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Distribution, Population, and Habitat of Siamang (*Symphalangus syndactylus*) in Bulu Mario, South Tapanuli

(Sebaran, Populasi, dan Habitat Siamang (Symphalangus syndactylus) di Bulu Mario, Tapanuli Selatan)

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ABSTRACT

The population of siamang in the forest around Bulu Mario Village needs attention even though it is outside the conservation area. Therefore, this study was conducted using survey methods, vegetation analysis, and concentration count. Based on the data, siamang was distributed at an elevation of 683 - 1123 m asl in forest and mixed plantations with a dominant slope of 70.02%. Furthermore, the population was 44 individuals from 15 groups with a density of 2.88 individuals/km^2, and the ratio of adult males to females was 14:12. The age classes of adults and juvenile-1 dominated the age structure pyramid; hence, the population's sustainability is considered good enough. Also, the low population density of the primate is due to habitat fragmentation in several locations. The siamang uses the entire canopy space and is associated with various other primates. Both hayu ndolok (Syzygium sp.) and rubber (Hevea brasiliensis) are the tree species with the highest abundance in the forest and mixed plantations. The siamang eats more of the fruit of 51 plant species dominated by the Euphorbiaceae family and tree habitus. Therefore, the development of animal corridors is needed to reduce the impact of habitat fragmentation.

1. Introduction

The siamang or *Symphalangus syndactylus* (Raffles, 1821) is a primate of the Hylobatidae family naturally found in Thailand, Malaysia and Indonesia (Sumatra). It is classified in Appendix I by CITES and protected by the state based on the Regulation of The Minister of Environmental and Forestry Number P.106 of 2018 (Permen LHK No. P.106, 2018) concerning the protection of Wild Plants and Animals. However, due to the declining population of the primate caused by hunting, trade, and habitat degradation, IUCN declared its conservation status to be endangered in 2020 (Nijman & Geissmann, 2008).

The population of siamang in Dolok Sipirok Nature Reserve and surrounding areas is 24 individuals, with an estimated density of 9.91 ± 3.4 individuals/km^2 (Kwatrina, Kuswanda, & Setyawati, 2013). This reserve is a part of the Batang Toru Ecosystem, and several anthropocentric activities, such as illegal logging and forest conversion, are threats to the sustainability of the siamang population. One of the primate's habitats outside the conservation area in the Batang Toru Ecosystem is in the forest of Bulu Mario Village, Sipirok District, South Tapanuli. It is located in the buffer zone of the Dolok Sibual-buali Nature Reserve and near the Dolok Sipirok Nature Reserve. The habitat in the village consists of a community forest with two land covers, forests and mixed plantation. Also, conservation areas and protected forests are currently the last bastions for

Editor: Dr. Rozza Tri Kwatrina
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Kontribusi penulis: **SAM**: Research preparation plan starting from the title, introduction, and background, research objectives, research methodology, and reference collection, Data collection (observation, documentation, plant identification) , data analysis, and results drafting and **AHM**: Supervisor and adviser in research planning, adviser in data collection, adviser in result drafting.

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the primate's defense in their natural habitat (Nijman, Geissmann, Traeholt, Roos, & Nowak, 2008). Nevertheless, their existence outside protected and conservation areas require attention to maintain their population and ecological value.

The conditions and quality of habitat determine wildlife composition, distribution and productivity. It was stated that conservation strategies for the Batang Toru have not been implemented, including siamang as an ecosystem element (Alikodra, 2010; Pasaribu & Harahap, 2017). The limited literature on the primate's distribution, population, and habitat characteristics outside the conservation area in the forest around Bulu Mario Village has motivated the need for this survey. Hence, this study can be included for other primate conservation strategies in this location, such as *Pongo tapanuliensis*, *Hylobates lar*, *Hylobates agilis*, *Presbytis melalophos*, and *Macaca nemestrina*. Furthermore, it is one of the first steps in the in-situ conservation strategy of siamang and their habitats, especially outside conservation areas. Therefore, this study aims to analyze the characteristics of the siamang habitat and determine their distribution and population in Bulu Mario Village.

2. Methodology

2.1. Time and Location of Study

This study was conducted from April to June 2021 in Bulu Mario Village and its surroundings, Sipirok District, Batang Toru Ecosystem, South Tapanuli Regency, North Sumatra Province (Figure 1).

2.2. Data Collection

Siamang distribution and population

Data collection for estimating the population size of siamang was carried out using the concentration count method, which is suitable for observing wild animals (Rinaldi, 1992). Furthermore, observations were made at points where animals usually congregate (Bismark, 2009). The concentrated observation was also conducted at a known gathering place for siamang, a member of the Hylobatidae family (Wahyuni & Erie, 2016). Finally, the selection was carried out by surveying the research location to find sleeping trees or siamang encounters. These observations were conducted on two land covers that allow encounters with siamang groups: forest and mixed plantation.

