. 2005).

Alarm calls made by male and female adults showed their alertness. We observed that alarm calls were made when there were other animals presents, such as an eagle or a leopard. Alertness was an advantage of living in groups, because each family member has the same role to detect the presence of disturbance or foreign things around them, thus primate will be aware of predator faster (Tobing 2002).

Affiliative Interaction

The high proportion of affiliative interaction either based on gender or age group indicated positive interaction in maintaining bonding among individuals in all the released Javan gibbon groups. Performing daily activities together allows individuals to interact with each other. We proved this by showing that the average proximity among individuals in each group was mostly in the range of 0-10 m. That was the closest distance among individuals, allowing them to see each other, indicating small opportunity for an individual to be separated from its group.

The proximity among individuals in the Jowo-Bombom-Yani-Yudi family and Mel-Pooh-Asri family were larger than that in Moli-Nancy and Robin-Moni pairs. The presence of an infant or juvenile in the Jowo-Bombom and Mel-Pooh families strengthened the bond among the parents, especially when exploring. If one of the parents was far from the group, the infant or the juvenile would give a call that caused the parent to come closer.

Interaction in a group consists of affiliative and agonistic behavior (Asteria 2008). Affiliative interaction is an interaction that strengthens bond and brings together individuals in a group. According to Fuentes (2000), affiliative behavior in primate aims to keep pair-bonds and affect other individuals (Koontz and Roush 1996), including to initiate copulation (*courtship*) (Estep and Dewsbury 1996).

Difference in social behavior proportion depends on the composition in a Javan gibbon group. If there is an infant or a juvenile in a group, then playing behavior will have a higher percentage compared to other social behaviors. Playing behavior does not only happen among juveniles but also between a juvenile and a subadult, and between a juvenile and an adult.

The Mel-Pooh family did not do any copulation, although there were courtship and social exploration activity. This was because Pooh was pregnant during our observation. Pooh gave birth to a male infant on 14 January 2017 (Figure 4). This success of giving birth in the wild showed that Javan gibbon adaptation in the release site went well. Pooh showed good parenting, nursing, and babysitting, as she had experience of parenting after the first birth at Javan gibbon Center. At the age of 5 months, the baby began to learn to hang on the branch and move but still close to the mother. When the study was being conducted, he was 1.5 years old, already playing alone and consuming its own food.

Territoriality

The territory sizes of the Jowo-Bombom-Yani-Yudi family, the Robin-Moni pair, the Moli-Nancy pair, and the Mel-Pooh-Asri family were 4.53 ha, 1.39 ha, 3.52 ha, and 7.84 ha, respectively (Figure 5). According to Supriatna and Wahyono (2000), the Javan gibbon has a territory size of 16-17 ha with daily travel distance reaching 1.5 km. Kappeler (1981) and Rinaldi (1991), each stated that the average of Javan gibbon's travel area in Ujung Kulon National Park (UKNP) was 13.4 ha and 8.53-8.82 ha. Landjar (1996) noted that Javan gibbon's travel area in MHNP was 26.25 ha.

We proved this from the average proximity among individuals in each group as follow: 51.63% at 0-10m, 35.63% at 10-20m, 12,36% at 20-30m, 0.76% at >30m. The average of tree strata used in each group as follows: 8.89% at 0-10m, 30.61% at 10-20m, 57.77% at 20-30m, 2.72% at >30m.

Each group started from its different release site, and slowly expanded their movement to have bigger home range. This is related to the distribution and abundance of feed around release site. The released Javan gibbon explored the area not only to find food, but also to investigate sound produced by other animals or humans. The high availability of feed causes an area to be maintained actively (Reichard and Sommer 1997). Territoriality is not only defending the spouse, but also to maintain a border area close to the food-source trees (Brockleman 2009).

Fuentes (2000) mentioned that competition to find food in gibbons is relatively high, since they are frugivorous. Fruit availability is much limited compared to leaf, causing increased aggression among females to keep their food source in their own territory by vocalization. Males help females to protect their territory from intruders and predators, and also to protect females from other males.

We found it interesting that Javan gibbon groups did not intrude and occupy each other's territory. Adult females in each group used morning calls as a way of communicating their territory. Female gibbons perform female solo song in the morning to affirm territory boundaries (Fuentes 2002, Geissmann et al. 2005).

In their home range, the eleven released Javan gibbon mostly used 20-30m tree strata. This showed their ability to locate food, to stay safe from predator, and do brachiation on tree branches in that height. The Javan gibbons spend most of their daily activities in the highest canopy strata, on 20-25m (Nijman 2001).