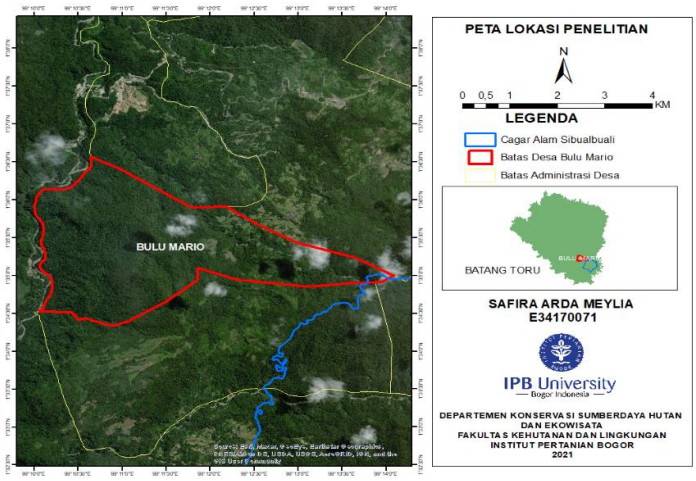


Figure 1. Research site map

The encounter points of the groups were observed, and the required parameters were recorded. It was reported that there were several individuals in each group, including male and female adults, juvenile-2, and juvenile-1. This study was conducted with three repetitions or three days in each group according to their active time, from 6 am to 6 pm. Furthermore, the presence of siamang was detected by direct encounter or sound, and the data recorded from sound observations include the time and coordinates of the sound source. The search for the sound source was conducted by walking toward the spot, gathering information from those who know the direction, and marking the location on GPS. Also, the coordinates of the encounters were obtained by marking using GPS at each point. Additionally, data in the form of coordinates were used as material to determine the distribution of each siamang group found.

Habitat characteristics

Data on abiotic and biotic components were collected to obtain information on the habitat of the siamang. First, abiotic component data were carried out directly in each land cover by measuring several elevation parameters, such as air temperature, humidity, slope, and location. The equipment needed in this data collection is a dry-wet thermometer, a clino, and Global Positioning System (GPS). Subsequently, rainfall and water sources were obtained by a literature study.

The biotic component data collected include vegetation, canopy continuity, and animals associated with siamang in the forest around the Bulu Mario Village. The data of associated animals were collected by noting the species that were seen or detected at the encounter point. Vegetation analysis is a method used for determining the composition of the dominance of a tree species in a community (Nurdin, 2010). Meanwhile, the plant species identification was carried out using several methods, including interviews with local communities, literature studies, and matching the plant species list from the Natural Resources Conservation Center of North Sumatra (BKSDA Sumatra Utara).

The vegetation analysis was carried out using a plotted line method at the encounter points of the siamang (Figure 2). Furthermore, three plots were made around sleeping trees or the encounter points. Ideally, the middle plot was placed in the encounter point; however, the placement depended on conditions (like topography). The selection of the vegetation analysis plot site was also considered based on its accessibility.

The data obtained for each plot size are as follows: tree data for a 20 × 20 m plot, pole for a 10 × 10 m plot, sapling for a 5 × 5 m plot, and seedling for a 2 × 2 m plot. Other data collected to determine the continuity of the canopy include the length and direction of the widest and narrowest canopy.

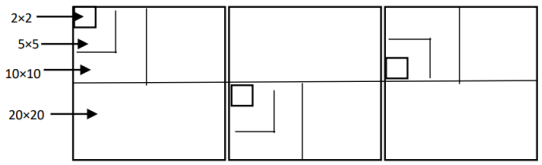


Figure 2. Vegetation analysis checkered line plot illustration

Use of space and feed

Data collection methods regarding the use of space and feed plants of siamang in the study location were carried out in three ways. These include direct observations in the field, interviews, and literature studies. The data collected to analyze the space use and feed plants of siamang include the type of tree used by the primate, the kind of activity, and the position of their activity on the tree. Furthermore, direct observations regarding the use of space and feed for the primate were carried out from 6 am to 6 pm. Finally, data collection on space and feed was obtained by conducting interviews with officers and local communities and literature studies.

2.3. Data Analysis

Siamang distribution and population

Observational data were used to map the distribution and determine the siamang population in the forest of Bulu Mario Village. Furthermore, the encounter coordinates data were processed using Geographic Information System (GIS) to produce a map for the distribution of siamang and were interpreted descriptively. The description of the distribution map is associated with each habitat type in the location and its characteristics. Additionally, the data related to the siamang population were analyzed to obtain information on population size, density, sex ratio, and age structure.

1. Population size, according to Herriott (1978)

   $P = Nmax$ (1)

Remarks:
P = Population size (individual)
Nmax = The largest number of population sizes found (individuals)

2. Population density (D), according to Seber (1986), is the total population size divided by the total area used:

$D = P/A$ (2)

Remarks:
D = population density (individuals/km^2)
P = population size (individuals)
A = area (km^2)

3. The sex ratio (S) is the ratio between the number of males and females in a population or group:

$S = \frac{X}{Y}$ (3)

Remarks:
S = sex ratio
X = Number of male individuals in a group or total
Y = Number of female individuals in a group or total

4. The population age pyramid, according to Caughley and Sinclair (1994), can be obtained using the formula:

$$\text{Pyramid of population} = \frac{Number\ of\ individuals\ in\ a\ certain\ age\ class}{range\ in\ a\ certain\ age\ class} \quad (4)$$

According to Gittins & Raemakers (1980), the age class of gibbons is divided into five classes infant, juvenile-1, juvenile-2, sub-adult, and adult. The difference between these age classes are:

1. The infant is the phase that begins after birth until the age of two or three years with a tiny body size. The young ones are usually carried by their female parent during the first year and their male parent during the second year.

2. Juvenile-1 is the phase that starts from about two to four years with a small body. At this stage, they can move independently but still prefer to be close to their mother.
3. Juvenile-2 is about four to six years old with medium body size. At this stage, they often move and look for their food.
4. Sub-adult is the phase that begins from the age of six years. They have almost the same body size as an adult. However, they are often separated and not sexually mature.
5. Adults are individuals with maximum body size, live in pairs, and are always close to their children.

Habitat characteristics

Data on the abiotic components of the siamang habitat in the form of temperature, humidity, elevation, and rainfall were analyzed descriptively. Meanwhile, the data on the biotic components from the results of the vegetation analysis on the plotted line were processed with several equations to produce information on density, relative density, frequency, relative frequency, dominance, relative dominance, and Important Value Index (IVI). Finally, the data were calculated using the following formula to analyze the abundance (Soerianegara & Indrawan, 1988):

$$\text{Specific Density (SD)} = \frac{\text{Number of individuals of a species}}{\text{Sample plot area}} \quad (5)$$

$$\text{Relative Density (RD)} = \frac{\text{Density of a species}}{\text{Density of all species}} x100\% \quad (6)$$

$$\text{Specific Frequency (SF)} = \frac{\text{Number of sample plots of a species found}}{\text{Number of all sample plots}} \quad (7)$$

$$\text{Relative Frequency (RF)} = \frac{\text{Frequency of a species}}{\text{Frequency of all species}} x100\% \quad (8)$$

$$\text{Species Dominance (SD)} = \frac{\text{The total area of the base plane of a species}}{\text{sample plot area}} \quad (9)$$

$$\text{Relative Dominance (RD)} = \frac{\text{Dominance of a species}}{\text{Dominance of all species}} x100\% \quad (10)$$

$$\text{Important Value Index (IVI) of Seedlings and Saplings} = \text{RD+RF} \quad (11)$$

$$\text{Important Value Index (IVI) of Poles and Trees} = \text{RD+RF+RD} \quad (12)$$

Also, canopy continuity was determined using the data obtained from the height, length, and direction of the tree's widest and narrowest canopy. The data were subsequently illustrated by making a canopy profile diagram and tree stratification.

Use of space and feed

The data on the use of space and feed for siamang from the study results were presented in illustration pictures and descriptively analyzed. Furthermore, data on space use were analyzed based on individual positions in the tree canopy space when the position of the space is vertically divided into five categories (Anggraeni, Rinaldi, & Mardiastuti, 2013). The tree canopy profile diagram data indicate the habitat's profile, including height, canopy continuity, and width. The types of plants or trees which become food sources for the primate were identified and analyzed by their family, habitus, or consumed part of the plant species.

3. Results and Discussions

3.1. Distribution of Siamang

The number of siamang groups in Bulu Mario Village was 15 and found in two land covers (Figure 3). Each group was distinguished based on their home range, according to Chivers (1977), who stated that the primate had a home range of 15-30 ha. Furthermore, 11 were found in forest land cover, while the remaining four were in mixed plantations. They

were distributed in the village and its surroundings at an elevation of 683-1,123 m above sea level with a dominant slope of 70.02%. According to Kwatrina et al. (2013), siamang in the Dolok Sipirok Nature Reserve and surrounding areas is found on the land cover of primary and secondary dryland forests or river banks adjacent to dry land agriculture at an elevation of 900-1,200 masl.

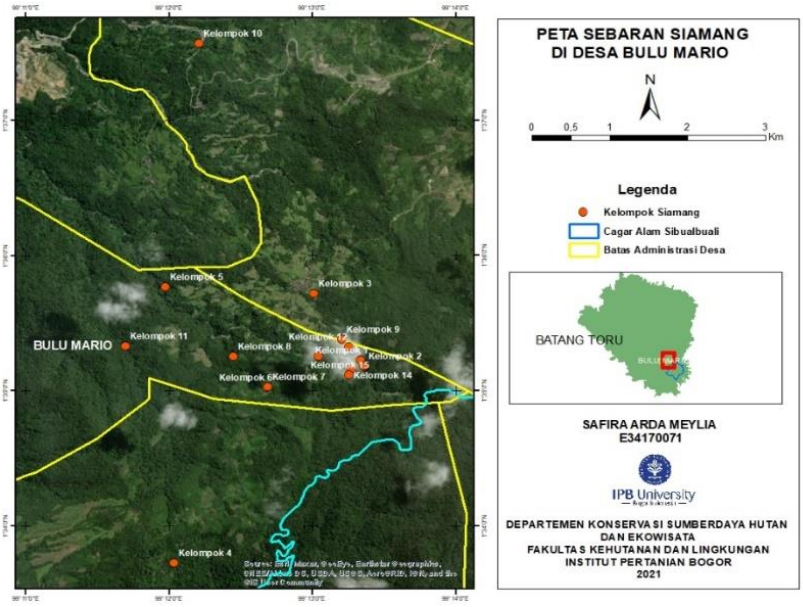


Figure 3. Siamang distribution map

Accordingly, siamang at the study location is usually found in the rivers or irrigations vicinity (small streams in or around plantations area). The number of the primate encounters around the river, according to Kwatrina et al. (2013), is stated to be related to the availability of feed trees around the area. Meanwhile, their number in steep areas is suspected as a strategy to avoid the risk of habitat destruction by humans because they tend to avoid, pass or occupy steep areas. However, this requires further studies to validate Nongkaew (2010), which explained that the primate is more likely to select the steep area than their sympatric one, *Hylobates agilis*. Also, their presence in this location indicates that the encounter points have the same habitat characteristics as siamang, such as the continuous canopy and food availability. In addition, the existence of continuous tree crowns can aid their movement (brachiation) and mobility from one tree to another (Sultan, 2009).