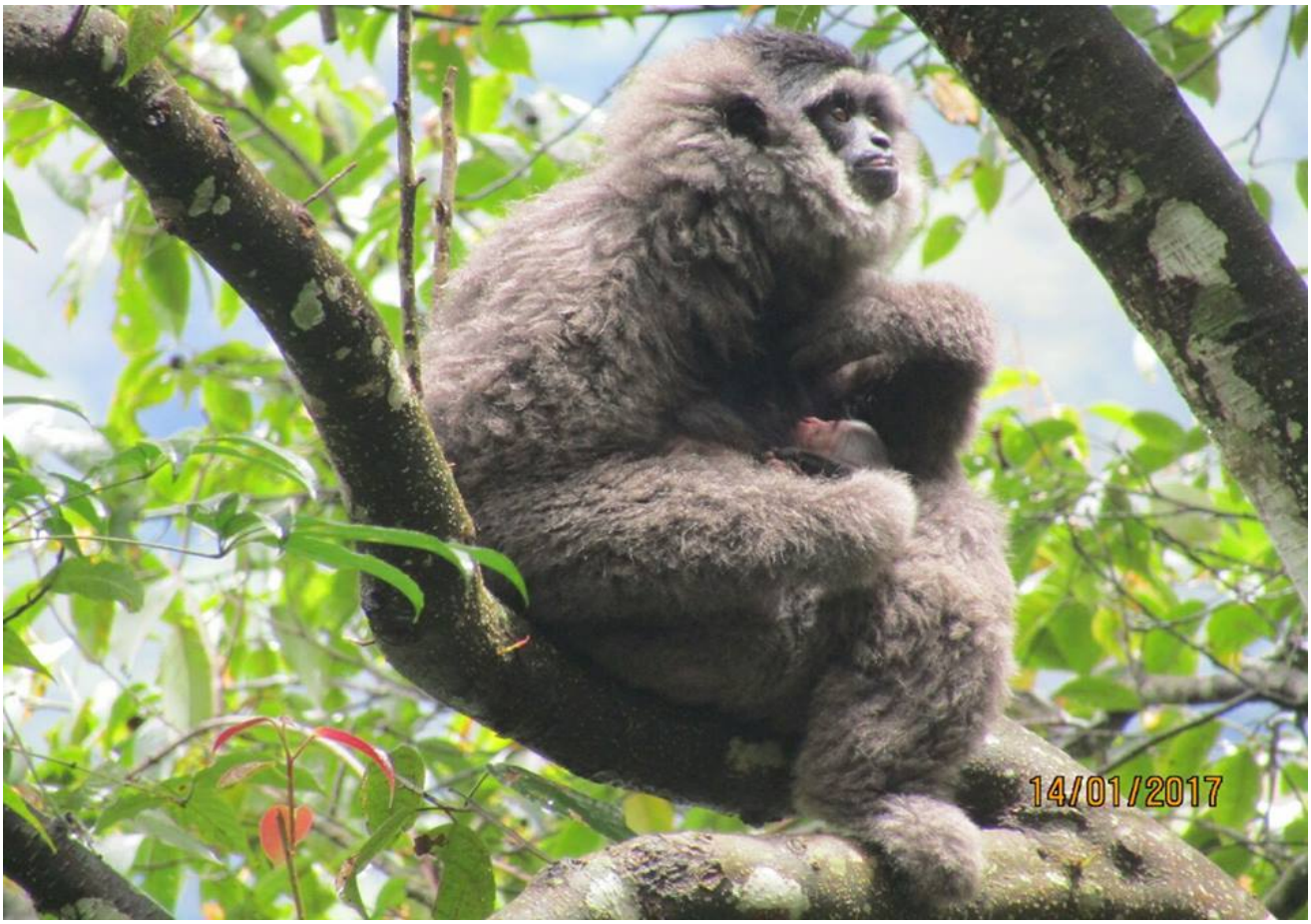

Figure 4. An infant birth of Java Gibbon in release site of in Mount Malabar Protected Forest, West Java, Indonesia