Those in forests far from the plantations only yielded one group, specifically Group 11, close to the Sitandiang River. The forest condition appears healthy outside, although there are several traces of tree cutting inside. The lack of encounters in this location is related to rampant illegal logging activities; hence, siamang and other animals are disturbed by the noise of the machines, which is quite loud. According to Meijaard et al. (2006), logging activities directly affect vertebrate life, especially population decline, the most obvious impact.

Based on observations, the primates are mostly found in steep areas close to plantations and even forests near village roads. Their presence around the location indicates that they are adaptable to human activities as long as they do not interfere with their existence. However, siamang tends to be intolerant of the sound from a chain saw machine. According to community information,

their presence in the vicinity of mixed plantations or settlements does not interfere with the activities or yields of community plantations. Additionally, when siamang invades mixed plantations, they usually eat only sugar palm and other small fruits that humans do not consume.

According to Chivers (1977), regarding their home range, they are frequently suspected of fighting over their home ranges in the higher concentration of groups in certain study site areas. However, one of the observed phenomena in Groups 1 and 2, which are only about 100-150 m apart, indicates one of the groups enters another home range radius. The chronology was that when Group 1 was engaging in activities under the tree canopy on a steep part of the riverbank, Group 2 participated in calling activities while moving from the forest to the riverbank. The trees around the riverbank, such as *titinurat* (*Litsea* sp.) and *lacat bodat* (*Shorea hopeifolia*) are known as their feed plants. After Group 2 arrived at the riverbank, Group 1 moved across the river with their mobility on tree crowns, supposedly to stay away from Group 2.

The siamang is a highly social primate species that communicate by using a variety of visual or tactile gestures and facial expressions (Liebal, Pika, & Tomasello, 2004), one of which is known as a morning call. This call is a loud sound that reaches out to each other in the morning with their unique voice or vocalization (Supriatna & Wahyono, 2000). Apart from marking the territory, this activity also serves to find a mate (Cowlishaw, 1992). The calling activity at the study location happens in the morning and the afternoon, and evening before sunset, with a duration of 15 minutes or more. Based on the observation, the highest calling activity intensity occurred in the morning and evening. During this activity, the primate uses the distal part of the hand to modulate the sound called hand modulation (Badraun, Mootnick, Deaner, Agoramoorthy, & Mc.Neese, 1998).

3.2. Siamang population

Population size and density

Based on the observation presented in the group details above, the population size of siamang in the study location and its surroundings was 44 individuals. The number in each group ranged from 1 individual found in Group 6, 10, and 14 to the highest being five individuals in Group 2. The group size is affected by several factors, including feed resources and the environment used in the nurturing process (Bismark, 2009), supporting the regeneration and growth of species populations. Besides these factors, group size can also be influenced by age and sex based on observations.

Group 10 and 14 members are one sub-adult male siamang, while Group 6 members are one juvenile-2 (adolescent) individual. During the observation periods, no other individuals were found at the encounter point of single groups. Therefore, the data recorded remained to only one individual. Two groups that are far apart, Group 10 and 4, were separated from the others because of the canopy condition cut off by the number of coffee plantations, roads, and settlements. The coffee plantations do not have a canopy with sufficient height to support the mobility of siamang. The area explored is 15.27 km² with a population density of 2.88 individuals/km². Meanwhile, the primate density in the Dolok Sipirok Nature Reserve, according to Kwatrina et al. (2013), showed a higher range than the outside area, precisely 6-14 individuals/km² (9.91±3.40 individuals/ km²). This difference in population density is due to the higher quality of the habitat in the nature reserve than those outside the conservation area, which are susceptible to various threats, such as logging and land-use change.

Table 1. Number of individuals in each siamang group

Group	Land Cover	Sex and Age Class					Total
		Male Adult	Female Adult	Juvenile-2	Juvenile-1	Infant	
1	Forest	1	1	0	2	0	4
2	Forest	1	1	0	2	1	5
3	Mixed plantation	1	1	0	1	1	4
4	Mixed plantation	1	1	0	1	0	3
5	Forest	1	1	0	1	0	3
6	Mixed plantation	0	0	1	0	0	1
7	Forest	1	1	0	1	0	3
8	Forest	1	1	0	1	0	3
9	Mixed plantation	1	1	1	0	1	4
10	Forest	1	0	0	0	0	1
11	Forest	1	1	0	0	0	2
12	Forest	1	1	0	1	0	3
13	Forest	1	1	0	1	1	4
14	Forest	1	0	0	0	0	1
15	Forest	1	1	0	1	0	3
Total		14	12	2	12	4	44

Sex ratio

Overall, the sex ratio of the male and female species in the adult age class at the study site was 14:12. The two unpaired adult males are those in Group 10 and 14, who are the sole members of the group. As a monogamous animal, ideally, the adult sex ratio in the population is 1:1 as a form of strategy to maintain population stability (Rinaldi, 1992). An imbalance in the sex ratio of animals can affect the stability of their population in the future (Zahra & Winarno, 2017).

However, Ario, Jatna, & Noviar (2011), in their study on the Javan gibbon (*Hylobates moloch*), a species member of the Hylobatidae family, stated that a sex ratio close to or equal to 1:1 in an area can still be regarded as healthy. This is supported by the possibility that siamang in the juvenile-2 and juvenile-1 age classes are female individuals; hence, they can meet the ideal sex ratio when they become adults. However, the determination of sex in these age classes was not carried out because the sexual characteristics were not fully mature (Bashari, 1999).

Age structure pyramid

According to Gittins & Raemakers (1980), there is a sub-adult age class in the age structure of siamang. This class has the same age as the adult, six years. The difference between the two is that sub-adult individuals often separate themselves from their groups (Gittins & Raemakers, 1980). However, since they are in the same age range as the adult class, in this study, the sub-adult class is melted down into the adult age class to form an age structure pyramid.

Table 2. Age class of the siamang population

Class Age	Age (year)	Age interval (years)	Number of individuals	Number of individuals/ age interval
Adult	6-33	27	26	0.96
Juvenile-2	4-6	2	2	1.00
Juvenile-1	2-4	2	12	6.00
Infant	0-2	2	4	2.00

Figure 4 (a) shows that the juvenile-2 age class has the least number of siamang compared to other classes. Nevertheless, the adult age class is the most frequently encountered category in the study. The ratio of adult, juvenile-2, juvenile-1 and infant age classes in this region is 26:2:12:4, respectively. Figure 4 (b) shows the pyramid condition of different age structures. After dividing by the age range, the juvenile-1's age class was the widest compared to other classes. This showed that the habitat in the forest around Bulu Mario Village still provides the resources to support the reproduction and parental care of the primate. Hidayat (2013) stated that many individuals in the juvenile-1 or young age class can guarantee productivity and birth rates in the population.

According to Alikodra (2010), age is one of the parameters used as a reference in managing wildlife populations. Therefore, the regeneration of siamang at the study site can be said to be good because the number of juvenile-1 is quite large. Also, the number of babies born by the female individual is usually not more than ten during their lifetime (Gron, 2008). The female parent aged 8 to 9 years generally experience a gestation period of 210-240 days with a birth distance of one infant from another, which is about 2-5 years (Supriatna & Wahyono, 2000).

3.3. Habitat Characteristics

Abiotic components

The habitat of the siamang in Bulu Mario Village and its surroundings is an area with sloping to wavy or hilly topography with various slopes and is generally not far from rivers or irrigation. The slope measurement in the two land covers where the primates were encountered was specifically in the range of 14.05-70.02% for both forest and mixed plantations. Furthermore, the dominating slope at the meeting locations in the study location was 70.02%. Topographic variations considerably influence the region's distribution and amount of rainfall (Adihaningrum, Dermawan, & Chandrasasi, 2018). This can be proven by the frequent occurrence of local rain phenomena at the study site.

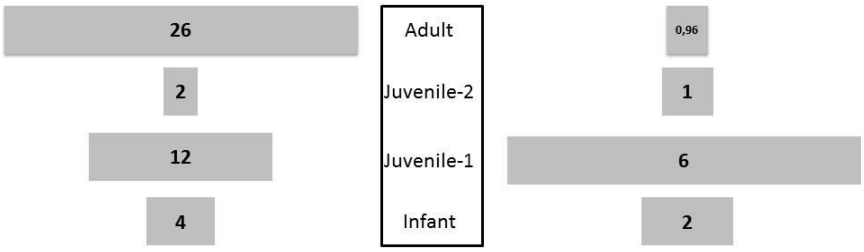


Figure 4. Age structure pyramid of siamang based on the number of individuals in each class (a) and the ratio of individuals divided by age interval (b)

Figure 5. Location of siamang encounters in the (a) forest and (b) mixed plantations

The location of the siamang encounter is divided into two land covers: forests and mixed plantations with different temperatures and humidity. Based on air temperature measurements, forest land cover had an average temperature of 25.5°C with a humidity of 87%. Meanwhile, the mixed plantation's land cover had an average temperature of 27°C with 91% humidity. Sanger, Rogi, & Rombang (2016) stated that converting elements in the natural environment to artificial ones can change the characteristics of the microclimate.

The abundance of plant species

Based on the land covers, vegetation analysis was carried out on 30 plots divided into 15 plots each on forest and mixed land covers and became the meeting point of siamang. Each land cover has a different composition and structure of vegetation.