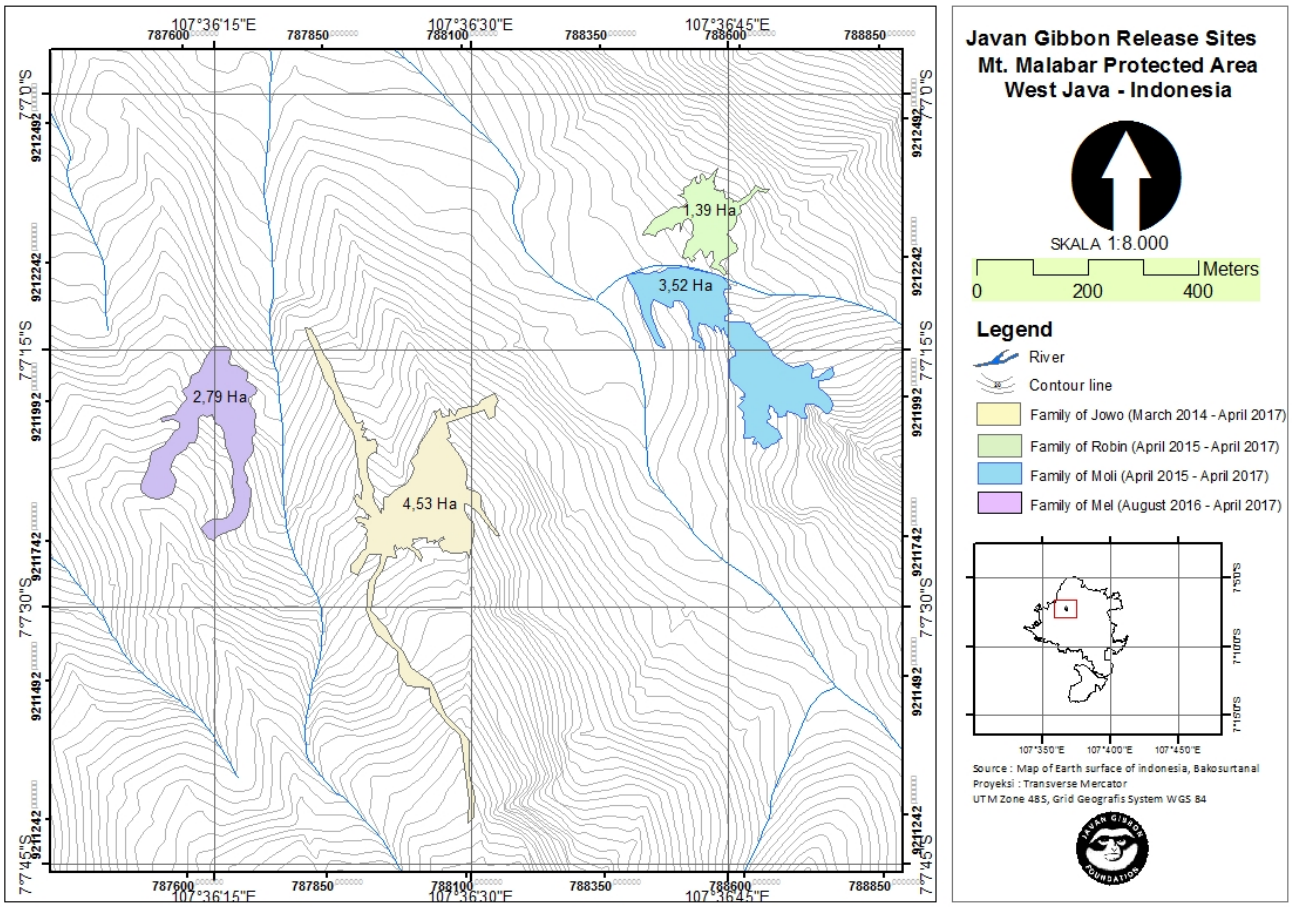

Figure 5. Map of territory sizes of four Java Gibbon group

The Javan gibbons use trees found in that strata as their sleeping trees, although they might not use the same tree each night. They often use rasamala (*Altingia excelsa*), kilame (*Alstonia scholaris*), pisitan monyet (*Dysoxylum alliaceum*), huru leuer (*Persea excelsa*), and kibeusi (*Rhodamnia cinereal*) as their sleeping trees. Sleeping tree is important to protect primates from predators while they sleep. The gibbon requires a forest with connected canopy, trees with height more than 25m, and high diversity of fruit-producing trees (Cheyne et al. 2013).

Adaptation to the environment

Four groups of Javan gibbon released in MMPF have experienced these three phases: rehabilitation, translocation, and acclimatization. In the acclimatization phase, the four groups were placed in different cages.