Analysis of vegetation on forest land cover resulted in a list of 71 species of trees as well as sugar palm and bamboo. The three highest IVI for both land covers can be seen in Appendix 2 and 3. According to the IVI calculation, the species with the highest IVI value was hayu ndolok (*Syzygium* sp.), with the growth rate of seedlings, saplings, and poles at 35.1%, 34.79%, and 55.65%, respectively. Also, Hoteng (*Quercus gamelliflora*) had the highest value of 22.62%, based on tree growth rate in forest land cover. Meanwhile, andulpak (*Homalanthus populneus*) had the highest value of 52.01% for plantations land cover at seedling level, coffee (*Coffea* sp.) at 20.84% in sapling level, rubber (*Hevea brasiliensis*) at 71.26% in the pole level, sugar palm (*Arenga pinnata*) and durian (*Durio zibethinus*) at 49.51% and 62.54% in the tree level, respectively.

A plant species with a high IVI value indicates its dominance over other species in its community (Indriyanto, 2006) and has a higher opportunity to maintain growth and sustainability (Mawazin & Subiakto, 2013) as well as the stability of its existence (Sutisna, 1981). The plants with high IVI in the habitat vegetation indicated that these species are essential for providing the needs and sustainability of siamang life, such as food source, shelter, and breeding site. This is indicated by the many dominant plant species found at the primate's encounter points. According to Loveless (1983), animals and humans significantly influence a plant's presence. In addition, siamang in this study location was also observed using bamboo clumps to play and move. This is in accordance with Permatasari, Setiawan, & Dermawan (2017) in Protected Forest Register 28 Pematang Neba, Tanggamus Regency, Lampung.

Use of space

Siamang, as an arboreal mammal, inhabits the tree canopy space. It is associated with other primate species, such as *Hylobates lar*, *Hylobates agilis*, *Prebytis melalophos, Ratufa bicolor*, *Macaca nemestrina*, and *Pongo tapanuliensis*. The *Macaca nemestrina* is a predominantly terrestrial primate that readily climbs and forages in the forest canopy (Boonratana, Chouhury, & Supriatna, 2020).

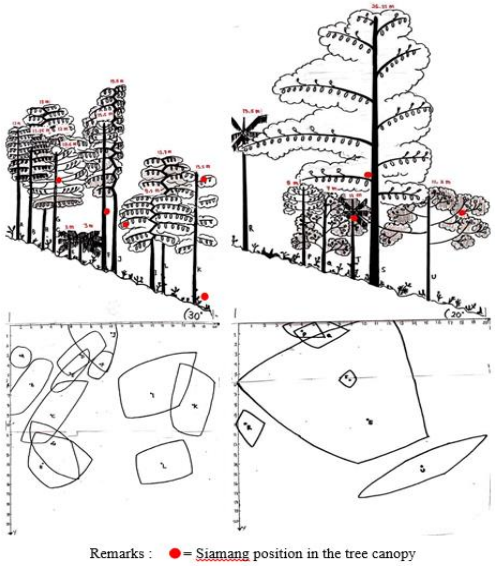
As a component of habitat, trees should provide basic needs like shelter and cover (Weddel, 2002). According to Master, Kanedi, Harianto, Prasetyaningrum, & Nurcahyo (2013), the primate uses the same tree for sleeping and other activities like calling. Based on Figure 6, vegetation with a continuous tree canopy at varying heights is mainly used for their activities. The tree strata variations were stratum A or emergent (height more than 30 m), stratum B or canopy (height 20-30 m), stratum C or sub-canopy (height 4-20 m), and stratum D or understory (height 1-4 m) (Indriyanto, 2006). The tallest tree in the vegetation analysis plot was banyan (*Ficus benjamina*), with a height of 35 m

found in forest land cover. The canopy height in the mixed plantation is almost the same as the forest land cover, although the canopy cover is uneven like in forests. This is because the plantation is improper since it only produces plant commodities used or consumed by humans, although there are still some large forest trees.

As shown in Figure 6, the primate's position can be at the bottom, middle, or top of the canopy, which fulfills all the canopy vertical space categories (Anggraeni et al., 2013). In addition, siamang around the study site was also observed walking on the ground to cross the fragmented area.

Feed

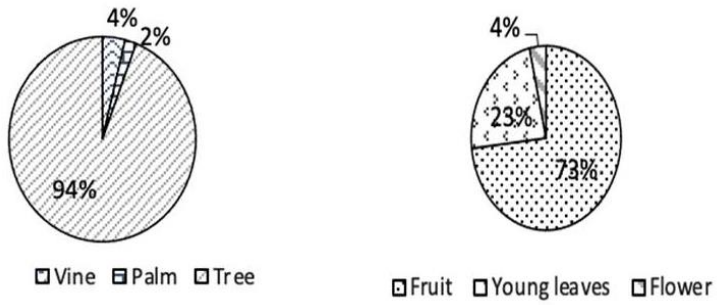
The siamang feeding plants in Bulu Mario Village were 51 species from 25 families. The species are grouped by family and habitus and partly eaten by the primate, as shown in Figure 8. Three families dominate their food plants: Euphorbiaceae with a percentage of 19.61%, Moraceae with 9.8%, and Fabaceae family with 7.84%. Most habitus of the feed plants were trees with 94%, followed by 4% liana (vine) and 2% palms habitus. Siamang in this study location is known to consume more parts of the plant, 73% fruit, 23% young leaves, and 4% flowers.



(a) (b)

Figure 6. Illustration on the use of canopy space (a) forest and (b) mixed plantation by siamang and the tree canopy projection

Figure 7. Siamang's position in the tree canopy



(a) (b)

Figure 8. Siamang feed composition based on (a) habitus and (b) the part of the plant eaten

Some of the feed plant species with high IVI values include *hayu ndolok (Syzygium sp.), hoteng (Quercus gamelliflora), simareme eme (Schefflera aromatica), andulpak (Homalanthus populneus), sapot (Macaranga gigantea), andarasih (Ficus glandulifera), aren (Arenga pinnata), landorung* (*Helicteres hirsuta*), rubber leaf shoots (*Hevea brasiliensis*), and small durian fruit (*Durio zibethinus*).

This study showed that the composition of plant parts is almost the same as that of Mawardi, Sri, Astuti, Rizwar, & Rizwar. (2016), which stated that the composition of the feed plant parts consisted of 70% fruit, 20% leaves, and 10% flowers. In contrast to Palombit (1997), the natural diet of the primates in their habitat is said to consist of 51% fruit, 33% leaves, 10% insects, and 6% flowers. According to Palombit (1997), siamang consumes more fruit than other Hylobatidae species on the island of Sumatra. Also, there is a difference in the percentage of the feed between Palombit (1997) and this study as the latter only included plants and not insect species. The siamang is a frugivorous animal that has the ecological role of regenerating its feed plants by spreading seeds through their feces.

The types of fruit they mostly consume are figs (*Ficus* spp.) (O'Brien, Kinnaird, Nurcahyo, Prasetyaningrum, & Iqbal, 2003) which contain sufficient water. The primates feed more on fruits with a high water content because they do not consume water directly, as with the Javan gibbon (Iskandar, 2007). Based on observations and information from the surrounding community, they are rarely seen descending from the tree canopy to reach the water directly on the ground. However, it was noted once when a siamang crossed a fragmented area. Several people thought this was a strategy to avoid predators like the Sumatran tiger (*Panthera tigris sumatrae*). However, according to Clarke et al. (2012), the vertical strata used on the primate were not affected by their ground predator's existence; hence, they increase their vigility when they see the predator directly (Clarke et al., 2012).

Impact based on research results

Based on the results, the relatively low population density of siamang in this area is caused by habitat fragmentation from infrastructure development activities, plantations, settlements, mining, and others. Therefore, special regulations are needed to regulate development that considers the range of animals, in this case, siamang, to avoid isolation and decline in their populations. Additionally, the construction of animal corridors is also recommended to support the movement of animals in fragmented areas.

4. Conclusions

Siamang has a habitat at an elevation of 683-1,123 masl in Bulu Mario Village. The habitats are found in forest land cover and mixed plantations with a dominant slope of 70.02% and varying temperatures and humidity. The population of this primate at the study site was 44 individuals from 15 groups with a density of 2.88 individuals/km^{2,} while the ratio of adult males to females was 14:12. The number of individuals in the juvenile-2 was less than in other age classes in the number pyramid of individuals in each class, while juvenile-1 was the widest. Therefore, although the regeneration of the siamang population in the study site is still considered good enough, the low density due to the various threats needs more attention and conservation efforts, especially in their disturbed habitat.

Hayu ndolok (*Syzygium* sp.) and *hoteng* (*Quercus gamelliflora*) were the tree species with the highest abundance in forest land cover. At the same time, rubber (*Hevea brasiliensis*) and sugar palm (*Arenga pinnata*) had the highest abundance in mixed plantations. The siamang at the study location used all stratum and was associated with other arboreal mammals. There are 51 plant species from 25 families of the feed plants dominated by Euphorbiaceae. Therefore, trees were the most consumed habitus (94%), with the most consumed part being the fruit (73%).

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Appendix 1. List of siamang feed plant species in the research site