In the Jowo-Bombom-Yani-Yudi family and Mel-Pooh-Asri family, the first individuals that exited the cage were the adult males, namely Jowo and Mel. In the Moli-Nancy and the Robin-Moni pairs, the adult females exited the cage first, namely Nancy and Moni. Jowo's and Mel's initiative to get out first showed adult male's protective role in a family with offspring. In the Moli-Nancy and the Robin-Moni pairs, initiative was shown by the adult female with no offspring, thus no alert behavior was observed. The presence of offspring obviously affects parents' level of alertness.

During exploration process, all the Javan gibbon groups that were released still wandered around the acclimatization cage, sometimes above the cage, and even re-entered the opened cage. This was because the acclimatization cage was considered as the safest location to avoid predators or human threats. Allowing them to wander around the cage was a gradual lesson before they completely left the cage.

The acclimatization cage was kept in its location, so the gibbons could still recognize their safe center point, considering more than half of their lifetime was spent in rearing cage and rehabilitation. Dependance on the cage would diminish slowly, while gibbons were still wandering near their cage within an average of 5-6 months post-release. All processes were left to happen as naturally as possible without human intervention.

Weather condition

The weather encountered during this study was relatively cold and foggy, with occasional rain in the morning or in the afternoon. Adaptation to weather conditions is highly needed, due to highly different conditions they encountered when they were pets or in

rehabilitation. The location of the rehabilitation was an area with an altitude of ±650 m asl, while the release site was 1000-2300 m asl. The Javan gibbon could be found in an altitude of 1600 m asl., although some could be found in an altitude of higher than 2000 m asl. (Nijman 2004).

The Javan gibbon has relatively thick hair, which helps its adaptation to live in cold places. The gibbons slept close to each other to keep them warm. Their adaptation to face cold weather in the study site was moving towards sunshine in the morning and warming their bodies before doing other activities.

Human presence

Human-directed behavior was a considerable concern. Given their history of being confined as pets, we expected that, they might be drawn to approach humans after they have been released in the wild.

During our observation, the released Javan gibbons still showed human-directed behavior although in smaller percentage compared to their whole behaviors. In adult males and females, the value was 0.43%-0.52%. In infants, juveniles, and subadults, the behavior was not observed, since, in that age group, they never interacted intensively with humans. This low level of response to human presence showed the positive effect of rehabilitation program on these eleven individuals of Javan gibbon. Limiting contact between the Javan gibbon and humans during rehabilitation is essential to reduce its dependency on and interest in humans.

The human-directed behavior showed to observers was an aggressive behavior, as an alertness to protect the member of the group. Whether a primate behavior is affected or not, can be detected early from its alertness to human presence (Tobing 2002).

Effects of rearing and rehabilitation to adaptation ability

Before being released, the Javan gibbon experienced two conditions: it was held as a pet, then it underwent rehabilitation at JGC. Both conditions involved close human interaction. The average age of gibbon when starting the rehabilitation process was 9 years, ranging from 2 to 11 years old, in male and 5 years, ranging from 6-11 years old in female gibbons. When a gibbon was kept as a pet for a prolonged period, its behavior changed. On average, we need five years to recover normal behavior in ex-captive Javan gibbons before they are ready for releasing.

During rehabilitation, they were given natural fruits found in the forest. We also trained them to use their forelimbs to brachiate through enrichment behavior. They were trained to vocalize by allowing them to listen to wild gibbon sounds in the wild. Intensive efforts to recover their abilities during rehabilitation is very important to prepare them to be released to their natural habitat. Another big challenge in Javan gibbon rehabilitation was forming adult pair bonds.

The released Javan gibbon had relatively good adaptive ability. All four groups have shown primary normal behavior, such as: consuming natural food, brachiating, morning calling and alarm calling, showing affiliative behavior among individuals, and creating a territory. These abilities were related to the rehabilitation efforts at JGC. Proper treatment during the rehabilitation process is important to ensure adaptive ability after release, although this ability is not the same for each gibbon. The longer they became a pet, the harder it was to rehabilitate them. In contrast, infants, juveniles, or subadults adapted faster during rehabilitation, because they had less interaction with humans.

In conclusion, Javan gibbon post-release behavioral adaptation is affected by internal and external factors. Internal factors include the ability of each individual to develop wild behavior according to its sex and age group. External factors include the ability of Javan gibbon to adapt to the environment, namely weather conditions and human presence. Treatment by an interaction with humans during captivity will highly determine the adaptative ability of the released Javan gibbon. The longer it is held in captivity, the longers are its rehabilitation process and adaptation process after being released. Releasing infants, juveniles, and subadults increase the probability of successful Javan gibbon rehabilitation and reintroduction program. Natural birth in the wild further increases the odds.

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