No.	Local Name	Scientific Name	Family	Habitus	Consumed Part
1	Andarasih	*Ficus glandulifera*	Moraceae	Tree	Fruit
2	Andulpak	*Homalanthus populneus*	Euphorbiaceae	Tree	Young leaves, fruit
3	Antuang	*Litsea velutina*	Lauraceae	Tree	Young leaves
4	Aren	*Arenga pinnata*	Arecaceae	Palm	Fruit
5	Asam beling	*Dracontomelon dao*	Anacardiaceae	Tree	Fruit
6	Balik-balik angina	*Agleaea argantea*	Meliaceae	Tree	Young leaves
7	Beringin	*Ficus benjamina*	Moraceae	Tree	Fruit
8	Durian	*Durio zibethinus*	Bombacaceae	Tree	Fruit
9	Gumbot	*Ficus toxicaria*	Moraceae	Tree	Young leaves, fruit
10	Habo	*Archidendron bubalinum*	Fabaceae	Tree	Fruit
11	Hapundung	*Pisonia sp.*	Nyctaginaceae	Tree	Fruit
12	Hole	*Ficus* sp.1	Euphorbiaceae	Tree	Fruit
13	Hopong	*Macaranga sp.*	Euphorbiaceae	Tree	Fruit
14	Hoteng	*Quercus gamelliflora*	Fagaceae	Tree	Fruit
15	Jambu-jambu	*Eugenia fastigiata*	Myrtaceae	Tree	Fruit
16	Jengkol	*Archidendron pauciflocium*	Fabaceae	Tree	Fruit
17	Jomak-jomak	*Trevesia* sp.	Araliaceae	Tree	Fruit
18	Kandis	*Garcinia parvifolia*	Guttiferae	Tree	Fruit
19	Karet	*Hevea brasiliensis*	Euphorbiaceae	Tree	Young leaves
20	Kayu aek	*Jackia ornata*	Guttiferae	Tree	Fruit
21	Kayu pahu	*Engelhardia serrata*	Juglandaceae	Tree	Young leaves
22	Lacat bodat	*Shorea hopeifolia*	Diptrocarpaceae	Tree	Fruit
23	Latong	*Urtica* sp.	Urticaceae	Tree	Fruit
24	Mangga-mangga	*Mangifera* sp.	Anacardiaceae	Tree	Fruit
25	Mayang	*Palaquium sp.*	Sapotaceae	Tree	Young leaves
26	Medang	*Litsea amara*	Lauraceae	Tree	Young leaves
27	Nangka	*Artocarpus heterophyllus*	Moraceae	Tree	Fruit
28	Petai	*Parkia speciosa*	Fabaceae	Tree	Flower, fruit
29	Pirdot	*Saurauia pendula*	Actinidiaceae	Tree	Fruit
30	Randuk	*Alstonia macrophylla*	Apocynaceae	Tree	Fruit
31	Risi-risi	*Ficus* sp.3	Euphorbiaceae	Tree	Fruit
32	Samodaka	*Gordonia multinervis*	Theaceae	Tree	Fruit
33	Sapot	*Macaranga gigantea*	Euphorbiaceae	Tree	Young leaves
34	Simar bawang	*Swintonia pangimain*	Anacardiaceae	Tree	Young leaves
35	Simar loba loba	*Mellettia atropurpurea*	Papaveraceae	Tree	Fruit
36	Simareme eme	*Schefflera aromatica*	Araliaceae	Tree	Fruit
37	Simartolu	*Schima wallichii*	Theaceae	Tree	Fruit
38	Sitarak	*Macaranga lowii*	Euphorbiaceae	Tree	Fruit

Appendix 1. List of siamang feed plant species in the research site (*continuation)*

No.	Local Name	Scientific Name	Family	Habitus	Consumed Part
39	Sitkam	*Bischofia javanica*	Euphorbiaceae	Tree	Fruit
40	Songgak	*Aquilaria malaccensis*	Thymelaeaceae	Tree	Fruit
41	Talun	*Styrax serrulatus*	Styracaceae	Tree	Young leaves, fruit
42	Tambiski	*Eurya acuminata*	Theaceae	Tree	Fruit
43	Tinggiran	*Syzygium* sp.2	Myrtaceae	Tree	Fruit
44	Tipa-tipa	*Bauhinia* sp.	Fabaceae	Tree	Flower, fruit
45	Titinurat	*Litsea* sp.*2*	Lauraceae	Tree	Young leaves, fruit
46	Torop	*Artocarpus elasticus*	Moraceae	Tree	Fruit
47	Ubar	*Shorea pauciflora*	Diptrocarpaceae	Tree	Fruit
48	Pege-pege	*Ficus crassiramea*	Euphorbiaceae	Vine	Fruit
49	Ulason	*Altingia excelsa*	Altingiaceae	Tree	Young leaves
50	Postop	*Ficus sp.4*	Euphorbiaceae	Vine	Fruit
51	Sihim	*Unidentified*	Unidentified	Tree	Fruit

Appendix 2. The three highest IVI in forest

Growth Rate	Ranking	Local Name	Scientific Name	IVI(%)
Seedling	1	Hayu ndolok	*Syzygium* sp.2	35,1
	2	Kopi	*Coffea* sp.	27,41
	3	Kopi-kopi	*Lasianthus constrictus*	12,17
Sapling	1	Hayu ndolok	*Syzygium* sp.2	34,79
	2	Suhul-suhul	*Macaranga bankana*	14,99
	3	Hoteng	*Quercus gamelliflora*	14,95
Pole	1	Hayu ndolok	*Syzygium* sp.2	55,65
	2	Simareme eme	*Schefflera aromatica*	19,07
	3	Hoteng	*Quercus gamelliflora*	18,54
Tree	1	Hoteng	*Quercus gamelliflora*	22,62
	2	Bayur	*Pterospermum blumeanum*	16,88
	3	Medang	*Litsea amara*	16,17

Appendix 3. The three highest IVI in mixed plantation

Growth Rate	Ranking	Local Name	Scientific Name	IVI(%)
Semai	1	Andulpak	*Homalanthus populneus*	52,01
	2	Kopi	*Coffea* sp.	29,71
	3	Lamtoro	*Leucaena leucocephala*	21,98
Pancang	1	Kopi	*Coffea* sp.	20,84
	2	Lamtoro	*Leucaena leucocephala*	18,31
	3	Kulit manis	*Cinnamomum* sp.	15,52
Tiang	1	Karet	*Hevea brasiliensis*	71,26
	2	Sapot	*Macaranga gigantea*	31,13
	3	Andarasih	*Ficus glandulifera*	22,92
Pohon	1	Aren	*Arenga pinnata*	62,54
	2	Durian	*Durio zibethinus*	49,51
	3	Landorung	*Helicteres hirsuta*	28,72